Fromlet, Pia

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Rational Expectations And Inflation Targeting - An Analysis For Ten Countries

Pia Fromlet

Department of Economics
Uppsala University
P.O. Box 513
SE-751 20 Uppsala
Sweden
Fax: +46 18 471 14 78

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Rational Expectations And Inflation Targeting
-An Analysis For Ten Countries*

Pia Fromlet†
2010-09-17

Abstract: In this paper I evaluate inflation targeting for ten countries. The evaluation is based on unconditional as well as conditional measures of the variance of inflation around target. With strict inflation targeting, expectations of the future deviation from target given information about the deviation from the target today should be equal to zero. Using the Consumer Price Index (CPI) when calculating the inflation rate, I find that the null hypothesis can be rejected for six of ten countries. In an extended approach I add lagged output gap as an information variable for countries where data was available. I then get the result that rational expectations and strict inflation targeting can be rejected for five countries. Out of the ten countries, the United Kingdom has conducted inflation targeting most in line with the theory of rational expectations and strict inflation targeting, and Poland the least.

Keywords: Inflation targeting, rational expectations, monetary policy
JEL Classification: E31, E52, E58

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1 Introduction

Since the early 1990s an increasing number of countries have adopted an inflation targeting framework when conducting monetary policy. Inflation targeting is a framework for monetary policy involving a public announcement of a quantitative target or target range for the inflation rate over one or more time horizons. Further, the announcement is often accompanied by an explicit acknowledgement that the primary long-run goal of monetary policy is low and stable inflation (Bernanke, Laubach, Mishkin and Posen, 1999). The pros and the cons of inflation targeting have been the topic of several academic research discussions. The positive aspects of inflation targeting are that it provides a nominal anchor for the path of the price level, it is easily understood by the public which results in low inflation expectations and lower nominal interest rates, and it reduces the pressure from government and private sector on the monetary authorities to pursue short-run output gains which could result in the time inconsistency problem. The negative aspects of inflation targeting are the inability of the monetary authorities to control inflation because of the uncertain effects of monetary policy on inflation, the time duration before evaluating the success of monetary policy in achieving its inflation target because of long lags of the effect of monetary policy on inflation, and the interpretation of inflation targeting as a strict rule that may preclude concern about output stabilization (Mishkin and Posen, (1997) and Bernanke et al. (1999)).

The purpose with this paper is to evaluate the experience of inflation targeting for the first ten inflation targeting countries. More specifically, I try to answer the question of how well the inflation targeting central banks have achieved their objectives when it comes to inflation. Unconditional as well as conditional measures for evaluating inflation targeting are used. The unconditional measure is simply the variance of inflation around target. The assumption behind the conditional measure is that the central bank uses all the available information when making forecasts of inflation around the target. More specifically, I test the theory of rational expectations and strict inflation targeting. Strict inflation targeting implies that inflation is the only variable that matters. Rational expectations and strict inflation targeting means that central banks' expectations of the future deviation of the inflation rate from its target given all available information today should be equal to zero. As a starting point, I assume that the only available information that the inflation targeting central banks use when they make their forecasts is today's inflation rate. Thus, testing the theory of rational expectations and strict inflation targeting implies testing the hypothesis that central banks' expectations are rational, i.e. that the deviation between future inflation and the inflation target is uncorrelated with inflation today. If the deviation of the future inflation rate from its target is correlated with inflation today, one can conclude that either monetary policymakers have had other objectives in addition to minimizing future inflation rate or they have made systematic forecasting errors.

The paper proceeds as follows: In section 2 some earlier approaches regarding inflation targeting countries will be mentioned. Inflation targeting has become a popular topic in the literature since the mid 1990s, most of which focuses on the implementation and the success of inflation targeting as a monetary policy strategy. Section 3 entails the presentation of the ten inflation targeting countries used in this analysis, their start of using inflation targeting as a monetary policy framework, the targets etc. Section 4 and 5 entail unconditional as well as conditional measures

for evaluating inflation targeting. Also, section 5 entails the presentation of the model, the data underlying the empirical approach, some empirical results using the inflation rate and both the inflation rate and lagged output gap as information variables, and some ranking of the inflation targeting countries in terms of some joint hypothesis testing and standard deviations of expected inflation from target. Finally, in section 6 some concluding remarks are being presented.

2 Earlier Approaches

Inflation targeting has been adopted in an increasing number of countries since the early 1990s. The literature analyzing the inflation targeting framework has become quite substantial. The number of papers analyzing the implementation and evaluation of inflation targeting is huge. Below , I shall mention some of these approaches.

Svensson (1997), argues that potential problems concerning the implementation and monitoring of the inflation target can be solved by forecast targeting. The central bank's ideal intermediate target is the inflation forecast. The inflation forecast is most correlated with the goal, it is more controllable than the goal, and it can be made very transparent implying that the central bank's communication with the public can be facilitated. Targeting the inflation forecast implies that the central bank should adjust the interest rate so that the inflation forecast, for say two years, equals the target. The notion of no deviation between the inflation forecast and the target rests on the assumption that inflation targeting is a single goal, i.e. that the inflation rate is the only variable in the central bank's period loss function. Additional goals, such as output or employment stabilization, motivate temporary deviations of the inflation forecast from the inflation target. When there is a conflict between different objectives, the central bank should let the inflation forecast return gradually to the long-run inflation target. The view that the optimal policy rule is a forecasting targeting rule is also shared by Giannoni and Woodford (2003) and Woodford (2004). Further, in another paper from 1997, Svensson extends the formal analysis of inflation targeting to a small open economy. The paper compares different variants of inflation targeting, for example strict and flexible inflation targeting of CPI and domestic inflation (defined as the deviation of log gross domestic inflation from a constant inflation target), and inflation targeting reaction functions and the Taylor rule. The main finding from the paper is that flexible inflation targeting stabilizes CPI inflation at a longer horizon and compared to strict inflation targeting it results in less variability in other variables.

In Mishkin and Posen (1997) and Ball and Sheridan (in Bernanke and Woodford, 2005) the actual experience of inflation targeting is being analyzed. Mishkin and Posen (1997) examine the adoption, operational design, and experience of inflation targeting as a framework for monetary policy in three inflation targeting countries: New Zealand, Canada, and the United Kingdom. Further, the authors also analyze the monetary framework in Germany, since the country shares many of the features of later inflation targeting regimes. In all three inflation targeting countries, there was a public announcement of numerical targets for inflation. The design of the inflation target allowed for a high degree of flexibility in that real output was taken into consideration. All three countries also allowed deviations from the target in response to supply shocks. This type of discretion on the

part of the central bank works efficiently only when the central bank communicates to the public the distinction between movements in trend inflation and onetime events. In fact, the authors stress that improvements in communicating monetary policy actions have been crucial to the success of inflation targeting. They conclude that inflation targeting in New Zealand, Canada and the United Kingdom has been a useful strategy when conducting monetary policy. All three countries have been able to maintain inflation at historically low levels without negative consequences with respect to output stabilization. Ball and Sheridan (2005) look at the effects of inflation targeting on macroeconomic performance. They include twenty Organization for Economic Cooperation and Development (OECD) countries in their analysis. Seven of these twenty countries have adopted inflation targeting during the 1990s and thirteen countries are non-inflation targeters. The authors find no evidence that inflation targeting, on average, improves macroeconomic performance. Both inflation targeting countries and countries that have not adopted inflation targeting have experienced falling and more stable inflation rates and more stable output growth since the early 1990s. The better macroeconomic performance must, thus, result from something other than inflation targeting. Also, the authors find no effect of inflation targeting on the level of long-term interest rates and the variability of short-term interest rates controlled by the monetary policymakers.

In table 1 there is a brief description of the ten inflation targeting countries studied in this analysis, the start of the inflation targeting framework, their current inflation targets and target horizons. Medium term means that the countries have target horizons of two years or more.[1]

Table 1: Inflation Targeting Countries, the Adoption Of IT , the Targets And Target Horizons

Country	**Adoption Of IT**	**Current IT**	**Current Target Horizon**
New Zealand	March 1990	$1-3\%$	Medium term
Chile	September 1990	$3\%\,(\pm 1\%)$	Around two years
Canada	February 1991	$1-3\%$	Six-eight quarters
Israel	January 1992	$1-3\%$	Over next twelve months
United Kingdom	October 1992	2%	At all times
Sweden	January 1993	$2\%\,(\pm 1\%)$	Two years
Australia	April 1993	$2-3\%$	Medium term
Czech Republic	January 1998	$3\% \pm 1\%$	From 2010 until euro entry
Korea	April 1998	$3\% \pm 0.5\%$	Three years
Poland	January 1999	$2.5\%\,(\pm 1\%)$	Medium term

[1] The term "medium term horizon" is specified in the monetary policy objective of the central banks.

3 The Framework For Inflation Targeting In the Ten Included Countries

In the following pages I briefly describe the ten inflation targeting countries, the adoption of inflation targeting, past and current inflation targets, and the inflation targeting framework. For the already informed reader it is possible to skip this section and go directly to section 4.

New Zealand

Adoption Of Inflation Targeting, Past And Current Targets

Zealand was the first country to adopt an inflation targeting regime in 1990. The decision to adopt inflation targeting was made after a period of substantial disinflation and poor economic performance. The first target called for achieving inflation in the range $0-2\%$ by December 1992 and price stability thereafter. This annual rate between 0 and 2% was perceived to be consistent with the goal of price stability. However, since inflation cannot be perfectly controlled the inflation band was widened at the end of 1996 from 0% to 2% to 0% to 3%. In September 2002 there was a narrowing of the band again to $1\%-3\%$ which still is the target today. The different targets for New Zealand are reported in table 2.

Inflation Targeting Framework

Inflation targeting in New Zealand was the result of a legislation mandating a Policy Targets Agreement (PTA) between the government and the newly independent central bank. This independence grants the Reserve Bank of New Zealand the right to set short term interest rates. Each PTA between the government and the central bank has resulted in different targets for inflation. From the start of the inflation targeting framework, the target was defined in terms of annual rises in CPI. In December 1997, however, there was a change in the definition of the inflation target in terms of annual rises in CPI to annual rises in CPIX. CPIX is defined as All Groups Consumer Price Index excluding Credit Services (such as interest rates). With the removement of the interest rates from the CPI, there was a shift back to defining the inflation target in terms of annual rises in CPI in October 1999. Further, the PTA entail escape clauses that allow the Reserve Bank to take into account first-round effects of certain shocks on prices. The purpose of the escape clauses is to balance the inflation target goal with other macroeconomic goals such as short-run stabilization of real output and employment in the event of a supply shock. With exception for these escape clauses, there has been relatively little room for discretionary short-run actions exercised by the Reserve Bank. Further, the Governor must report on inflation performance twice each year. If the inflation rate falls outside the specified target band, the Governor can even be dismissed before the end of his appointment (Bernanke et al. 1999). The room for discretionary policy in the short run, however, was increased in December 1999. In addition to pursuing the primary objective of price stability the Reserve Bank should seek to avoid unnecessary instability in output, interest rates and the exchange rate (Policy Targets Agreement, PTA, December 1999, Reserve Bank of New Zealand).

Table 2: Inflation Targets In New Zealand

Inflation Targets	Set in
$0-2\%$	March 1990
$0-2\%$	December 1992
$0-3\%$	December 1996
$0-3\%$	December 1997
$0-3\%$	December 1999
$1-3\%$	September 2002
$1-3\%$	May 2007

Chile

Adoption Of Inflation Targeting, Past And Current Targets

Chile implemented inflation targeting in September 1990. Initially, inflation targets were set annually every September for next year's December/ December inflation until the year of 2001 when the inflation target was set as a target range of $2-$ 4% onward (Valdés, 2007). The new target for the following year was only moderately lower than the preceding one, reflecting the Central Bank's gradual approach in achieving the goal of price stabilization. The first target, a $15-20\%$ target range for the December 1990-1991 CPI inflation rate can be interpreted as a hard policy target since inflation was as high as 27% in 1990. This target for inflation represented the central bank's strong commitment in reducing inflation (Schmidt-Hebbel and Tapia, 2002). The different inflation targets in terms of headline CPI for different years in Chile are listed in table 3 below.

Inflation Targeting Framework

In the process of inflation targeting, Chile passed a new legislation which gave independence to the Central Bank in 1989. This independence implies that the Bank of Chile has the right to set both the inflation targets and short term interest rates. Inflation targeting was perceived as the right measure to bring inflation down from 27% in 1990 to a stationary level of 3% and at the same time enhance credibility of monetary policy. However, during the first nine years of inflation targeting there was a nominal objective for the exchange rate as well in terms of an exchange rate band. In September 1999, the exchange rate objective was abandoned and a free-floating regime was adopted (Bank of Chile). In the beginning, inflation targeting was more interpreted as official projection rather than as hard targets. Only when it became clear that the inflation objectives were actually met and that inflation had been lowered from historically high levels, there was a hardening of the inflation targets. Another feature of the inflation targeting framework in Chile is the very gradual approach in lowering the inflation objectives. When inflation targeting was adopted the target was stated in terms of a range of $15-20\%$. Since then there has been a gradual reduction of the targets over the years to a point target of 3% from 2001 onwards. As part of the process of hardening the inflation targets, there was a switch from target ranges to point targets in September 1994 (Mishkin, 2000). This switch to point target emphasizes price stability as the main objective of monetary policy. However, as long as the objective of price stability is fulfilled there is room for stabilizing short run output as well. Finally, it is worth emphasizing the different target horizons for the monetary policy conducted in Chile. In the beginning, inflation targets were set for the next twelve months. Since the year of 2000, however, the monetary policy has been

more focused on the medium term. A monetary policy horizon over the medium term implied a 12-24 months inflation targeting focus in 2000-2006 and around two years since 2007 (Valdés, 2007)

Table 3: Inflation Targets In Chile

Inflation Target	**Start Of Different Inflation Targets**
$15-20\%$	December 1990
15%	December 1991
$10-20\%$	December 1992
$9-11\%$	December 1993
9%	December 1994
6.5%	December 1995
5.5%	December 1996
4.5%	December 1997
4.3%	December 1998
3.5%	December 1999
$2-4\%$	2001 onward

Source: González et al. 2003

Canada

Adoption Of Inflation Targeting, Past And Current Targets

The circumstances under which Canada adopted inflation targeting as a monetary framework were the same as those in New Zealand: poor performance of the domestic economy. Canada adopted inflation targeting in a period when inflation was already falling, which made it more likely for the inflation target to be met. Inflation targeting started in 1991; more specifically, there was an announcement of a series of inflation target bands with a width of 2 percentage points for the coming years. The first goal specified a reduction of inflation to 3% at the end of 1992, then to 2.5% at the end of June 1994, and finally to 2.0% at the end of 1995. In December 1993, there was an extension of the inflation targeting range to the end of 1998. The target range was $1-3\%$. In February 1998, this target range of $1-3\%$ was extended again to the end of 2001. The 2% target midpoint has been used since then (Bank of Canada).

Inflation Targeting Framework

In Canada, there is a joint decision about the inflation target by the government and the central bank. However, the Bank of Canada conducts monetary policy independently in that it has control over the short term interest rates. The Minister of Finance cannot dismiss the Governor. However, it is possible to issue a "policy directive". A central feature of the inflation targeting framework in Canada is the strong element of transparency and communication of the central bank's monetary policy actions to the public. Another important characteristic is the flexibility of the inflation targeting regime. Real output growth and fluctuations are taken into consideration when conducting monetary policy. The official measure used as the target is the CPI inflation rate. However, a core inflation rate excluding food, energy, and the effects of changes in indirect taxes has also been used when looking at the medium run prospects for the inflation rate (Bernanke et al. 1999).

Israel

Adoption Of Inflation Targeting, Past And Current Targets

The transition to inflation targeting in Israel was gradual. It began at a time when the Israel economy was in deep crisis with hyperinflation and large fiscal deficits in the mid 1980s. In January 1992, the government set an inflation target for the Israeli monetary policy strategy. The practice has been to announce inflation targets for the end of upcoming calender years. The inflation target, of 14% to 15% inflation in 1992, was initially defined as a narrow range, only 1% wide. The targets for 1993 and 1994 were both stated as point targets (10% and 8%). Since 1995, targets have been defined in terms of broader ranges, with a width of 2% in 1996 (8% to 10%) and 3% in 1995 (8% to 11%),1997 (7% to 10%) and 1998 (7% to 10%). Since 2003, the Bank of Israel has set a midpoint target for the inflation rate equal to 2.0% (Argov et al, 2007). From 2003 onward, the inflation target was defined as inflation in the range of $1-3\%$ over next twelve months.

Inflation Targeting Framework

In the early 1990s, Israel set official targets for both the exchange rate and inflation. However, since 1997, there has been a transition to an inflation targeting regime with a floating exchange rate. Inflation targeting is perceived as the right measure to sustain stable economic growth. The Finance Minister has, in consultation with the Bank of Israel, the task of setting the inflation target. However, the Bank of Israel is strongly independent in that the Governor is appointed by the president of Israel for a term of five years. Also, the Bank of Israel is granted instrument independence, i.e. control over short term interest rates. Every year a new inflation target is set taking into account both political and economic factors. The timing of the announcements of the different targets has varied over the years, implying a tendency of a reduction in transparency and an increase in uncertainty. The inflation target is measured by "headline" CPI which is an all-items index. However, a core CPI excluding, the prices of housing, fruits, and vegetables is reported and taken into consideration as well (Bernanke et al. 1999).

Table 4: Inflation Targets In Israel

Inflation Target	**Year**
$14-15\%$	1992
10%	1993
8%	1994
$8-11\%$	1995
$8-10\%$	1996
$7-10\%$	1997
$7-10\%$	1998
4%	1999
$3-4\%$	2000
$2.5-3.5\%$	2001
$2-3\%$	2002
$1-3\%$	2003 onward

Source: Bank Of Israel

The United Kingdom

Adoption Of Inflation Targeting, Past And Current Targets

The United Kingdom adopted inflation targeting in October 1992, after the foreign-exchange crisis

of September 1992. Inflation targeting was meant to restore a nominal anchor and strengthen the credibility of monetary policy. Like Canada, the United Kingdom adopted inflation targeting during a period when inflation was already falling, increasing the probability of hitting the initial inflation target. The first target was set to the range $1- 4\%$. By late spring 1997, i.e. the end of the present Parliament in May 1997, a point target of 2.5% was adopted. Since 2004 the inflation target has been 2%.

Inflation Targeting Framework

The target was initially defined in terms of the annual change in the retail price index (RPIX) excluding mortgage interest payment. RPIX was the target rate of inflation from October 1992 to April 2003 where there was a switch to specifying the inflation target in terms of the CPI. Before 1997, independence of the Bank of England (BoE) was very limited. Control over the instruments of monetary policy was exercised by the Chancellor of the Exchequer. Instead, the main tasks of the BoE were to forecast inflation and asses past inflation performance. This implied a division of responsibilities between the elected government and the BoE. In May 1997, the new Labour government granted operational independence to the BoE. The BoE was given control over the base rate and of short-term exchange-rate intervention. (Bernanke et al. 1999). The inflation target, however, is set by the government and the Governor of the BoE still has to report inflation performance to the Chancellor whenever necessary. A deviation of the inflation rate of more than one percentage point in either direction requires an open letter from the Governor to the Chancellor explaining the reasons for these deviations and the response of the Monetary Policy Committee for inflation to meet its target. Finally, subject to the main objective of achieving price stability, the BoE is concerned with economic growth and employment as well (Bank of England).

Sweden

Adoption Of Inflation Targeting, Past And Current Targets

Sweden adopted inflation targeting in January 1993, following the exchange rate crisis in November 1992 when the country abandoned its exchange-rate peg. In the early 1990s, Sweden was in deep recession with falling GDP, high unemployment rates and growing government budget deficits. The adoption of an inflation targeting framework was a way to restore a nominal anchor for expectations, as well as communicating the price stability intentions of the policy-makers. The target was defined in terms of the headline CPI and implied an annual inflation rate of 2% with a tolerance up or down of 1 percentage point from 1995 onwards. The 2% target has been used since then.

Inflation Targeting Framework

The adoption of inflation targeting had two objectives, the first of which was to allow monetary policy to take into account domestic objectives, such as short–run output stabilization. The fixed-exchanged rate peg had complicated such domestic considerations in the past. The second objective was to strengthen the public's belief about the long-term orientation of monetary policy. The implementation of the inflation targeting framework in Sweden was more flexible than, for example in New Zealand. In 1999, the Riksbank was granted independence in relation to the Swedish Parliament meaning that the Riksbank sets the inflation target and the interest rates. However, the Parliament still has some control over the Riksbank. For example, the Parliament

chooses the members of the monetary policy delegation, which in turns chooses the members of the Monetary Policy Committee. The head of the Monetary Policy Committee is appointed by the Government. In addition to the main objective of price stability, the Riksbank also takes into account the development in other real factors such as growth, employment and unemployment.

Australia

Adoption Of Inflation Targeting, Past And Current Targets

Inflation targeting was implemented in April 1993. Like in New Zealand, high inflation had been a problem since the late 1980s. The shift in the monetary policy regime was a gradual reorientation of monetary policy towards focusing on price stability as its main objective. The implementation of inflation targeting came from the need to anchor the public's inflation expectations (Pétursson, 2004). The target, which has been the same during the inflation targeting period, was set to a rate of $2-3\%$ over the medium run.

Inflation Targeting Framework

The adoption of inflation targeting was unilaterally decided upon by the Reserve Bank of Australia. Initially, the target was specified in terms of underlying or core inflation to exclude the impact of interest on CPI (Bernanke et al. 1999). From September 1998 onwards the interest charges were removed from the CPI index implying that the CPI could now be used as the headline target. The advantage of using the CPI instead of some underlying measure is that it is widely recognized by the public. This public recognition of CPI might outweigh the disadvantages of using CPI in terms of its greater volatility (Cockerell, 1999). Beside the main objective of achieving an inflation rate of $2-3\%$ per annum over the medium run, monetary policy should be conducted so that strong and sustainable growth in the economy is encouraged (Reserve Bank of Australia). The Reserve Bank of Australia is granted instrument independence, i.e. it sets short term interest rates in order for the medium term inflation objective to be met.

The Czech Republic

Adoption Of Inflation Targeting, Past And Current Targets

The Czech National Bank (CNB) was the first transition economy to adopt an inflation targeting framework in 1998. The decision to adopt inflation targeting was made after the fixed exchange rate regime following the turbulence of the currency in May 1997 was abandoned. The main purpose was to provide the economy with a nominal anchor which it had lost in the exchange rate turbulence in 1997 (Jonas and Mishkin, 2005). The circumstances under which the Czech Republic adopted inflation targeting were somewhat different compared to the other inflation targeting countries, especially the advanced countries. For example, the two-digit inflation in Czech Republic was accelerating at that time. This contrasts to the more advanced inflation targeting countries which adopted inflation targeting when inflation was already falling. By the end of 1997, a medium-term inflation target for end 2000 was announced. This medium term target for end 2000 was an annual net inflation within the range $3.5-5.5\%$. However, to better anchor inflation expectations, the CNB set a target range for net inflation of $5.5-6.5\%$ for end 1998. In November 1998, a target range of $4-5\%$ was set for end 1999. In April 2000 the CNB set a target for end 2001. For the period January 2002-December 2005, the target was set in terms of a continuous

band The inflation targeting band started in January 2002 at $3-5\%$ and ended in December 2005 at $2-4\%$. Assuming that the target decreases linearly for this period it is straightforward to calculate the "new" inflation target for each quarter. For the period of January 2006-January 2009, the inflation target, set in terms of headline inflation, is $3\% \pm 1\%$. The different targets for different time periods are presented in table 5 and 6 below.

Inflation Targeting Framework

The CNB has, since the adoption of inflation targeting, been a relatively independent central bank. This independence is both legally stipulated and implemented practically by the CNB in that there is a clear mandate for the CNB to pursue price stability. The CNB is target as well as instrument independent, meaning it has the right to set both inflation targets and short term interest rates. At the end of 1998, the CNB introduced some "exceptions" that could justify missing an inflation target. These exceptions refer to exceptional and unpredictable events which the CNB cannot control. Examples of these exceptions could be significant differences between actual and predicted world prices of commodities, significant differences between actual and predicted exchange rates not reflecting changes in domestic economic fundamentals and monetary policy, changes in the agriculture conditions causing the agriculture producer prices to change etc. In the beginning of the inflation targeting period, the CNB used "net inflation" when setting inflation targets. Net inflation is CPI adjusted for regulated prices, prices affected by administrative interventions and for indirect tax changes. In April 2001, there was a switch to target inflation in terms of the total consumer price index (Jonas and Mishkin, 2005).

Table 5: Inflation Targets In the Czech Republic

Year	Inflation Target	Target Month	Set In
1998	$5.5-6.5\%$	December 1998	December 1997
1999	$4-5\%$	December 1999	November 1998
2000	$3.5-5.5\%$	December 2000	December 1997
2001	$2-4\%$	December 2001	April 2000
2005	$1-3\%$	December 2005	April 1999

Source: Czech National Bank

Table 6: Inflation Targeting Band In the Czech Republic

	Month	Target Level	Target Month	Set In
Band starts	January 2002	$3-5\%$	January 2002	April 2001
Band ends	December 2005	$2-4\%$	December 2005	April 2001

Source: Czech National Bank

Korea

Adoption Of Inflation Targeting, Past And Current Targets

The Bank of Korea (BOK) adopted an inflation targeting framework in April 1998. In the beginning, the inflation target was defined annually for each year. The BOK set the inflation target, defined as the CPI inflation, for 1998 to be $9 \pm 1\%$. In 1999, the inflation target was set at $3 \pm 1\%$. The targets for 2000 and 2001 were $2.5\% \pm 1\%$ and $3\% \pm 1\%$ respectively. From 2000 there was a shift to a medium-run inflation targeting framework . The medium run target was 2.5% for 2002 and $2.5-3.5\%$ for 2003. For the period 2004-2006 the inflation target was defined as a range of $2.5-3.5\%$. From 2007, the medium-term target was defined as an increase in the consumer price

index of $3\% \pm 0.5\%$.

Inflation Targeting Framework

The 1998 act stipulated that the primary objective of the BOK should be to pursue price stability. As secondary policy objectives, the BOK also pays attention to economic and financial stability. The BOK consults with the government when setting the inflation target and then announces this target to the public. However, the BOK is granted instrument independence in that the BOK sets monetary policy independently. In year 2000, core inflation was adopted as the target indicator. Core CPI is CPI excluding certain non-grain agricultural products and petroleum products, items which can have large short-lived swings in their prices. The weakness of using core CPI as the target indicator is that both agricultural and petroleum products constitute a large share in the cost of living for the typical consumer. This weakness together with the government's use of the CPI as the major price indicator resulted in a shift back to the CPI from 2007 (Sánchez, 2009).

Table 7: Inflation Targets In Korea

Inflation Target	**Year**
$9\% \pm 1\%$	1998
$3\% \pm 1\%$	1999
$2.5\% \pm 1\%$	2000
$3\% \pm 1\%$	2001
2.5%	2002
$2.5 - 3.5\%$	2003
$2.5 - 3.5\%$	2004-2006
$3\% \pm 0.5\%$	2007-2009

Source: Bank Of Korea

Poland

Adoption Of Inflation Targeting, Past And Current Targets

In Poland, the inflation targeting framework was implemented in 1999. The economy had then for some years been experiencing an unfavorable policy mix between fiscal and monetary policy. The fiscal policy was too loose with large fiscal expenditures. As a consequence of this expansionary fiscal policy, inflation increased and monetary policy became contractionary. The adoption of inflation targeting in Poland was perceived as an efficient way to bring down inflation and inflation expectations as a precondition for an EU-membership. In order to fulfill the convergence criteria of a 3% budget deficit as a pre-requisite for an EU-membership, Poland would have to come up with ways to tighten fiscal policy. The idea was that an inflation targeting framework aiming at enhancing credibility for the monetary authority and a tighter fiscal policy would result in a better policy mix, with one policy balancing the other. It should be noted that at the time of the adoption of inflation targeting, Poland still maintained its exchange rate band. However, in April 2000, the exchange rate band was abandoned. The first target for end 1999 was set in the range of $8 - 8.5\%$. Since inflation fell faster than expected, the NBP modified the end 1999 target to $6.4 - 7.8\%$ in March 1999. In September 1999, a medium-term target of 3% ($\pm 1\%$) for the end of 2003 was announced. Also, in September 1999, the NBP set the end 2000 inflation target in the range of $5.4 - 6.8\%$. Since inflation started to increase from the beginning of 1999 to mid 2000, the inflation

target for end 2001 was set higher than in 2000, $6-8\%$. However, the targeted inflation range for end 2002 was reduced to $4-6\%$ (Jonas and Mishkin, 2005). Since the beginning of 2004, the independent National Bank of Poland (NBP) has used a continuous inflation target at the level of 2.5% with a tolerance interval of $\pm 1\%$ (National Bank of Poland). The different inflation targets, set in terms of annual CPI growth rate, are shown in table 8.

Inflation Targeting Framework

The adoption of inflation targeting was the result of an amendment of the Act on the NBP. The Act specified that the primary objective of the NBP was to maintain a stable price level and at the same time support economic policy of the government, as long as the main objective of price stability was not threatened. The Act also established the Monetary Policy Council (MPC) of the NPC. The MPC replaced the NBP Management Board when it came to making important monetary policy decisions. Before the adoption of inflation targeting, there was a high degree of cooperation between monetary and fiscal policy. However, since the adoption of the inflation targeting framework in 1998, monetary and fiscal policy are conducted independently of each other. Also, the NBP is an independent central bank with a clear mandate to set short term interest rates in order to pursue price stability (Jonas and Mishkin, 2005).

Table 8: Inflation Targets In Poland

Inflation Target	**Year**
$6.4-7.8\%$ $(8-8.5\%)$[a]	1999
$5.4-6.8\%$	2000
$6-8\%$	2001
$4-6\%$	2002
$3\% \pm 1\%$	2003
$2.5\% \pm 1\%$	2004 ~

Source: Jonas and Mishkin in Bernanke and Woodfoord, 2005

[a]Initial target in parenthesis

Summary

Inflation targeting has been adopted for industrialized as well as developed economies. Most developing countries adopted inflation targeting during periods when inflation rates were still very high. This implied that targets were set so that they fell gradually over time. When inflation rates became low and stable, these countries employed more constant targets. This is in contrast to a majority of the industrialized economies where inflation targeting was adopted when inflation was already falling. For these countries more constant targets have been employed during the whole inflation targeting period, making the medium to long-run objective of monetary policy somewhat easier to interpret. Although there are differences between the inflation targeting regimes, no central bank can be classified as a strict targeter without concern of real economy. Instead, the inflation targeting countries are concerned with both low inflation and a stable real economy. Thus, they are flexible inflation targeters. Finally, the inflation targeting central banks in the ten countries considered in this analysis are fairly independent in that they exercise control over short term interest rates in order for the price stability objective to be met.

4 Unconditional Measure For Evaluating Inflation Targeting

The unconditional measure for evaluating the experience of inflation targeting is the variance of inflation around target. Here, no assumptions regarding the central bank's preferences and the information it uses when making forecasts of inflation around target are made. I simply look at how much inflation two years ahead has fluctuated around target, i.e. it is assumed that the inflation targeting horizon is two years for all ten countries. As a starting point I use the Headline Consumer Price Index (CPI) when calculating the deviation of the inflation rate from target. In column 2 in table 9, the variance of CPI inflation around target is presented.[2] However, five countries define or have defined their targets in terms of annual rises in other price indices than the CPI. These countries are: New Zealand, the United Kingdom, Australia, the Czech Republic, and Korea. In table 10, the variances of other inflation measures are presented for these five countries in addition to the variance of CPI inflation around target.

From table 9 we see that the variance of CPI inflation around target is the lowest for the United Kingdom and the highest for Israel. In general, the variance of inflation around target seems to be higher for countries which started at high inflation rates and gradually lowered their targets, such as Chile and Israel. Countries which started at lower inflation rates and had more constant targets also have the lowest variance of inflation around target, such as the United Kingdom, Canada, and Sweden.

Table 9: Variance Of CPI Inflation Around Target

Country	**Variance Of CPI Inflation Around Target**
New Zealand	1.641
Chile	8.352
Canada	1.142
Israel	10.508
The United Kingdom	1.101
Sweden	1.769
Australia	2.332
The Czech Republic	4.472
Korea	4.719
Poland	8.798

[2] The variance of CPI inflation around target is calculated according to $\frac{\sum(\pi^C_{t+8}-\pi^*_t)^2}{n}$.

Table 10: Variances Around Target For Countries With Other Target Definitions

Country	Index	Variance Around Target
New Zealand	CPIX	1.247
The United Kingdom	RPIX	0.669
Australia	Core CPI	0.477
The Czech Republic	Index Of Net Inflation	7.055
Korea	Core CPI	4.793

5 Conditional Measure For Evaluating Inflation Targeting

In this paper, the conditional measure for evaluating the experience of inflation targeting implies testing whether the ten countries have conducted monetary policy in line with the theory of rational expectations and strict inflation targeting. Next, the central bank's model of the economy is presented.

5.1 The Model

The inflation targeting central bank's model of the economy looks as follows

$$\pi_{t+\tau} = F\left(i_t, z_t, \eta_{t,t+\tau}\right) \tag{1}$$

where $\pi_{t+\tau}$ is the inflation rate in period $t+\tau$, i_t is the the central bank's "instrument rate", i.e. a short nominal interest rate in period t, z_t is a vector of state variables in period t and $\eta_{t,t+\tau}$ is a set of exogenous shocks between period t and $t+\tau$. The state variables z_t include the inflation rate, the output gap, the inflation target and other variables known by the central bank. The parameter τ is the inflation targeting horizon for the central bank. Today, a majority of the countries have targeting horizons of two years or more. However, this has not always been the case for some countries. For example, in the beginning of the inflation targeting regime the inflation targeting horizon for Chile was one year. As mentioned earlier, to simplify the analysis I assume that the central bank's inflation targeting horizon is two years. This means that if there is an inflation target for the upcoming year today, this target is interpreted as the target for the coming two years as well. The Central Bank's goal is to minimize the expected deviation between the inflation rate τ periods ahead and a pre-specified inflation target π_t^* in period t, i.e.

$$\min E_t\left[\frac{1}{2}\left(F\left(i_t, z_t, \eta_{t,t+\tau}\right) - \pi_t^*\right)^2 \mid z_t\right] \tag{2}$$

Thus, the success of a strict inflation targeting policy can be measured as the ability to minimize the expected deviation of the inflation rate τ periods ahead from the target given information about the inflation rate and the state of the economy in period t. All information available in period t should be used. Taking the derivative with respect to i_t the following first-order condition is derived:

$$E_t\left[\left(\pi_{t+\tau} - \pi_t^*\right)\frac{\partial F\left(i_t, z_t, \eta_{t,t+\tau}\right)}{\partial i_t} \mid z_t\right] = 0 \tag{3}$$

If F is linear the first-order condition becomes:

$$E_t\left[(\pi_{t+\tau} - \pi_t^*) \mid z_t\right] = 0 \tag{4}$$

On the basis of the information available today, the expected inflation rate in period $t+\tau$ should not deviate from the inflation target in period t. Specifically, the deviation should not be correlated with inflation or the output gap today. For instance, if the terms $\pi_{t+\tau} - \pi_t^*$ and π_t are positively correlated the central bank could have reduced the deviation from target by reacting more to π_t. If there is some relation between the deviation of future inflation rate from a pre-specified target and the inflation rate today this contradicts the theory of rational expectations. According to the rational expectations theory, central banks' expectation of future variables are on average correct. The deviations imply that monetary policy could have been conducted in a more restrictive or loose manner.

The analysis is first conducted using only the deviation of the inflation rate from target in period t as the information variable. I then get the following first order condition:

$$E_t\left[(\pi_{t+\tau} - \pi_t^*) \mid \pi_t - \pi_t^*\right] = 0 \tag{5}$$

where π_t^* is taken to be exogenous. This first order condition says that given today's deviation between the inflation rate and the inflation target, the expected deviation between the inflation rate τ quarters ahead and today's target is equal to zero.

5.2 The Data

The baseline analysis is conducted using quarterly data for two variables, the inflation target and the annual inflation rates. The reason for using annual inflation rates is to accomplish a certain seasonal adjustment. In an extension, I also include lagged output gap as an information variable**.** The period for the data collection procedure is two quarters before the starting date of the adoption of inflation targeting (since lagged output data is needed for the analysis) and ends the second quarter of 2009, i.e. 2009Q2. The data is collected from central banks, statistical institutions, and from the OECD. The analysis is conducted for each country's inflation targeting period. I consider the first ten countries that have used inflation targeting as a monetary policy framework.[3] As a starting point, I use CPI for all ten countries. However, as already mentioned, five countries define or have defined their inflation targets in terms of other measures, such as underlying CPI. These other indices will also be included to test the robustness of the estimation results using headline CPI. Finally**,** some countries define their targets in terms of a narrow band, say $2-3\%$. For these countries, I use the midpoint of the band, for instance 2.5%, when calculating the deviation of the inflation rate from the target.

[3] I do not include Finland and Spain in the analysis, which became inflation targeters in 1994 and 1995 respectively. This is because they are members of the Euro project which started in 1999. Including them in the analysis would imply too short a time period when running the regressions in the empirical sections.

5.3 Results Using the Inflation Rate

Rational central banks should conduct monetary policy in such a way that the expected deviation of the future inflation rate from target equals zero given information about the corresponding deviation today. Hence, there should be no correlation between today's deviation of the inflation rate from its target and the deviation τ quarters ahead. I will use eight quarters as the inflation targeting horizon, i.e. $\tau = 8$. To test this hypothesis, I estimate the following equation for all ten countries separately:

$$\pi^C_{t+8} - \pi^*_t = \alpha + \beta\left(\pi^C_t - \pi^*_t\right) + \varepsilon_{t+8} \tag{6}$$

where π^C_{t+8} is the realized annual CPI inflation rate eight quarters ahead, π^*_t is the inflation target in period t, π^C_t is the annual CPI inflation rate in period t, and ε_{t+8} is the unpredictable deviation from target in period $t+8$. In addition, for countries with changed target definitions following equation is also estimated:

$$\pi^R_{t+8} - \pi^*_t = \alpha + \beta\left(\pi^R_t - \pi^*_t\right) + \varepsilon_{t+8} \tag{7}$$

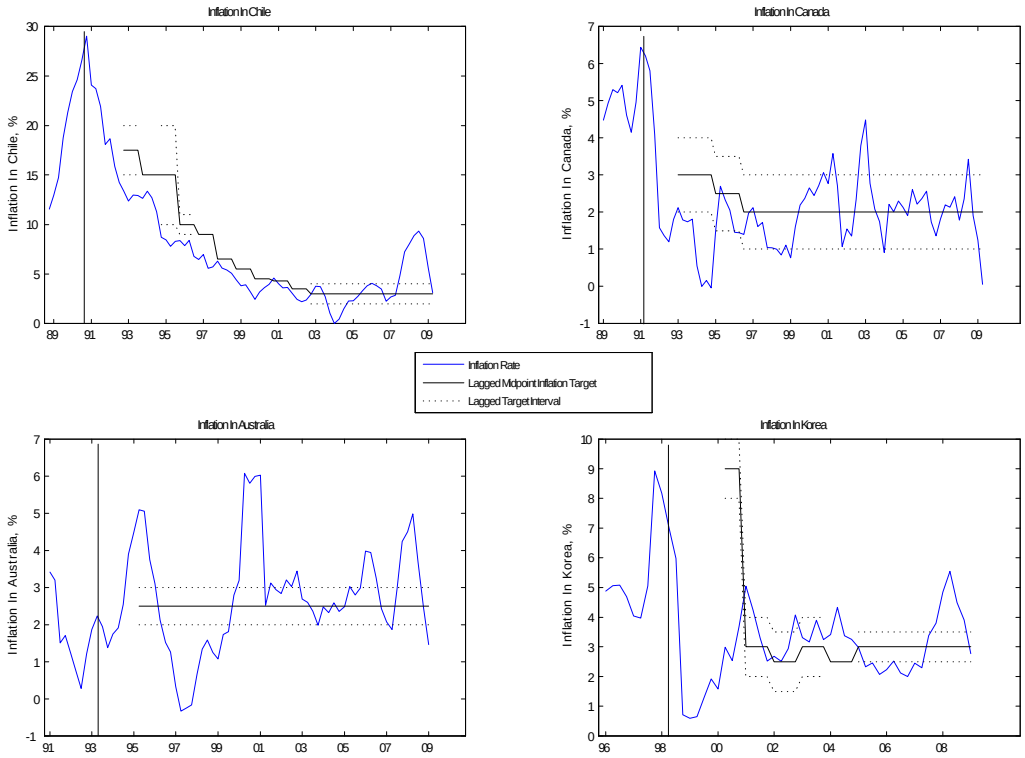
where the variables are the same as in equation(6) with the only exception being that annual inflation rates (i.e. π^R_{t+8} and π^R_t) are calculated using those price indices for which the inflation targets are actually defined. A test of rational expectations and strict inflation targeting implies testing the null hypothesis that α and β are both equal to zero. If I can reject the null hypothesis, I can conclude that central bank is making systematic forecasting errors or has other objectives. The applied method is OLS with Newey-West standard errors since I can reject the null hypothesis of no positive serial autocorrelation in the error terms. Estimation results for equations (6) and (7) are presented in table 11. Column 2 and 3 entail the estimation results using CPI inflation rates.[4] In addition, column 4 and 5 entail the estimation results using other price indices than the CPI when calculating the inflation rates for five of the ten countries.

Starting with the result using CPI inflation rates, I see from column 2 and 3 in table 11 that I cannot reject the null hypothesis of rational expectations and strict inflation targeting for *Chile*, *Canada*, *Australia*, and *Korea.* Figures 1, 2, 3, and 4 illustrate the CPI inflation rate (the solid line), the inflation target band eight periods before (the dashed line), and the starting date for

[4] I also test for the presence of a unit root in the $\left(\pi^C_t - \pi^*_t\right)$ series. The reason for not testing whether the $\left(\pi^C_{t+8} - \pi^*_t\right)$ series is stationary is that both series entail the same variables. The former is todays deviation of the inflation rate from target and the letter is the corresponding future deviation of the inflation rate from target. Thus, both series should have the same properties. So if the $\left(\pi^C_t - \pi^*_t\right)$ series is stationary this should imply that the $\left(\pi^C_{t+8} - \pi^*_t\right)$ series is stationary as well. The applied unit root test is the well-known Augmented Dickey-Fuller (ADF) test. The null hypothesis of a unit root in the $\left(\pi^C_t - \pi^*_t\right)$ series can be rejected for the following countries: New Zealand, Chile, Canada, Sweden, Australia, Israel, and the Czech Republic. The null hypothesis cannot be rejected for the United Kingdom, Korea and Poland. However, the $\left(\pi^C_t - \pi^*_t\right)$ series for these countries should be stationary in order for the inflation targeting policy to make sense. The reason for not being able to reject the null hypothesis of a unit root for these three countries might be the relatively short time period during which inflation targeting has been used. The power of the ADF-test increases with the time span of the data. Thus, the reason for not being able to reject the null hypothesis of a unit root might be due to the low power that the ADF test gives to data with small time spans. This is especially true for countries lika Korea and Poland, where inflation targeting was adopted in the end of the 1990s. Relating the non-stationary properties of the $\left(\pi^C_t - \pi^*_t\right)$ series for the United Kingdom, Poland, and Korea to the low power properties of the ADF-test implies that I estimate equation (6) for the United Kingdom, Poland, and Korea in the same way as I do with the remaining seven countries

the inflation target (the black vertical line). The starting date of the inflation rate is two years before the adoption of the inflation targeting framework. Figure 1 is for those countries with a non-rejection of rational expectations and strict inflation targeting. For these four countries it seem as if there has been no systematic errors when forecasting the deviation of future inflation rate from its target given the theory of rational expectations.

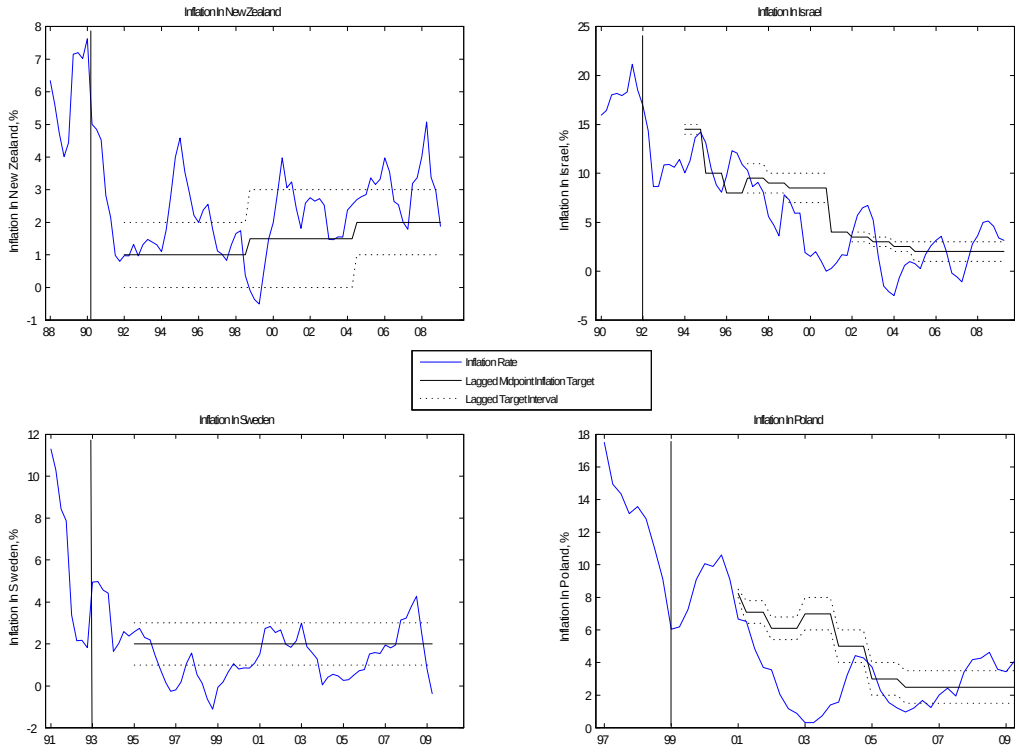
Figure 1: CPI Inflation And (Two Years) Lagged Inflation Targets For Countries With No Significant Variables



Next, I turn to those countries where I can reject the null hypothesis of rational expectations and strict inflation targeting due to the constant being significant, i.e. *New Zealand, Israel, Sweden,* and *Poland*. Significant negative constants imply that the Bank of Israel, the Swedish Riksbank and the National Bank of Poland have made systematically errors when forecasting the deviation of future inflation rate from target, given my null hypothesis of rational expectations and strict inflation targeting. The inflation rate has been systematically below target. This can be seen from Figure 2 which illustrates inflation for New Zealand, Israel, Sweden, and Poland since the adoption of inflation targeting in 1990, 1992, 1993 and 1999 respectively. I see that the inflation rate has been below target for some years in Israel, Sweden and Poland. The inflation rates have even been lower than the lower limit of the tolerance intervals for some years in all three countries suggesting that monetary policy in these three countries has been too contractionary. For example, in Poland, there was a very tight monetary policy and low economic activity resulting in falling inflation in 2001 with subsequent undershooting of the 2001 and 2002 inflation targets. New Zealand was

the first country implementing inflation targeting and among all the included inflation targeting countries, New Zealand is the most rule-based one. We may therefore expect that policy makers in New Zealand should put a large weight on minimizing expected deviations from the target given information about the deviation of inflation from its target today. Thus, the null hypothesis is expected to hold. As can be seen from column 2 and 3 in table 11, this is not the case. The constant is positive and significant at the 1% level. Sticking to the theory of rational expectations, the Reserve Bank of New Zealand has made systematic forecasting errors causing the inflation rate to be systematically above target. This can also be seen from figure 2, where it is clear that for most of the inflation targeting period, the inflation rate has been above target.

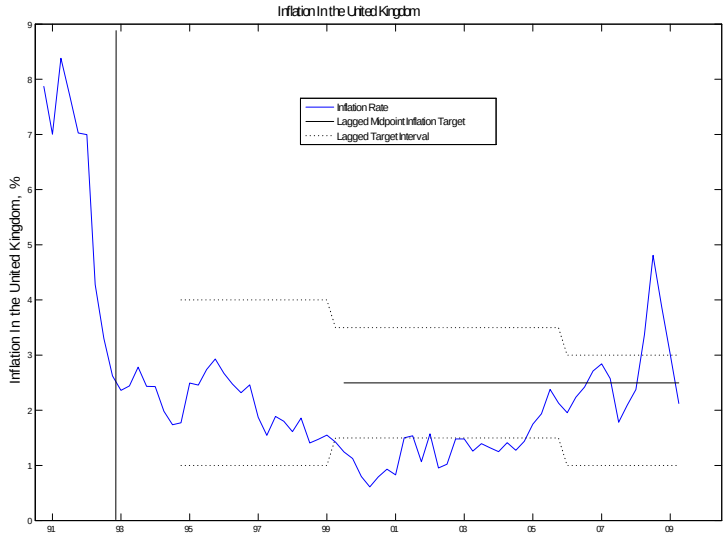
Figure 2: CPI Inflation And (Two Years) Lagged Inflation Targets For Countries With the Constant Being Significant



As a third case, there is the United Kingdom where the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable is significant at the 1% level but the constant is not significantly different from zero. This result indicates that the Bank of England has reacted somewhat too weakly to the deviations between the inflation rate from the target at time t. A positive deviation at time t implies a positive deviation two years ahead as well. In a similar way, a negative deviation at time t implies a negative deviation two years ahead as well. Thus, the deviation of the inflation rate from target is persistent. One possible explanation for this could be the fact that I use CPI inflation rates, whereas the inflation target in the United Kingdom for over ten years was specified in terms of annual rises in the RPIX index (excluding mortgage interest payments). Using CPI as the relevant

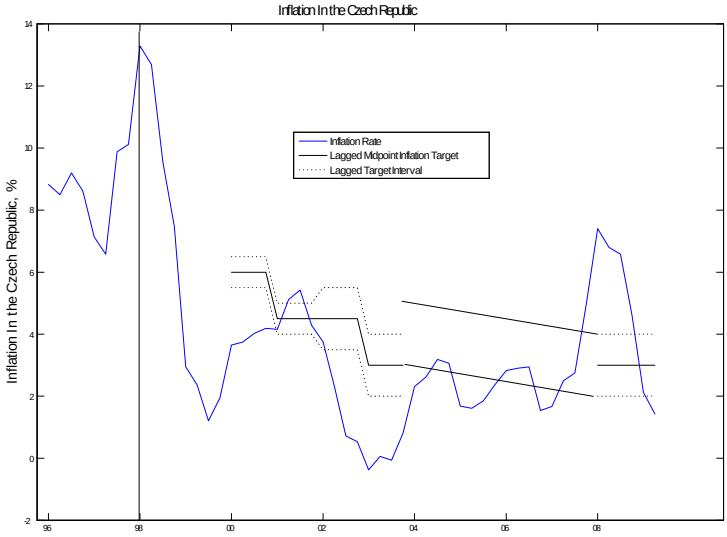
target (as was done here), implies that a rise in the repo rate aimed at bringing inflation lower, would imply raising interest payments on individuals' mortgages, causing higher inflation. Since the adoption of inflation targeting in October 1992, the base rate has fallen from 8% to 0.5% in March 2009. Low interest rates have implied higher increases in the prices of the housing market. Since CPI incorporates these lower interest rates on mortgages, inflation is expected to be on quite low levels. From figure 3 it can be seen that inflation has been at the lower limit of the target range or even lower than the lower limit of the target range for the period 1995-2005. Also, a negative deviation of today's inflation rate from target has implied that the deviation of the inflation rate two years ahead from target is negative as well. Thus, the BoE could have reacted more to today's deviation of the inflation rate from target in order to reduce future deviations. However, as will be shown shortly, these results are not valid when the RPIX index, instead of the CPI, is used when calculating the inflation rates. This supports the view that the low mortgage interest rate payments could have caused the low and persistent CPI inflation.

Figure 3: CPI Inflation And (Two Years) Lagged Inflation Targets For the UK With the Coefficient For the $\left(\pi_t^C\text{-}\pi_t^*\right)$ Variable Being Significant



Finally, the estimation results for the *Czech Republic* show significant values for both the constant and the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable, suggesting that the null hypothesis of rational expectations and strict inflation targeting can be rejected at the 10% level. Not only has inflation been systematically below target, but there has also been a too strong reaction to the deviations between the inflation rate from target at time t. Thus, monetary policy has been somewhat to contractionary in the case of the Czech Republic.

Figure 4: CPI Inflation And (Two Years) Lagged Inflation Targets For the Czech Republic With Both Variables Being Significant



In summary, the estimation results using today's deviation of the CPI inflation rate from target as an information variable implies that the null hypothesis of rational expectations and strict inflation targeting can be rejected for six out of ten countries. However, one has to keep in mind that as a starting point, inflation targets are assumed to be defined in terms of CPI. My next approach is to check what happens to the estimation results in the baseline specification when other price indices are included. For the interested reader, the periods for the initial and modified definitions of the targets are presented in table A1 in Appendix 1.

First, I need to calculate the deviation of the inflation rate two years ahead from the target today, i.e. the $\left(\pi_{t+8}^{R} - \pi_{t}^{*}\right)$ variable. At first, this might look problematic because when the switching to the new target occurs, I have to subtract one series (for example the annual CPI inflation rate two years ahead) from another series (for example the Core CPI inflation target today). However, this is not necessary the case. Suppose there is an unexpected change in the target definition in period t. Instead of targeting core CPI, headline CPI will now be the basis when formulating the inflation target. Since this modification of the inflation target was not expected in period t, the expected deviation of the inflation rate two years ahead from its target in period t will be calculated using core CPI. In period $t+1$, however, this change in the inflation target is known and the expected deviation of the inflation rate two years ahead from its target in period $t+1$ (i.e.$\pi_{t+9}^{R} - \pi_{t+1}^{*}$) will be calculated using headline CPI. Thus, one crucial assumption behind this way of proceeding is that the changes in the definition of the inflation targets are not known in advance.

Looking at column 4 and 5 in table 11, I notice that the result in the baseline specification are not sensitive to which definition of the inflation target one chooses to apply for *New Zealand, Australia*,

and *Korea*. For New Zealand, including the CPIX inflation rates for the years when the inflation target is specified in terms of annual rises in CPIX does not change the estimation results much compared to the case where CPI inflation rates are used for the whole period. Now the constant is significant at the 1% level, a result which is in line with the result for when CPI inflation rates are included for the whole period. For Australia and Korea, including the "real" target definitions for the relevant period results in a non-rejection of the null hypothesis of rational expectations and strict inflation targeting. This was also the case when CPI was used for the whole period.

For the *United Kingdom* and the *Czech Republic*, it seems that the estimation results are not robust to which definition of the inflation target is included. For the United Kingdom, using CPI when calculating the inflation rate and the deviation of the inflation rate from its target today and eight periods ahead results in a rejection of the null hypothesis of rational expectations and strict inflation targeting. Including RPIX for a part of the sample period results in a non-rejection of the null hypothesis of rational expectations and strict inflation targeting. The same is true for the Czech Republic. Including net inflation rates instead of CPI inflation rates implies estimation results that are insignificant. Thus, for the United Kingdom and the Czech Republic it seems that monetary policy has been in line with rational behavior taking into account this other definition of the inflation target.

Thus, for New Zealand, Australia, and Korea the inclusion of other price indices has no effect on the estimation results compared to the results when using CPI inflation rates. However, for the United Kingdom and for the Czech Republic, the inclusion of other indices results in a non-rejection of the null hypothesis of rational expectations and strict inflation targeting, compared to a rejection when CPI was used. Thus, including the correct indices increases the number of countries where monetary policy has been conducted rationally to six. Consequently, in the remainder of this paper estimation results using only these other price indices will be reported for New Zealand, the United Kingdom, Australia, the Czech Republic, and Korea. For the remaining five countries, i.e. Chile, Canada, Israel, Sweden, and Poland, the targets have been defined in terms of annual CPI inflation rates during the whole inflation targeting period and hence estimation results using

annual CPI inflation rates will be reported for these five countries.

Table 11: Estimation Results When the Dependent Variable Is $\pi^C_{t+\tau}-\pi^*_t$ And $\pi^R_{t+\tau}-\pi^*_t$ Respectively.

Country	**Constant**	$\pi^C_t-\pi^*_t$	**Constant**	$\pi^R_t-\pi^*_t$	**Observations**
New Zealand	0.859^{***}	-0.109	0.875^{***}	-0.107	69
	(0.259)	(0.097)	(0.283)	(0.116)	
Chile	-0.957	-0.176			67
	(0.654)	(0.231)			
Canada	-0.261	0.138			66
	(0.207)	(0.195)			
Israel	-1.161^{*}	0.065			62
	(0.662)	(0.233)			
The United Kingdom	-0.012	0.841^{***}	0.140	0.268	59
	(0.252)	(0.222)	(0.121)	(0.224)	
Sweden	-0.629^{**}	0.090			58
	(0.265)	(0.162)			
Australia	0.316	-0.208	0.341	-0.038	57
	(0.340)	(0.252)	(0.239)	(0.215)	
The Czech Republic	-0.977^{*}	-0.186^{*}	-1.268	-0.120	38
	(0.541)	(0.095)	(0.876)	(0.232)	
Korea	0.101	0.563	-0.181	0.427	37
	(0.416)	(0.509)	(0.303)	(0.549)	
Poland	-1.778^{**}	-0.297			34
	(0.756)	(0.209)			

A variable marked by *, **, or *** indicates significance at the 10, 5, and 1% levels, respectively.
Newey-West standard errors reported in parenthesis.

5.4 Results Including Both the Inflation Rate And Lagged Output Gap

Even though the current inflation rate is an important input, it is clearly not the only variable that the central bank uses to decide upon the interest rate. An extension of the analysis is to include further information variables. For example, an inflation targeting central bank may also look at the output gap, defined as the percentage deviation of output to its potential level. I still assume strict inflation targeting, i.e. that future deviations of the inflation rate from target is the only goal variable. One problem with the output gap is that it cannot be directly observed and measured. Instead, it has to be estimated by some estimation method. There are a number of methods to estimate the output gap, such as the well-known Hodrick-Prescott (HP) filter. However, there is a problem using the HP- filter specific for this study, since it assumes that the monetary authorities have access to real time data, i.e. available data at the time of the policy making decisions. Thus, I need a method to estimate output gap in real time. Remember that according to the rational expectations theory it is assumed that agents use all available information at the current date when predicting future variables. Since output data is revised and available only with a lag I assume

that the monetary authorities have access to real output data with a lag of two quarters.

For five of the ten inflation targeting countries included in this analysis, GDP data are available from late 1970s onwards.[5] Due to lack of data availability I exclude Chile, Korea, the Czech Republic and Poland from this extended approach, i.e. these countries are only included in the baseline analysis. In this paper, lagged output gap will be estimated by a sliding window approach, i.e. giving a constant weight to each observation. The sliding window approach can be described as follows. First, I drop the first ten observations and estimate a linear trend to the quarter six months before the adoption of inflation targeting. Next, I drop the first eleven observations and estimate a linear trend to the quarter three months before the adoption of inflation targeting. This implies including 41 observations in the estimation procedure irrespective of the quarter estimated. The linear trend estimation is repeated for all quarters included in the sample. These iterated measures of potential output then constitute the potential output series. The procedure when including 41 observations when estimating potential output and the following output gap series is referred to as window 1. The reason for including 41 observations in the estimation procedure is that I want to exclude temporary deviations from the trend while still being able to pick up actual changes in the trend itself. The number of observations included in the sliding window approach will be the same for all six included inflation targeting countries. After iterating the potential output series, output gap is calculated by taking the percentage deviation of output from its potential level

The estimation results using window 1 will decisive for whether I reject or not reject the null hypothesis of rational expectations and strict inflation targeting. However, as a robustness check I will include further measures of the lagged output gap. If these measures and their implications for the estimation results differ significantly from the first output gap measure (i.e. window 1) it might be due to, for example, a non-linear trend or a structural break in the GDP series. It might be interesting to test if the results depend on which output gap measure one applies. Window 2 is an output gap measure narrowing the sliding window by including only 31 observations when estimating potential output. Window 3 is an estimation method where 26 observations are included in the estimation procedure.

The GDP data are collected from the OECD databases and are in constant prices with national base years. For Israel, the GDP data are obtained from the website of the Bank of Israel, which publishes current GDP levels. In order to get historical levels, I calculate them through the quantity changes which are also available at the Bank of Israel website. Finally, the GDP data for all

[5] For New Zealand quarterly GDP data is not available until the second quarter of 1987. However, I approximate quarterly GDP numbers for the first eight years (since I want GDP data from the last quarter of 1979 onwards) by using an industrial production index, using the fact that the correlation between GDP and industrial production is known to be high. For those year when quarterly GDP data is available I estimate the following equation:

$$\frac{GDP_t - \overline{GDP_t}}{\overline{GDP_t}} = \alpha + \beta \left(\frac{IND_t - \overline{IND_t}}{\overline{IND_t}} \right) + \varepsilon_t$$

where GDP_t and IND_t are GDP and industrial production index in quarter t. Further, $\overline{GDP_t}$ and $\overline{IND}_t$ is average GDP and industrial production index for the calendar year in quarter t. The estimation results from the equation above is then used to calculate quarterly GDP for the first missing eight years. I simply use the estimates for α and β in the equation above together with average GDP and industrial production index for the calendar year in quarter t ($\overline{GDP_t}$ and $\overline{IND}_t$), and the industrial production index in quarter t (IND_t) in order to obtain quarterly GDP (GDP_t) numbers for the first eight years.

ten countries are seasonally adjusted.

The following equation is estimated for those countries which have defined their targets in terms of CPI inflation rates during the whole inflation targeting period:

$$\pi_{t+8}^{C} - \pi_{t}^{*} = \alpha + \beta_1 \left(\pi_{t}^{C} - \pi_{t}^{*}\right) + \beta_2 \hat{y}_{t-2} + \varepsilon_{t+8} \tag{8}$$

where $\hat{y}_{t-2}$ is the output gap in period $t-2$. As in the previous estimations, π_{t+8}^{C} is the CPI inflation rate eight quarters ahead, π_{t}^{*} is the inflation target in period t, π_{t}^{C} is the CPI inflation rate in period t, and ε_{t+8} is the unpredictable deviation from target in period $t+8$. For those countries with changed definition of the inflation targets the following equation is estimated:

$$\pi_{t+8}^{R} - \pi_{t}^{*} = \alpha + \beta_1 \left(\pi_{t}^{R} - \pi_{t}^{*}\right) + \beta_2 \hat{y}_{t-2} + \varepsilon_{t+8} \tag{9}$$

where the variables are the same as in equation (8) with the only exception being that annual inflation rates (i.e. π_{t+8}^{R} and π_{t}^{R}) are calculated using those price indices for which the inflation targets are defined. Again, the applied method is OLS with Newey-West standard errors since I can reject the null hypothesis of no positive serial autocorrelation in the error terms for all six countries. [6]

The results are reported in table 12 and 13. Column 2-4 are for countries with unchanged target definitions, i.e. where the targets have been defined in terms of annual rises in the CPI during the whole inflation targeting period. Column 5-7 are for countries with changed target definitions. Starting with *New Zealand,* the estimation results using window 1 show that the inclusion of the lagged output gap as an information variable does not change the results compared to the baseline specification. In the extended specification I get the result that the constant is significant at the 1% level, the same result as in the baseline specification when using the CPIX index. Using window 2 and 3 results in both the constant and the coefficient for the $\left(\pi_{t}^{R} - \pi_{t}^{*}\right)$ variable being significant at the 1 and 10% levels respectively. Thus, the estimation results are not robust to which measure of the lagged output gap one chooses to apply.

The estimation results for *Canada* are somewhat different compared to the estimation results when I include only today's deviation of the inflation rate from target as an independent variable. The theory of rational expectations and strict inflation targeting can now be rejected, which was not the case in the baseline specification. Using window 1 and 2 results in both the constant and the coefficient for the lagged output gap being significant. The two windows, however, differ with respect to their significance levels for the constant. The constant is significant at the 5% level

[6] In addition to testing for unit root in the $(\pi_t - \pi_t^*)$ series I also test for the presence of unit root in the lagged output gap series. I can reject the null hypothesis of a unit root in the lagged output gap $\left(\hat{y}_{t-2}\right)$ series for the United Kingdom. I cannot reject the null hypothesis of a unit root in the lagged output gap series for the five remaining countries, i.e. New Zealand, Canada, Israel, Sweden, and Australia. However, the output gap series should be stationary since the difference between output and potential output, which both are non-stationary series, should be stationary. Further, the output gap is mean reverting implying that output reverts to its potential by the end of one or more business cycles. One explanation of the contradicting test results in this paper could be that the power of the ADF-test is too low because of the relatively short time periods included in the estimation procedure. Therefore, I run equations (8) and (9) and assume that the output gap series have stationary properties over the longer run.

using window 1, whereas using window 2 results in the constant being significant at the 10% level. As can be seen from table 12, the estimation results for Canada using window 3 are different from window 1 and 2 in that only the coefficient for the lagged output gap is significant. However, the rejection of rational expectations and strict inflation targeting is valid for all three windows in the case of Canada.

Also for *Israel*, I can reject the theory of rational expectations and strict inflation targeting when equation (8) is estimated. Using window 1 results in the constant being significant at the 5% level. This result is in line with the baseline specification since the theory of rational expectations and strict inflation targeting can be rejected due to the constant being significant in both cases. The estimation results using window 2 and 3 are different from the results using window 1. Now both the constant and the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable are significant. However, the coefficient for the lagged output gap is more significant using window 3 instead of window 2. The constant is significant at the 5% level for both window 2 and 3.

Next, I turn to the United Kingdom. Using window 1 results in a rejection of the theory of rational expectations and strict inflation targeting since the coefficient for the lagged output gap is significant at the 10% level. This result is not in line with the baseline specification since the baseline specification using the RPIX index do not reject the null hypothesis of rational expectations and strict inflation. The estimation results using window 2 and 3 do not reject the theory of rational expectations and strict inflation targeting. Thus, the estimation results differ somewhat depending on which measure of lagged output gap is used.

For *Sweden* the null hypothesis of rational expectations and strict inflation targeting can be rejected since the constant in the extended specification is significant at the 5% level. Also, adding lagged output gap as information variable implies estimation results identical to the baseline specification since only the constant is significant in both cases. Further, from table 13, one can conclude that the estimation results are not sensitive to which measure of the lagged output gap one chooses to apply, since only the constant takes a significant value for all three windows.

Finally, I look at the estimation results for Australia. When including both today's deviation of the inflation rate from target and lagged output gap I get the result that the theory of rational expectations and strict inflation targeting cannot be rejected for all three windows. This result is

in line with the baseline approach using the core CPI index.

Table 12: Estimation Results When the Dependent Variable Is $\pi^C_{t+\tau}-\pi^*_t$ And $\pi^R_{t+\tau}-\pi^*_t$ Respectively.

Country	**Constant**	$\pi^C_t-\pi^*_t$	$\hat{y}_{t-2}$	**Constant**	$\pi^R_t-\pi^*_t$	$\hat{y}_{t-2}$	**Observations**
New Zealand							
Window 1				0.991***	−0.122	−0.076	69
				(0.272)	(0.120)	(0.066)	
Window 2				1.026***	−0.168*	−0.085	69
				(0.255)	(0.097)	(0.067)	
Window 3				0.971***	−0.164*	−0.042	69
				(0.269)	(0.097)	0.060	
Canada							
Window 1	−0.323**	0.102	0.204***				66
	(0.152)	(0.091)	(0.055)				
Window 2	−0.286*	0.190	0.216***				66
	(0.168)	(0.118)	(0.083)				
Window 3	−0.287	0.216	0.230**				66
	(0.175)	(0.141)	(0.101)				
Israel							
Window 1	−1.312**	0.064	0.139				62
	(0.655)	(0.228)	(0.145)				
Window 2	−1.397**	0.088	0.355*				62
	(0.644)	(0.227)	(0.207)				
Window 3	−1.427**	0.120	0.446**				62
	(0.635)	(0.235)	(0.222)				

A variable marked by *, **, or *** indicates significance at the 10, 5, and 1% levels, respectively.
Newey-West standard errors reported in parenthesis.

Table 13: Estimation Results When the Dependent Variable Is $\pi^C_{t+\tau}-\pi^*_t$ And $\pi^R_{t+\tau}-\pi^*_t$ Respectively.

Country	Constant	$\pi_t-\pi^*_t$	$\hat{y}_{t-2}$	Constant	$\pi^R_t-\pi^*_t$	$\hat{y}_{t-2}$	Observations
The United Kingdom							
Window 1				0.185	0.187	-0.076^*	59
				(0.119)	(0.229)	(0.041)	
Window 2				0.156	0.266	-0.032	59
				(0.125)	(0.229)	(0.046)	
Window 3				0.122	0.267	0.038	59
				(0.125)	(0.224)	(0.036)	
Sweden							
Window 1	-0.635^{**}	0.197	0.066				58
	(0.273)	(0.195)	(0.071)				
Window 2	-0.620^{**}	-0.020	-0.090				58
	(0.256)	(0.143)	(0.072)				
Window 3	-0.606^{**}	0.001	-0.105				58
	(0.252)	(0.141)	(0.088)				
Australia							
Window 1				0.612	-0.025	0.042	57
				(1.119)	(0.178)	(0.144)	
Window 2				-0.838	-0.088	-0.174	57
				(1.013)	(0.217)	0.136	
Window 3				-0.763	-0.073	-0.159	57
				(0.996)	(0.218)	(0.136)	

A variable marked by *, **, or *** indicates significance at the 10, 5, and 1% levels, respectively.
Newey-West standard errors reported in parenthesis.

In summary, including the lagged output gap implies estimation results that are rather sensitive to which of the three measures of the lagged output gap is being used. However, the main findings in terms of a rejection of the null hypothesis of rational expectations and strict inflation targeting are the same for all three windows for a majority of the countries. Only for the United Kingdom, the three windows results in different conclusions in terms of whether the null hypothesis can be rejected or not.

5.5 Ranking Of the Inflation Targeting Countries For the Baseline Case

The estimation results from equations(6) - (9) show whether the null hypothesis of rational expectations and strict inflation targeting can be rejected or not. Based on these estimation results, it is interesting to do some ranking of the ten inflation targeting countries included in this analysis. I do the ranking only for the baseline case, since all ten countries are included here. The ranking should be based mainly on the the joint hypothesis that the constant and the coefficients for the $\left(\pi^C_t-\pi^*_t\right)$ and $\left(\pi^R_t-\pi^*_t\right)$ variable in equations (6) and (7) are simultaneously equal to zero. Thus, I test the hypothesis that $\alpha=\beta=0$.[7] Test results are reported in column 4 in table 14. I also

[7] I apply the Wald test when testing the null hypothesis that $\alpha=\beta=0$. The results from this test should, however, be viewed as illustrative and for comparison reasons only. This is because I have used Newey-West standard errors when estimating equations (6) and (7). The reported F-statistic from the Wald test is only valid when the residuals are i.i.d. which apparently is not the case here. However, since this is the case for all ten countries

present the estimation results for equations (6) and (7) in column 2 and 3. For New Zealand, Chile, Sweden, the Czech Republic, and Poland the null hypothesis that $\alpha = \beta = 0$ is rejected. For four of these five cases, it is clear from column 2 in table 14 that inflation has been below target. For Canada, Israel, the United Kingdom, Australia, and Korea the null hypothesis that $\alpha = \beta = 0$ cannot be rejected.

Also, I do some ranking based on standard deviations of expected inflation from target.[8] The reason for calculating these standard deviations is that these results should be in line with the ranking results in column 4 in table 14. For countries where the null hypothesis that $\alpha = \beta = 0$ is rejected, standard deviations of expected inflation from target should be higher and vice versa. With the exception of Israel, we see that this is also the case. The standard deviations of expected inflation from target are presented in column 5 in table 14. If the standard deviation of expected inflation is high, this could probably have been reduced had the central bank conducted monetary policy more in line with the theory of rational expectations and strict inflation targeting. We have the following ranking order with the best performer represented by the lowest number and the worst performer represented by the highest ranking number: The United Kingdom (1), Canada (2), Australia (3), Korea (4), Sweden (5), New Zealand (6), the Czech Republic (7), Chile (8), Israel (9), and Poland (10). One can tell that the standard deviations of expected inflation from target are higher for those countries which adopted inflation targeting at high inflation rates and then gradually lowered the targets, for example Chile and Israel. The standard deviations of expected inflation from target are lower for those countries which adopted inflation targeting when inflation rates where already falling and the targets have been relatively constant, for example the United Kingdom and Australia.

On the basis of these ranking results it is clear that among the ten countries, the United Kingdom has conducted monetary policy most in line with the theory of rational expectations and strict inflation targeting. Poland is the country where monetary policy has been the least in line with

and I do the ranking for comparative reasons the results can serve as guidelines for how well monetary policy has been conducted in line with the theory of rational expectations and strict inflation targeting.

[8] The standard deviations of expected inflation from target is calculated according to $\sqrt{\frac{\sum\left(\hat{\pi}^{C}_{t+8}-\pi^{*}_{t}\right)^{2}}{n}}$ and $\sqrt{\frac{\sum\left(\hat{\pi}^{R}_{t+8}-\pi^{*}_{t}\right)^{2}}{n}}$ respectively.

the theory of rational expectations and strict inflation targeting.

Table 14: Standard Deviations Of Expected Inflation From Target And Joint Hypothesis Testing

Country	**Coefficient** α	**Coefficient** β	**Null Hypothesis That** $\alpha = \beta = 0$	**Sd. Dev. Of Expected Inflation From Target**
New Zealand	0.875^{***}	-0.107	Reject	0.790 (6)
Chile	-0.957	-0.176	Reject	1.131 (8)
Canada	-0.261	0.138	Not Reject	0.314 (2)
Israel	-1.161^{*}	0.065	Not Reject	1.184 (9)
The United Kingdom	0.140	0.268	Not Reject	0.194 (**1**)
Sweden	-0.629^{**}	0.090	Reject	0.687 (5)
Australia	0.341	-0.038	Not Reject	0.334 (3)
The Czech Republic	-1.268	-0.120	Reject	1.115 (7)
Korea	-0.181	0.427	Not Reject	0.593 (4)
Poland	-1.778^{**}	-0.297	Reject	1.753 (**10**)

6 Concluding Remarks

The purpose with this paper is to evaluate the experience of inflation targeting for the first ten inflation targeting countries. First, I do the evaluation on an unconditional measure of good inflation targeting, i.e. the variance of inflation around target. The variance of inflation around target is the lowest for those countries which began using inflation targeting as a monetary policy framework when inflation rates were already falling and vice versa. The conditional measure tests the theory of rational expectations and strict inflation targeting. Looking at the obtained estimation results for the baseline specification using CPI inflation as the only information variable I conclude that these results are in line with the null hypothesis of rational expectations and strict inflation targeting central banks for four out of ten countries. These countries are: *Chile, Canada, Australia*, and *Korea*. The estimation results, however, show that for six of these countries the results differ from the rational expectations theory. These countries are: *New Zealand, Israel,* the *United Kingdom, Sweden,* the *Czech Republic*, and *Poland*. For these six countries the null hypothesis of rational expectations and strict inflation targeting is rejected. In addition, I check what happens to the estimation results when I use other price indices than the CPI when calculating the annual inflation rates. This is relevant because five of the ten inflation targeting countries, namely New Zealand, Australia, the Czech Republic, Korea, and the United Kingdom, have modified their definitions of the inflation target in terms of annual rises in some other index than the CPI. Including these other indices changes the conclusions in terms of a rejection of the null hypothesis of rational expectations and strict inflation targeting for the United Kingdom and the Czech Republic. For these two countries, the null hypothesis of rational expectations and strict inflation targeting cannot be rejected when including the real targets, compared to a rejection when CPI is used for the whole period. For the three remaining countries the estimation results with respect to their significance levels remain unchanged. In total, including other price indices increases the number of countries where monetary policy has been conducted in line with the theory of rational expectations and strict inflation targeting to six. Consequently, these other price indices are used for the relevant countries in the remainder of the paper.

Next, in the extended analysis using the lagged output gap as an information variable I end up rejecting the null hypothesis of rational expectations and strict inflation targeting for five of six countries. These countries are: *New Zealand, Canada, Israel,* the *United Kingdom*, and *Sweden*. For *Australia*, I cannot reject the null hypothesis. However, it seems that my estimation results are rather sensitive to which measure of lagged output gap I choose to apply. Different output gap measures can imply somewhat different estimation results.

Finally, I do some ranking of the inflation targeting countries for the baseline specification in terms of some joint hypothesis testing. For five countries, the joint hypothesis that the constant and coefficient for the independent variable are equal to zero is rejected. For four of these five cases, inflation has been below target. A rejection of the joint hypothesis of a zero constant and coefficient for the independent variable should, in turn, imply a high standard deviation of expected inflation from target. In a similar way, a non-rejection of the joint hypothesis of a zero constant and coefficient for the independent variable should be in line with a low standard deviation of expected inflation from target. With the exception of Israel, this is also the case. Based on these ranking results, I conclude that the best performer of the ten countries is the *United Kingdom*, whereas *Poland* is the country where monetary policy has been conducted the least in line with the theory of rational expectations and strict inflation targeting.

To sum up, for both the baseline and extended specifications, two possible explanations for the rejection of the null hypothesis of rational expectations and strict inflation targeting could be forecasting errors or targeting of other variables. For example, it is possible that the inflation targeting central banks have not prevented CPI inflation to deviate from target, but instead have focused too much on underlying measures such as core inflation being within the inflation targeting band. The volatility of food and energy prices might have resulted in more focus on underlying inflation rates, especially for small open economies like New Zealand. This despite the fact that the inflation targets have been specified in terms of annual rises in the CPI for a majority of the years during the inflation targeting period.

Finally, in this analysis, it is assumed that the inflation targeting central banks are strict inflation targeters. This implies that low and stable inflation is the only objective for the central bank. A further approach would be to include both inflation and real output concerns in the inflation targeting central bank's loss function, i.e. assuming flexible inflation targeting central banks.

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Data Appendix

1. Consumer Price Index (CPI)
Source: CPI inflation rates are calculated using Consumer Price Index obtained from SourceOECD (The Organisation for Economic Cooperation and Development).

2. Gross Domestic Product (GDP)
Source: Data for Gross Domestic Product are obtained from SourceOECD (The Organisation for Economic Cooperation and Development). For Israel, current GDP data are obtained by the website of the Bank of Israel. Historical GDP data are calculated through the quantity changes which are also available at the Bank of Israel website.

3. All Groups Consumer Price Index excluding Credit Services (CPIX) for New Zealand.
Source: CPIX inflation rates are calculated from the CPIX index. The CPIX index is downloaded using the Infoshare tool available at the webpage of Statistics New Zealand.

4. The Retail Price Index (RPIX) for the United Kingdom
Source: Office for National Statistics. Quarterly data.

5. Core CPI excluding agricultural products and oil for Korea
Source: Core CPI inflation rates are calculated from the Core CPI index obtained from the Bank of Korea Economic Statistics System (ECOS).

6. Index of Net Inflation for Czech Republic
Source: Net inflation rates are calculated from the index of net inflation from the Czech Statistical Office.

7. Core CPI excluding interest charges for Australia.
Source: Core CPI inflation rates are obtained from the webpage of the Reserve Bank of Australia.

8. Industrial Production Index for New Zealand
Source: The numbers for industrial production index are obtained from SourceOECD (The Organisation for Economic Cooperation and Development).

Appendix 1

Table A1: The Definitions Of the Initial And Modified Targets For Countries With Changed Inflation Targets

Country	**Initial Target**	**Modified Target(s)**
New Zealand	CPI March 1990-November 1997	CPIX December 1997-November 1999 CPI December 1999 ∼
The United Kingdom	RPIX October 1992-April 2003	CPI May 2003 ∼
Australia	Core CPI April 1993-August 1998	CPI September 1998 ∼
Korea	CPI April 1998-December 1999	Core CPI 2000-2006 CPI January 2007 ∼
The Czech Republic	Net Inflation January 1998-March 2001	CPI April 2001

Appendix 2- Checking If the Results In the Baseline Specification Are Sensitive To Outliers

A relevant robustness check is to test whether the estimation results are sensitive to the exclusion of outliers. In the main analysis I include the outliers and in the sensitivity analysis I test whether the results are sensitive to the exclusion of outliers that are influential for the fitted regression. I choose the following measure to test the influence of a single observation i on the fitted value $\hat{Y}_i$:

$$(DFFITS)_i = \frac{\hat{Y}_i - \hat{Y}_{i(i)}}{\sqrt{MSE_{(i)}h_{ii}}} \tag{10}$$

where the letters DF stands for the difference between the fitted value $\hat{Y}_i$(for the ith observation when all n observations are included when fitting a regression function) and the predicted value $\hat{Y}_{i(i)}$(for the ith observation when the ith observation is omitted when fitting a regression function). Further, $MSE_{(i)}$ is the error mean square when the ith observation is omitted when fitting a regression function and is defined according to

$$MSE_{(i)} = \frac{\Sigma e^2_{i(i)}}{n-k} \tag{11}$$

where $e_{i(i)} = Y_{i(i)} - \hat{Y}_{i(i)}$. Finally, h_{ii} is a measure of the distance between the X values for the ith observation and the means of the X values for all n observations. A large value of h_{ii} , thus implies that the ith observation is far away from the mean of all X observations. In table A2 I present the estimation results for the model excluding outliers that are influential for the fitted regressions.

First, I look at the case when inflation are calculated using CPI for all ten countries. Comparing the estimation results in column 2 and 3 in table A2 to the ones in column 2 and 3 in table 11 some important conclusions can be drawn. Excluding influential outliers does not have an effect for the following countries: *Canada*, the *United Kingdom*, *Sweden*, *Australia*, and *Korea*. However, excluding influential outliers does seem to have an effect for the following countries: *New Zealand*, *Chile*, *Israel*, the *Czech Republic*, and *Poland*. For New Zealand, both the constant and the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable are significant at the 1% level when influential outliers are excluded, compared to only the constant being significant at the 1% level when all observations are included. When excluding influential outliers for Chile, the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable is significant at the 10% level, compared to no variables being significant when these outliers are included. For Israel I get somewhat different results when influential outliers are excluded from the baseline specification. The constant is now significant at the 5% level, compared to 10% when all observations are included. Also, the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable is significant at the 10% level, compared to the variable being insignificant in the case where influential outliers are included. Finally, for the Czech Republic and Poland both the constant and the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable are significant when influential outliers are excluded from the baseline specification. For the Czech Republic, this result is almost the same as in table 11 with the only difference being that the significance level for the two variables has increased to 5% instead of

10%. For Poland, excluding influential outliers implies that both the constant and the coefficient for the $\left(\pi_t^C - \pi_t^*\right)$ variable are significant, whereas the same is true only for the constant when these outliers are included.

Second, I look at the estimation results using the correct price indices and compare the estimation results in column 4 and 5 in table A2 to the ones in column 4 and 5 in table 11. For the *United Kingdom,* the estimation results do not change when influential outliers are excluded. This is not the case when it comes to *New Zealand, Australia,* the *Czech Republic*, and *Korea.* Starting with New Zealand, it seems that the estimation results changes somewhat when influential outliers are excluded. Excluding influential outliers results in both the constant and the coefficient for the $\left(\pi_t^R - \pi_t^*\right)$ variable being significant at the 1% level, compared to only the constant being significant at the 1% level when these outliers are included. When it comes to Australia, excluding influential outliers also implies somewhat different estimation results since the coefficient for the $\left(\pi_t^R - \pi_t^*\right)$ variable now is significant at the 5% level compared to no variables being significant in the case when these outliers are included. For the Czech Republic, excluding influential outliers changes the estimation results drastically. Looking at column 4 and 5 in table A2, we see that the constant and the coefficient for the $\left(\pi_t^R - \pi_t^*\right)$ variable are significant at the 1 and 5% levels respectively. These results should be compared to the insignificant results where the outliers are included, i.e. column 4 and 5 in table 11. Finally, for Korea the coefficient for the $\left(\pi_t^R - \pi_t^*\right)$ variable is significant at the 10% level when influential outliers are excluded compared to no variables being significant when all observations are included in the fitted regression.

Table A2: Estimation Results When the Dependent Variable Is $\pi^C_{t+\tau}-\pi^*_t$ And $\pi^R_{t+\tau}-\pi^*_t$ Respectively And Influential Outliers Are Excluded.

Country	**Constant**	$\pi^C_t - \pi^*_t$	**Constant**	$\pi^R_t - \pi^*_t$	**Observations**
New Zealand	0.993^{***}	-0.177^{***}	1.034^{***}	-0.194^{***}	65
	(0.163)	(0.054)	(0.173)	(0.061)	
Chile	-0.626	-0.338^{*}			59
	(0.419)	(0.170)			
Canada	-0.084	0.086			58
	(0.136)	(0.133)			
Israel	-1.301^{**}	-0.278^{*}			57
	(0.560)	(0.143)			
The United Kingdom	-0.182	0.671^{***}	0.076	0.145	57
	(0.200)	(0.156)	(0.092)	(0.144)	
Sweden	-0.661^{**}	-0.004			56
	(0.269)	(0.167)			
Australia	0.252	-0.001	0.068	0.161^{**}	51
	(0.278)	(0.153)	(0.145)	(0.074)	
The Czech Republic	-1.125^{**}	-0.193^{**}	-1.876^{***}	-0.257^{**}	37
	(0.472)	(0.087)	(0.494)	(0.119)	
Korea	0.447	-0.142	-0.063	-0.344^{*}	33
	(0.294)	(0.214)	(0.267)	(0.184)	
Poland	-1.523^{**}	-0.453^{***}			32
	(0.667)	(0.150)			

A variable marked by *, **, or *** indicates significance at the 10, 5, and 1% levels, respectively.
Newey-West standard errors reported in parenthesis.

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