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WHAT IS THE CENTRAL BANK EFFECTIVELY TARGETING IN PRACTICE? SVENSSON'S CONCEPT OF INFLATION FORECAST TARGETING AND MEASURES OF INFLATION PROJECTIONS -THE EXPERIENCES OF SELECTED EUROPEAN COUNTRIES

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What is the central bank effectively targeting in practice? Svensson's concept of inflation forecast targeting and measures of inflation projections-the experiences of selected European countries[1]

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Abstract

This article presents a comparative study of central paths' projections of Consumer Price Index (CPI index), core inflation and monetary policy-relevant inflation measure (MPRI) in the central banks of Sweden, Norway and Czech Republic. The analysis refers to the possibility of using core and MPRI inflation projections as a tool (intermediate goal) for the implementation of Svensson's concept of optimal inflation forecast targeting strategy (IFT) and determines what the chosen central banks are effectively targeting in practice. The study includes a reference of the central paths of the CPI, core inflation and MPRI inflation projections, based on the endogenous rate, to the inflation target. The analysis has allowed us to determine that the central paths of core inflation projections have converged with the inflation target as the time horizon became longer, but still remained medium-term. Such a result is not given for all of the CPI projections. The implications for the implementation of the Svensson's concept of optimal IFT strategy are that a projection of core inflation may be a typical, operational tool which anchors inflation expectations; as such (as CPI projection), it should be published, treated and used as an intermediate goal of monetary policy.

JEL: E58, E52, E59

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1. Introduction

The paper relates Svensson's concept of inflation forecast targeting (IFT) regime (Svensson, 1997) and analyses inflation projections as a one of the main tools for implementing this regime and anchoring the inflation expectations.

The author examined the central paths of inflation projections published by central banks and made on the assumption of an endogenous instrument rate. Such an assumption is connected to Svensson's optimal forecast targeting rule and assumes the use of an optimal instrument plan (Svensson, 2003). According to Svensson and Tetlow (2005), an optimal instrument plan implies the publication of inflation projection which, at the end of the forecast horizon, (Svensson counseled 3 years forecast horizon) should attain the inflation target.

More and more central banks have declared the use and implementation of IFT, publishing at least two kinds of inflation projections[3]. One of them is the headline Consumer Price Index (CPI) inflation projection, while the other is the core or monetary policy-relevant inflation (MPRI) projection. Both differ from each other in terms of the inflation measure used. It is said that the measure of inflation forecast (intermediate target in IFT) should be the same as the inflation target (Svensson, 1999). The question is which of these projections are the real intermediate targets? Which, at the end of the forecast horizon, behaves as a Svensson's intermediate target and accomplishes the inflation target? What, as an intermediate target, is the central bank effectively targeting in practice? Which of these projections shape the inflation expectations?

Professional forecasters and central bankers may argue that, for an inflation targeting central bank producing macroeconomic forecast in a general equilibrium model with endogenous instrument rates, it is true almost by construction that the inflation forecasts converge at the inflation target in the medium term monetary policy horizon. For which measure of inflation this is true for its forecasting model, may depend on which specific measure of inflation is included in the central bank's reaction function. Conceptually speaking, if the central bank is assumed to target CPI inflation in the model, then the forecasted CPI inflation should converge to the target. If the model assumes targeting core inflation, then this may hold for core measure. In the paper, we may see this theoretical relationship is true but not that it always occurs in the central banking practice. Firstly, inflation projections published by central banks are not only the products of the model, but the

[3] On 27 central banks implementing IT regime in 2014, 10 published two kinds of inflation projections: CPI and core or MPRI inflation projections.

products of model and experts' opinions. Hence, the inflation projection published by central bank may differ from the original model's projection. Secondly, the decision-making body may use some discretion to deviate from the endogenous interest rate path prescribed by the forecasting model. This is why we assume in the paper that the central bank, which declares the implementation of Svensson's concept of IFT, publishes inflation projections to anchor the inflation expectation on the inflation target. In this sense, the intermediate target of monetary policy does not have to be a projection which is in the central bank's reaction function in the general equilibrium model, but which is published by the central bank (to anchor the inflation expectations) and attains or converges with the inflation target in the medium term horizon This means that the publication of additional (to CPI inflation projection) core or MPRI inflation projections may be necessary to perform the IFT regime.

The aim of this study is to (1) find what the central banks are effectively targeting in practice, as an intermediate target (whether it is Consumer Price Index (CPI), core or monetary policy-relevant inflation measure (MPRI) projections) and (2) analyse the possibility of using core and MPRI inflation projections, as an additional to the CPI inflation projections, intermediate targets of monetary policy.

The analysis conducted is based on the inflation projections published by central banks of Norway, Sweden and the Czech Republic. The choice of central banks in the research was dependent on the monetary policy strategy used – inflation targeting - while the parallel publication of the CPI, core inflation or MPRI projections was based on the endogenous rate, presented in the form of fan charts. The central banks of the chosen countries:

1. have been applying the inflation targeting strategy for at least 10 years,
2. have the inflation target specified in the form of a quantitative point with a symmetrical tolerance range for deviations,
3. have implemented and officially declared implementing the monetary policy under Svensson's concept of inflation forecast targeting (IFT) strategy, especially optimal IFT,
4. in parallel, they have published the CPI and core/MPRI inflation projections (based on the endogenous rate) in the form of fan charts,
5. have publicized the value of the central path of projection inflation (together with the areas of uncertainty),
6. have forecast inflation with the dynamic stochastic general equilibrium (DSGE) models,
7. do not belong to the Euro zone.

In addition, the selected central banks have the largest comparative experience in terms of implementing the IFT; thus, they are pioneers in the field of modeling and forecasting inflation.

The paper is organised as follows. It consists of nine parts. The author begins in section 2 by providing some theoretical background about Svensson's concept of IFT and the measures of inflation projections made by central banks. In section 3 the author briefly introduces the IFT regime framework in the chosen central banks. The next three sections include the description of the methodology, the data and the results of the research. The conclusions and implications for countries implementing the IFT regime are contained in section eight. The ninth section of the paper features the author's comments in conducting the research.

2. Theoretical background

Inflation targeting (IT) strategy is currently used to conduct monetary policy in 27 countries[4]. Some of them have already implemented this regime over twenty years. The countries selected by the author have been pursuing the inflation targeting strategy (IT) for over ten years (Norway – 2001, Sweden – 1995, Czech Republic - 1998). The complete version of the IT strategy is defined by the following five elements (Mishkin, 2009, p. 255):

1. public announcement of the quantitative medium-term inflation target,
2. institutional commitment to price stability as the main objective of monetary policy,
3. the dependency of decisions regarding monetary policy tools on a wide range of information relating a number of variables, not just the behaviour of the exchange rate or monetary aggregates,
4. greater transparency of the strategy through communication with the public and the markets in the objectives, targets and decisions of monetary authorities,
5. increased accountability of the central banks towards the realisation of the objectives of democratic institutions.

The last three of the mentioned elements are directly or indirectly related to the central banks' inflation projections. According to the concept of inflation forecast targeting (IFT), the final goal is published as an inflation target and the intermediate goal is the inflation projection (Svensson, 1999). Hence, a properly executed and announced inflation projection

[4] Countries which are implementing inflation targeting strategy: Armenia, Australia, Brazil, Chile, Sweden, Czech Republic, Philippines, Ghana, Guatemala, Indonesia, Iceland, Israel, Canada, South Korea, Colombia, Mexico, Norway, New Zealand, Peru, Poland, South Africa, Romania, Serbia, Thailand, Turkey, Hungary and Great Britain.

has many fundamental functions in the implementation of the strategy (Cobham *et. al.*, 2010). Here, inflation projections (Bernanke *et. al.*, 1999):

1. are intermediate targets of monetary policy,
2. are instruments of democratic control which the public exerts over central banks,
3. are the basis for the creation of a transparent monetary policy of the central banks,
4. are one of the key elements of the information policy of the central banks,
5. affect the formation of inflation expectations,
6. are indirectly responsible for the proper implementation of an inflation targeting strategy,
7. are a bridge between monetary authorities and the public.

The IT strategy requires central banks to implement a transparent monetary policy which will influence the creation of inflation expectations of economic actors appropriately. An integral part of the central banks' inflation targeting strategy is to announce future inflation to the public. This is reflected in the publication of inflation projections, the most popular form of which are fan charts (Svensson, 2009). Countries applying the IT strategy have chosen the inflation target as the main objective of their monetary policy, specified in a quantitative, point-based manner and, in most cases, with a symmetrical tolerance range for deviations. Inflation forecasts targeting (IFT) requires an intermediate goal, which may be the projection of inflation (Svensson, 1999). Therefore, it is appropriate to verify published inflation projections from the perspective of their function as an intermediate goal.

The IT strategy and its implementation have been discussed many times on theoretical and empirical grounds, and are now being verified in the face of the central banking crisis. However, direct links between this strategy and inflation projections have not been widely discussed so far. There are two most popular types of research concerned Svensson's IFT concept. The first type of research involves studies on the accuracy of the inflation forecasts. Such a research had been performed by Dowd (2004) for inflation projections published by Swedish National Bank, and by Skrova-Falsch and Nymoen (2011) for inflation projections made by the Central Bank of Norway. These studies are related to the inflation projections made by the CIR assumption. Inflation projections published by the central banks of Sweden, Norway and Czech Republic had been analysed in order to calculate their credibility by Tura (2015) and Tura-Gawron (2016). The second type of research concerned are influences of the inflation projections on the inflation expectations. Such research has been done for Czech National Bank by Szyszko (2013), and Szyszko and Tura (2015).

Inflation projections in central banks differ from each other in the main assumptions concerning the instrument-rate, time horizon and the measure of inflation in inflation projections. Firstly, inflation projections in central banks which implement the inflation targeting strategy may be based on the assumption of the constant instrument rate (called CIR) during the entire forecast horizon, on the assumption of the market expectations of future instrument rates (called ME) and based on the endogenous rate (Svensson, 2005). The CIR assumptions imply the use of a rule of the thumb. This means that if the inflation forecast, in the chosen horizon, is above the inflation target, then the central bank should raise the repo rate. If the inflation forecast in the chosen horizon is lower than the inflation target, then the central bank should reduce the repo rate. If the inflation forecast is equal to the inflation target, then the repo rate should remain unchanged (Svensson, 1997). The inflation projections based on the endogenous rate are connected with an optimal instrument rate plan (Svensson, 2006). This assumption implies that, at the end of the forecast horizon, the inflation forecast should be equal or very close to the inflation target (Svensson, 2003).

Secondly, the horizon of inflation projections is medium-term. Inflation projections based on the CIR assumption in practice usually have a two-year horizon. The forecast horizon for inflation projections based on the endogenous repo rate is longer (usually three years) (Svensson, 2013).

Thirdly, inflation projections are made on the basis of the CPI[5] measure of inflation and the core measure of inflation. Setting the inflation target in the CPI index implies that the main inflation projection is also CPI, while other core inflation projections are treated as additional projections. Currently, out of the twenty seven countries implementing IT, ten publish the projections of CPI inflation and the projections of core inflation in parallel.

The measures of inflation projections and its instrument rate assumptions in countries implementing the IT strategy in 2014 are shown in Table 1.

[Table 1 about here]

3. Inflation forecast targeting in selected central banks

In Sweden 1993 the inflation target was set at 2% (+/- 1%), measured using the CPI. In parallel to the CPI inflation projection, the projections of the core inflation UND1/UND1X/CPIX (CPI excluded from mortgage interest expenditure and effects of indirect taxes and subsidies), and CPIF (CPI with a constant mortgage rate) indexes were also

[5] Consumer Price Index.

published. The first nucleus of the report of Swedish National Bank (Sveriges Riksbank, SR) inflation report was published in October – "Inflation and Inflation Expectations in Sweden". The competent "Inflation Report" was presented in 1996. Since then it was presented four times per year (every March, June, September and December) until December 2006. Since 2007, SR has published the "Monetary Policy Report" three times per year. Since 2009, the publication of the relevant report took place every February, July and October.

The CPI inflation projection appeared for the first time in December 1997 and it was made for a two-year horizon, assuming a constant rate over the forecast horizon (CIR). This assumption includes all inflation projections made before March 2005. From June 2005 to the end of 2006, projections were made assuming the rate is coincident with market expectations of future instrument rates. Since March 2007, inflation projections have been based on the endogenous rate and SR started the publication of repo rate projections in the form of fan charts.

The data on the central path of the inflation projection is given for projections since September 1999 on a monthly basis. The horizon of the inflation projection was gradually lengthening. From September 1999 to June 2005, it varied between 26 and 28 months; since September 2005, it was in the range of 37 to 40 months. Some difficulties in analysing the data may be a result of a change which took place in early 2005 in the method of determining statistical components of the CPI index.

The main inflation projection in SR is the CPI projection. Additionally, in reports made before the first *Monetary Policy Report* in 2008 there were also CPIX inflation projections. In the years 2008-2009, SR did not publish core inflation projections. In the years 2010-2013, SR presented two parallel inflation projections: CPI projections and CPIF projections.

The decision-making procedure in Swedish National Bank was based, for the first quarter of 2005, on a standard Svensson's rule of the thumb. From the second quarter of 2005 to the third quarter of 2006 the algorithm declared and used may be described as constituting a compromise approach. In 2003, L.E.O. Svensson suggested a change of the decision making-procedure into the algorithm of the optimal forecast targeting rule. From the first quarter of 2007, SR officially implements the decision-making procedure based on the optimal path monetary policy path (Svensson, 2013). Table 2 presents a brief overview of the inflation projections published by SR in the years 1999-2013.

[Table 2 about here]

Since 2001, the Central Bank of Norway (Norges Bank, NB) has been implementing the inflation targeting strategy with a point inflation target of 2.5%, measured using the CPI

Index. As a part of the strategy, the NB has published projections of the CPI inflation and core inflation (CPI-ATE and CPIX). Until 2006, the NB published three “Reports of inflation” per year. From 2007 to 2012, it published three “Monetary Policy Reports” per year (every March, June, and November). In 2013, the NB started publishing the “Monetary Policy Report with the Financial Stability Assessment” four times per year (every March, June, September and December).

Until 2005, the inflation projections in NB were made on the basis of the CIR and ME assumptions. Since 2006, inflation projections have been based on the endogenous rate. From 2001-2013, the horizon of inflation projections gradually evolved from two years to three years. The values of each of the inflation projections’ central paths are given quarterly.

In November 2001, S. Gjedrem[6] described, specific monetary policy rule consistent with the rule of the thumb for used in NB: "If it turns out that the forecast assuming CIR will be above 2.5%, the interest rates will be raised. If it turns out that the forecast assuming CIR will be below 2.5%, the interest rates will be reduced." Moreover, "(...) Within two years, inflation should reach the inflation target." (Gjedrem, 2001, p. 3). Until 2005, a decision-making procedure was the rule of the thumb. In 2006, NB changed the decision-making procedure into an optimal monetary policy path. Such an approach was directly reflected in “Criteria for an appropriate future interest path” in the “Inflation Report with Monetary Policy Assessment” published by NB in 2005. “If monetary policy is to anchor inflation expectations around the target, the interest rate must be set so that inflation moves towards the target. Inflation should be stabilized near the target within a reasonable time horizon, normally 1-3 years. For the same reason, inflation should also be moving towards the target well before the end of the three-year period’ (Inflation Report …., 2005, p. 8). Table 3 presents a brief overview of the inflation projections published by NB in the years 2001-2013.

[Table 3 about here]

Since 1998, the Czech National Bank (CNB) has implemented an IT strategy. In the years 1998-2006, the CNB used annual or a few years’ inflation targets presented in the form of the range and measured by core inflation. It was not until 2007-2009 that CNB applied a real continuous inflation target 3% +/- 1 p.p. measured by the CPI. Since 2010, CNB has lowered the inflation target to 2% +/- 1p.p.

The first inflation projection was described in the “Inflation Report” in 1999 and published in 2001. In the years 1999-2001, inflation projections were made by CIR assumption and CNB implemented the rule of the thumb. Since 2002, CNB has been

[6] President of the NB in 1999-2010.

publishing inflation projection made by endogenous instrument rate and has been using optimal monetary policy path. In the years 2001-2007, inflation projections were presented in the form of a shadow without the central path. Since 2008, the inflation projection has a form of fan chart. The CNB publishes four inflation reports per year. Since 2001, the CNB has been publishing CPI while, since 2008, the MPRI has performed inflation projections (Monetary Policy Relevant Inflation – headline inflation-adjusted for first round effects of changes in indirect taxes). The horizon of the projections is 8-9 quarters. Table 4 presents a brief overview of the inflation projections published by CNB in the years 2002-2013.

[Table 4 about here]

The main information about selected central banks is presented in Table 5.

[Table 5 about here]

The central banks selected forecast the inflation with the DSGE models. In each model, the central bank reaction function includes the headline inflation. Table 6 presents a brief overview of the forecasting models used by selected central banks.

[Table 6 about here]

4. Methodology and chosen research assumptions

The aim of this study is to analyse the central paths of CPI inflation projections and the central paths of core or MPRI inflation projections based on the endogenous rate in the central banks of Sweden, Norway and Czech Republic. The aim of the study will be achieved in the framework of the main hypothesis. The central paths of core or MPRI inflation projections based on the endogenous rate in the central banks of Sweden, Norway and Czech Republic in the implementation of inflation forecast targeting (IFT) converges with the inflation target, as the time horizon progresses, while they may play the role of the intermediate target. In coinciding with the optimal IFT rule, such a result is not given for all the CPI projections.

According to Svensson (2005), the optimal inflation forecast targeting rule implies that the central paths of inflation projections, made by the assumption of endogenous instrument rate, converged with the inflation target as the time horizon becomes longer. At the end of the forecast horizon, the inflation forecast reaches the inflation target. Such forecasts shape the inflations expectations in the 12-24-month monetary policy transmission horizon and anchor them to the inflation target at the end of the forecast horizon. These relationships are to be checked in the study for CPI and core or MPRI inflation projections in five steps for the central banks selected.

In the first step, the absolute deviations of the inflation projections from the inflation target for chosen central banks are calculated after a one-year forecast horizon. In the second step, the absolute deviations of the inflation projections from the inflation target for chosen central banks are calculated after a two-year forecast horizon. In the third step, the absolute deviations of the inflation projections from the inflation target for central banks of Norway and Sweden (CNB publishes only two years horizon's inflation projections) are calculated after a third-year forecast horizon. The absolute deviations for CPI and core or MPRI inflation projections in the different time horizons are compared.

We shall denote:

i – inflation forecast horizon (years), $i \in \{1,2,3\}$,

x_j – inflation forecast central path, $j \in N$,

x_{j_i} – the value of inflation forecast central path in the chosen horizon $x_{j_i} \in \{x_{j_1}, x_{j_2}, x_{j_3}\}$,

π – inflation target.

The Svensson's (2005) optimal inflation forecast targeting rule may be shortly presented as a formula:

$$\lim_{\substack{i \to 3 \\ j \to \infty}} \left| x_{j_i} - \pi \right| = 0. \tag{1}$$

In the fourth step, for the absolute deviations of CPI and core or MPRI inflation projections from the inflation, the basic descriptive statistics are designate. The samples of the deviations are connected and small, while not all of them have the normal distribution. To check the significance of the differences between the absolute deviations of CPI and core or MPRI inflation projections from the inflation target for the central banks selected in the chosen research horizon, we used two nonparametric tests: the Sign Test and the Wilcoxon Matched Pairs Test. The chosen tests are performed in the research for each of chosen central banks, in the one, two and three-year forecasts' horizons, and between CPI and core or MPRI inflation projections. The tests conducted are shown in table 7.

[Table 7 about here]

The four steps of the study from the perspective of the main objective are presented in Figure 1.

[Figure 1 about here]

For the CPI and core or MPRI inflation projections, which differ significantly from each other at the end of the forecast horizon, the author at the fifth step of the research analysed its influence on inflation expectations. The purpose of this stage is to investigate

which kind of inflation projection (whether it is CPI or core or MPRI inflation projection) shape the inflation expectations. The independences between the inflation projections and inflation expectations are calculated for the central paths of CPI, core or MPRI inflation projections at the prognostic moments of first (t+1) and second (t+2) year of the forecast's horizon and inflation expectations one (t+1) and two years (t+2) ahead. In order to test it, we used four correlation coefficients - one linear Pearson product-moment correlation coefficient and three nonparametric correlation coefficients: Spearman's rank correlation coefficient, Kendall rank correlation coefficient and Goodman and Kruskal's gamma rank correlation coefficient. The fifth step of the research is shown in Figure 2.

[Figure 2 about here]

5. Data

The main subject of research in this paper are the values of central paths of CPI and core or MPRI inflation projections. The analysis tracks the central paths of inflation projections published in Sweden, and based on data from the years 2007-2013, published in Norway from 2006-2013 and in Czech Republic from 2008-2013. The data has been collected from the inflation reports uploaded on the websites of the central banks of Norway and Sweden. The central paths of inflation projections published by CNB were collected and then forwarded by bank's staff. The above years have been chosen for research due to the availability of the data and used, in the projections, the assumption of the endogenous instrument .

The detailed information about inflation projections, the necessity to perform the test and the verification of the main hypothesis are presented in Table 8.

[Table 8 about here]

The central paths of inflation, published by the central bank of Norway are shown in Figures 3, 4 and 5, published by the central bank of Sweden in Figures 6, 7 and 8 and by the Czech National Bank in Figures 9 and 10.

[Figures 3-10 about here]

The inflation expectations of one and two years ahead in Sweden, which were needed to perform the research at the stage five, were collected from the TNF Sifo Prospera Survey website. For each year we have taken the data prepared by TNF Sifo Prospera Survey comprising of the mean values of the annual expected increase of inflation. The inflation expectations are based on data for the years 2010-2015.

6. The results

At the beginning of the first phase of the study, the central paths of the CPI and core or MPRI inflation projections were isolated due to the forecast horizon. The inflation projections' central paths published by central banks of Norway and Sweden were divided into three sets for the individual values of 12, 24 and 36 months. The inflation projections' central paths published by CNB were divided into two sets for the individual values of 12, and 24 months (due to the time horizon). The inflation forecasts targeting (IFT) requires that, in the medium term, the values of the central paths of inflation projections are convergent with the inflation target. Figures 11-13 show the sequence of all the central paths of inflation projections at the chosen prognostic moment; that is, at the end of the first year of the forecast horizon (so-called, prognostic moment of the first year of the forecast horizon) in Sweden, Norway and CNB.

[Figures 11-13 about here]

The analysis allowed us to observe the following:

1. In Sweden, the central paths of the core inflation projections (for CPIX, CPIF), at the prognostic moment of the first year of the forecast horizon, achieve similar, but slightly lower, values than the central paths of the CPI inflation projections. These differences are not significant, while the values are mainly in the range of deviations from the target.
2. In Norway, the central paths of the core inflation projections (for CPI-ATE, CPIX), at the prognostic moment of the first year of the forecast horizon are similar to the central paths of the CPI inflation projections. These differences are not significant. The values are mainly in the range of deviations from the target.
3. In Czech Republic, at the prognostic moment of the first year of the forecast horizon, the central paths of the MPRI inflation projections are similar to the central paths of the CPI inflation projections. These differences are not significant. The values are mainly in the range of deviations from the target.

In the second phase, the central paths were isolated into individual values of 24 months. Inflation targeting forecasts require that in the medium-term the values of the central paths of inflation projections are convergent with the inflation target. Figures 14-16 show the sequence of all the central paths of inflation projections at the chosen prognostic moment – at the end of the second year of the forecast horizon (so-called, prognostic moment of the second year of the forecast horizon) in Sweden, Norway and Czech Republic.

[Figures 14-16 about here]

The analysis has enabled us to note the following:

1. In Sweden, at the prognostic moment of the second year of the forecast horizon, the central paths of the projections of core inflation (for CPIX, CPIF) still display similar trends, but achieve much lower values than the central paths of the CPI inflation projections. These differences are significant for α=0.05. The values are mainly in the range of deviations from the target.
2. In Norway, at the prognostic moment of the second year of the forecast horizon, the central paths of the projections for core inflation (for CPI-ATE, CPIX), achieve similar values to the central paths of the CPI inflation projections. These differences are not significant. The values are mainly in the range of deviations from the target.
3. In Czech Republic, at the prognostic moment of the second year of the forecast horizon, the central paths of the projections for MPRI inflation achieve similar values to the central paths of the CPI inflation projections. These differences are not significant. The values are mainly in the range of deviations from the target. The central paths of the projections for MPRI and CPI at the end of the forecast horizon do not achieve the inflation target.

In the third phase, the central paths of the projections published by central banks of Norway and Sweden were isolated into individual values of 36 months. Inflation forecasts targeting requires that, in the medium term, the values of the central paths of inflation projections are convergent with the inflation target. Figure 17 shows the sequence of all the central paths of inflation projections at the prognostic moment selected at the end of the third year of the forecast horizon (so-called, prognostic moment of the third year of the forecast horizon) in Sweden.

[Figure 17 about here]

The analysis allowed us to notice the following:

1. At the prognostic moment of the third year of the forecast horizon, the central paths of the core inflation projections (for the CPIX) display similar trends, but are closer to the inflation target in comparison to the central paths of the CPI projections.
2. The central paths of the core inflation projections (for the CPIF), at the prognostic moment of the third year of the forecast horizon are convergent with inflation target, while the central paths of the CPI projections are not. The differences are significant for α=0.01.

Figure 18 shows the sequence of all the central paths of inflation projections at the end of the third year of the forecast horizon in Norway.

[Figure 18 about here]

The analysis allowed us to notice the regularities.

1. Relatively speaking, there is no difference between the values of the central paths of CPI inflation and core inflation projections at the prognostic moment of the third year forecast horizon in Norway. The differences are not significant.
2. At the prognostic moment of the third year of the forecast horizon, the central paths of the CPI and core inflation projections are convergent with and achieve the inflation target in Norway.

At the prognostic moment of the first year of the forecast horizon, the central paths of CPI inflation projections and core or MPRI inflation projections in Norway, Sweden and the Czech Republic differ from each other while, in relative terms, they are not convergent with the inflation target. At the prognostic moment of the middle, second year of the forecast horizon, the central paths of CPI inflation projections and core inflation projections differ from each other in Sweden, but are similar in Norway and are not comparatively convergent with the inflation target. At the end of the forecast horizon at the prognostic moment of the second year of the forecast horizon in CNB, the central paths of the CPI and MPRI inflation projections were similar and did not achieve the inflation target. At the end of the forecast horizon at the prognostic moment of the third year of the forecast horizon, the central paths of the CPI and core inflation projections in Norway were similar and achieved the inflation target. Finally, at the end of the forecast horizon at the prognostic moment of the third year of the forecast horizon, the central paths of the CPI and core inflation projections in Sweden were different and only the core CPIF inflation projections converged with the inflation target. These relationships are shown in table 9.

[Table 9 about here]

To summarise, only the inflation projections (both, CPI and core inflation projections) published by the Central Bank of Norway were similar and achieved the inflation target, while remaining in line with the Svensson's IFT concept and were shaped as a proper intermediate target. In the Swedish National Bank, the CPI and core inflation projections differ from each other and only the CPIF inflation projections converged with the inflation target. So, CPIF may be seen and played a role of the intermediate target. However, such a strange result may be explained. CPIF is not a typical core inflation measure (in the traditional sense), but rather a monetary policy-relevant measure. CPIF assumes constant mortgage interest rates to cancel

the direct effects of monetary policy changes on inflation. If the mortgage rates are expected to follow some trend over the forecast horizon in line with the endogenous path for short term interest rate, then CPI and CPIF will differ and the difference may actually increase over time. According to the above, we may see that the SR effectively targets CPIF, even though officially its target is set for CPI. The central paths of core inflation projections are convergent with the inflation target, both- in Sweden and Norway, at the prognostic moment of the third year of the forecast horizon. In CNB, at the end of the forecast horizon (two years horizon), the inflation projections (both, CPI and MPRI inflation projections) were similar and did not converge with the inflation target; that is, they did not behave as intermediate targets.

The descriptive statistics designated and calculated for the deviations of the central paths of the inflation projections from the inflation target at the selected moments of the chosen forecast horizon are shown in Table 10. In Sweden, at the prognostic moment of third year of the forecast horizon, the average deviation of the central paths' projections from the inflation target was relatively lower for core inflation projections than for the CPI inflation projections. In Norway, at the prognostic moment of third year of the forecast horizon, the average deviations of the central paths' of CPI inflation projections and the average deviations of the central paths' of core inflation projections from the inflation target were similar. The performed Sign Tests and Wilcoxon Matched Pairs Tests validate the results shown on the graphs. The differences between the deviations of the central paths of CPI and core inflation projections from the inflation target at the prognostic moment of second and third year of the forecast horizon in Sweden are significant (for α=0.01). Figures 19-29 present the Box-Whisker plots for deviations of CPI and core or MPRI inflation projections from the inflation target in the central banks selected.

[Table 10 about here]

[Figures 19-29 about here]

At the fifth step of the research, the inflation projections in Sweden are analysed to find investigate whether the CPI inflation projections or CPIF inflation projections shape the inflation expectations. Figures 30-31 show the central paths of inflation projections at the chosen prognostic moments and inflation expectations in Sweden.

[Figures 30-31 about here]

The independences between the central paths of CPI inflation projections at the prognostic moment of the first and second year of the forecast horizon and one and two years ahead inflation expectations are calculated. According to the chosen correlation coefficients,

there is a significant correlation between the central paths of CPI inflation projections at the prognostic moment of the first and second year of the forecast horizon and inflation expectations one and two years ahead. We then calculated the independences between the central paths of CPIF inflation projections at the prognostic moment of the first and second year of the forecast horizon and inflation expectations one and two years ahead. According to the chosen correlation coefficients, compared to the CPI inflation projections, there is a smaller and not significant correlation between the central paths of CPIF inflation projections at the prognostic moment of the first and second year of the forecast horizon and inflation expectations one and two years ahead. The conducted research shows that CPI inflation projections mainly shape the inflation expectations. The values of correlation coefficients for CPI and CPIF inflation projections versus inflation expectations are presented in Table 11. Figures 32-33 show the scatterplots between CPI and CPIF inflation projections and inflation expectations.

[Table 11 about here]

[Figures 32-33 about here]

7. Conclusions and implications for countries implementing inflation forecast targeting

The analysis did not allow for a confirmation that a properly selected core inflation rate is a better indicator of inflation in the inflation projections than the CPI measure. It cannot be stated explicitly that the central paths in core inflation projections are characterised by smaller deviations from the inflation target. However, one may state that, in Sweden and Norway, the central paths of the core inflation projections at the prognostic moment of the third year of the forecast horizon were convergent with the inflation target. This relation may be also confirmed by the CPI inflation projections in Norway but cannot be for the CPI inflation projections in Sweden. This result should be underlined. The central paths of core inflation projections converge with the inflation target as the time horizon became longer, but still remained medium term. Such a result should be recognised as a signal that core inflation projection may be treated as an intermediate target. Such a conclusions may not be drawn for the inflation projections made for a two-year horizon (like it was in CNB). The case of Sweden, where CPIF inflation projection at the end of the forecast horizon achieves the inflation target and where the differences between CPIF and CPI inflation projections are large and significant, may even indicate that the CPIF inflation projection may be better

intermediate target than CPI inflation projection. This conclusion was not confirmed by the independences analysis between CPI, CPIF inflation projections and inflation expectations. The inflation expectations of economic actors one and two years ahead are still shaped by the CPI inflation projection (not CPIF inflation projection).

The implications for the implementation of the IT strategy therefore follow a single direction. The central bank pursuing Svensson's IFT concept should decide on a parallel publication of the CPI inflation projection and a correct choice of core inflation projection.

8. Comments

Difficulties in the analysis of inflation projections are caused by the fact that the IT strategy was evolving during the implementation of the guidelines in practice. First, theoretical works were based on a contemporary paradigm of treating inflation projection as an intermediate target. In fact, it turns out that inflation projections may have a wide range of different features, while central banks should decide upon which of them should be emphasised. According to the author, a compromise between the properties of the prognostic function and the targeting of the forecast is very difficult to achieve. In contrast, the area of the characteristics of inflation projection is often sidelined as a specific operational tool within the IT strategy. This study compares the projected CPI inflation and core inflation in Sweden, Norway and Czech Republic only in terms of treating an inflation projection as an intermediate target with its ability to anchor inflation expectations. The scope of this subject was significantly narrowed. In addition, it was presented from the point of view of how an inflation projection 'should' be shaped. This analysis represents only a part of the entire spectrum of the possible research to be conducted. These features were selected by the author in a subjective manner, using the principle of deduction, and starting from the function of the projection; in other words, shaping inflation expectations.

The analysis was deliberately limited by the author to features selected from the inflation projections. Additional information regarding the published inflation projections was taken into account. The research was based only on the results of the central projection paths, while the study areas of uncertainty were not within is scope; however, upon further analysis, these may also play a very important role. The author did not take into account the economic situation and the economic crisis. On the one hand, the above could affect the outcome. On the other hand, the above actually produced even more interesting results because it allowed for a comparison of the central projection paths in more extreme conditions. One obvious

limitation is the fact that the conclusions are based on studies conducted on central paths published only by two central banks. Thus, this article contributes to and indicates directions for further research on the proper adjustment of inflation projection as an operational tool in IT strategy.

9. Acknowledgements and Disclaimers

The article presents the results of research financed by the National Science Center in Poland: ‘’Forecasting inflation on the basis of DSGE models in the implementation of inflation targeting in selected central banks’’ contract No.: 2013/09/N/HS4/03766.

We thank the audience at the workshop ‘’Experiments in Monetary Policy’’ organized by GATE-LSE Research Center in 5-6 November 2014 in Lyon in France and the audience at the conference ‘’Future of Finance’’ organized by University of Łódź in 6-7 October 2015 in Łódź in Poland for developing the ideas presented here and a critical support.

References

Adolfson, M., Laséen, S., Jesper, L & Villani, M. (2007). RAMSES — A New General Equilibrium Model for Monetary Policy Analysis. S*veriges Riksbank Economic Review*, Vol. 2007:2, 5-39.

Adolfson, M., Laséen, S., Jesper, L & Villani, M. (2008). Evaluating an Estimated New Keynesian Small Open Economy Model. *Journal of Economic Dynamics and Control* 32, 2690—2721. http://dx.doi.org/10.1016/j.jedc.2007.09.012

Bernanke, B., Laubach, T., Mishkin F. & Posen, A. (1999). *Inflation targeting. Lessons from the International Experience*. Princeton University Press. ISBN 978-0-691-08689-7.

Brubakk, L., Anders, T., Husebø, J., Maih,, K., Olsen, M. & Ostnor, M. (2006). *Finding NEMO: Documentation of the Norwegian economy model.* Staff Memo Monetary Policy, Vol. 2006/6, Norges Bank.

Coats, W., Laxton D. & Rose, D. (2005). *The Czech National Bank’s Forecasting and Policy Analysis System*. CNB Prague.

Cobham, D., Eitrheim, Ø., Gerlach, S. & Qvigstad, J. (2010). *Twenty years of inflation targeting. Lessons Learned and Future Prospects*. Cambridge University Press. ISBN 978-0-521-76818-4.

Dowd, K. (2004). *The Swedish Inflation Fan Charts: An evaluation of the Riksbank's Inflation Density Forecasts.* Working Paper Nottingham University Business School, January.

Giavazzi, F. & Mishkin, F. (2006). *An evaluation of Swedish monetary policy between 1995-2005*. Sveriges Riksbank, Stockholm.

Gjedrem, S. (2001). The Work of Setting Interest Rates. *Finansavisen*, November 9.

Mishkin, F. S. (2009). *Monetary Policy Strategy.* The MIT Press Books: The MIT Press. ISBN 978-0-262-13482-8.

Monetary Policy Report 2008/2. (2008). Sveriges Riksbank, Stockholm.

Monetary policy in Sweden 2010. (2010). Sveriges Riksbank, Stockholm.

Norges Bank (2005). *Inflation Report with Monetary Policy Assessment.* Oslo: Norges Bank.

Skrove-Falsch, N. & Nymoen , R. (2011). The Accuracy of a Forecast Targeting Central Bank. Economics. *Open Assessment E-Journal*, Vol. 5. http://dx.doi.org/10.5018/economics-ejournal.ja.2011-15

Svensson, L.E.O. (1997). Inflation forecasts targeting: implementing and monitoring inflations targets. *European Economic Review*, vol. 41 (6), 1111-1146. http://dx.doi.org/10.1016/S0014-2921(96)00055-4

Svensson, L.E.O. (1999). Inflation targeting as a monetary policy rule. *Journal of Monetary Economics*, Vol. 43, No. 3, 607-654. DOI: http://dx.doi.org/10.1016/s0304-3932(99)00007-0.

Svensson, L.E.O. & Woodford, M. (2003*). Implementing Optimal Policy through Inflation-Forecast Targeting*. NBER Working Papers 9747, National Bureau of Economic Research.

Svensson, L.E.O. & Tetlow, R. (2005). Optimal Policy Projections. *International Journal of Central Banking*, December, 177-207.

Svensson, L.E.O. (2006). *The instrument rate projection under inflation targeting: The Norwegian Example*. CEPS Working Paper No. 127, Center for European Policy Studies.

Svensson, L. E. O. (2009). Transparency under Flexible Inflation Targeting: Experiences and Challenges. *Sveriges Riksbank. Economic Review*, Vol 1/2009, 5-44.

Svensson, L.E.O. (2013). *Forward guidance in Theory and Practice: The Swedish Experience*. SIFR- The Institute for Financial Research, CEPR & NBER, Cambridge, December.

UND1X changes its name to CPIX. (2007), PRESS RELEASE, Sveriges Riksbank, Stockholm.

Szyszko, M. (2013). The Interdependences of Central Bank's Forecasts and Inflation Expectations of Consumers, *Bank & Credit,* Vol. 44. No. 1, 33-65. http://dx.doi.org/10.2139/ssrn.2006341

Szyszko, M. & Tura, K. (2015). Can Inflation Forecast and Monetary Policy Path be Really Useful? The Case of the Czech Republic. *EQUILIBRIUM. Quarterly Journal of Economics and Economic Policy,* Vol 10 (3), 9-26. http://dx.doi.org/10.12775/EQUIL.2015.022

Tura, K. (2015). *Projekcja inflacji banku centralnego. Na skraju podejścia strategicznego i technicznego*. Difin, Warszawa. ISBN 978-83-7930-959-7

Tura-Gawron, K. (2016), *Credibility of central banks inflation forecasts*, GUT FME Working Papers Series A, No 7/2016(37).

TABLES AND FIGURES

Table 1. Measures of inflation projections in countries implementing the IT regime in 2014

Country	Instrument rate in inflation projection	Measure of inflation target	Measure of main inflation projection	Measure of additional inflation projections
Armenia	CIR	CPI	CPI	-
Australia	CIR and ME	CPI	CPI	-
Brasil	CIR and ME	IPCA	*IPCA* – Broad Consumer Price Index.	-
Canada	Endogenous	CPI	CPI	*Core inflation* – CPI excluding the effect of the HST and changes in other indirect taxes
Chile	No data	CPI	CPI	*CPIEFE* – CPI excluding food goods and energy prices, leaving 72.3% of the total CPI basket
Colombia	Endogenous	CPI	CPI	*CPI excluding food*
Czech Republic	Endogenous	CPI	CPI	*Monetary policy relevant inflation* – Headline inflation adjusted for first-round effects of changes in indirect taxes
Ghana	No data	CPI	CPI	-
Great Britain	CIR and ME	CPI	CPI	-
Guatemala	No data	CPI	CPI	-
Hungary	Endogenous	CPI	CPI	-
Iceland	Endogenous	CPI	CPI	*CPI excluding tax effects*
Indonesia	ME	CPI	CPI	-
Israel	Endogenous	CPI	CPI	
Mexico	Endogenous	CPI	CPI	*Core inflation*
New Zealand	Endogenous	CPI	CPI	-
Norway	Endogenous	CPI	CPI	*CPIATE* – CPI adjusted for tax changes and excluding energy products
Peru	Endogenous	CPI	CPI	-
Philippines	CIR	CPI	CPI	-
Poland	CIR	CPI	CPI	-
Romania	Endogenous	CPI	CPI	-
Serbia	Endogenous	CPI	CPI	-
South Africa	CIR	CPI	CPI	-
South Korea	Endogenous	CPI	CPI	-
Sweden	Endogenous	CPI	CPI	*CPIF* – CPI with a fixed mortgage rate
Thailand	CIR	Core inflation	CPI	*Core inflation*
Turkey	Endogenous	CPI	CPI	*CPI excluding unprocessed food, tobacco products and alcoholic beverages*

Source: central banks' web pages.

Table 2. Brief overview of the inflation projection published by SR in the years 1999-2013

<table>
<tr><th rowspan="3">Inflation Report</th><th colspan="6">Inflation projections</th></tr>
<tr><th rowspan="2">Projection horizon [quarter]</th><th rowspan="2">Main assumption (repo rate)</th><th rowspan="2">Number of projections per year</th><th rowspan="2">Headline inflation</th><th colspan="2">Core inflation</th></tr>
<tr><th>UND1X/CPIX</th><th>CPIF</th></tr>
<tr><td>1999.03</td><td rowspan="26">9</td><td rowspan="26">CIR</td><td rowspan="31">4</td><td rowspan="34">CPI</td><td rowspan="31">UND1X/CPIX</td><td rowspan="31"></td></tr>
<tr><td>1999.04</td></tr>
<tr><td>2000.01</td></tr>
<tr><td>2000.02</td></tr>
<tr><td>2000.03</td></tr>
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<tr><td>2004.03</td></tr>
<tr><td>2004.04</td></tr>
<tr><td>2005.01</td></tr>
<tr><td>2005.02</td><td rowspan="5">ME</td></tr>
<tr><td>2005.03</td><td rowspan="5">13</td></tr>
<tr><td>2005.04</td></tr>
<tr><td>2006.01</td></tr>
<tr><td>2006.02</td></tr>
<tr><td>2006.03</td></tr>
<tr><td>2007.01</td><td>14</td><td rowspan="29">Endogenous rate</td><td rowspan="29">3</td></tr>
<tr><td>2007.02</td><td>13</td></tr>
<tr><td>2007.03</td><td rowspan="27">14</td><td rowspan="27"></td><td rowspan="27"></td></tr>
<tr><td>2008.01</td></tr>
<tr><td>2008.02</td></tr>
<tr><td>2008.03</td></tr>
<tr><td>2009.01</td></tr>
<tr><td>2009.02</td></tr>
<tr><td>2009.03</td></tr>
<tr><td>2010.01</td><td rowspan="20">CPIF</td></tr>
<tr><td>2010.02</td></tr>
<tr><td>2010.03</td></tr>
<tr><td>2011.01</td></tr>
<tr><td>2011.02</td></tr>
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<tr><td>2012.02</td></tr>
<tr><td>2012.03</td></tr>
<tr><td>2013.01</td></tr>
<tr><td>2013.02</td></tr>
<tr><td>2013.03</td></tr>
</table>

Source: central banks' web pages.

Table 3. Brief overview of the inflation projection published by NB in the years 2001-2013

Inflation Report	Inflation projections					
	Projection horizon [quarter]	Number of projections per year	Main assumption (repo rate)	Headline inflation	Core inflation	
					CPIXE	CPI-ATE
2001.01	8	3	CIR		CPIXE	
2001.02						
2001.03	no data		no data	no data	no data	no data
2002.01	8		CIR			CPI-ATE
2002.02			ME			
2002.03						
2003.01			CIR and ME			
2003.02						
2003.03			no data	no data	no data	no data
2004.01			ME			CPI-ATE
2004.02						
2004.03						
2005.01						
2005.02						
2005.03			Endogenous rate			
2006.01						
2006.02	15			CPI		
2006.03	13					
2007.01	16					
2007.02	14					
2007.03	13					
2008.01	16					
2008.02	15				CPIXE	
2008.03	13					
2009.01	15					
2009.02	14					
2009.03	13					
2010.01	16					
2010.02	15					
2010.03	13					
2011.01	16					
2011.02	15					
2011.03	13					
2012.01	16					
2012.02	15					
2012.03	13					
2013.01	16	4				
2013.02	15					
2013.03	14					
2013.04	13					

Source: central banks' web pages.

Table 4. Brief overview of the inflation projection published by CNB in the years 2002-2013

Inflation Report	Inflation projections				
	Projection horizon [quarter]	Number of projections per year	Main assumption (repo rate)	Headline inflation	MPRI inflation
2002.03	9	4	Endogenous	CPI	
2002.04	9				
2003.01	9				
2003.02	8				
2003.03	9				
2003.04	9				
2004.01	9				
2004.02	8				
2004.03	9				
2004.04	9				
2005.01	9				
2005.02	8				
2005.03	9				
2005.04	9				
2006.01	9				
2006.02	8				
2006.03	9				
2006.04	9				
2007.01	9				
2007.02	8				
2007.03	9				
2007.04	9				
2008.01	9				MPRI
2008.02	8				
2008.03	9				
2008.04	9				
2009.01	9				
2009.02	8				
2009.03	9				
2009.04	9				
2010.01	9				
2010.02	8				
2010.03	9				
2010.04	9				
2011.01	9				
2011.02	8				
2011.03	9				
2011.04	9				
2012.01	9				
2012.02	8				
2012.03	9				
2012.04	9				
2013.01	9				
2013.02	8				
2013.03	9				
2013.04	9				

Source: central banks' web pages.

Table 5. Main information about selected central banks

Central banks	The Norwegian Central Bank	Swedish National Bank	Czech National Bank
Inflation target in 2013	2.5 % (+/- 1 %)	2 %	2.5 % (+/- 1 %)
Type of inflation target	Quantitative point with symmetrical deviations		
Date of introduction of inflation target	2001	1995	1998

Source: (Giavazzi and Mishkin, 2006); (*Monetary policy in …,* 2010).

Table 6. Forecasting models in selected central banks

Central Bank	DSGE model	Measure of inflation in a reaction function	Years
NB	NEMO	Headline	2006-2013
CNB	G3	Headline	2008-2013
SR	RAMZES	Headline	2007-2013

Source: (Adolfson, *et. al.*, 2007), (Adolfson, *et. al.*, 2008), (Brubakk, *et. al*., 2006), (Coats, *et. al.*, 2005).

Table 7. The tests performed in the research

Forecast horizon	Inflation projections' deviations from the inflation target							
	Swedish National Bank		The Central Bank of Norway				Czech National Bank	
	CPI	CPIF	CPI	CPI-ATE	CPI	CPIXE	CPI	MPRI
1 year	Sign test		Sign test		Sign test		Sign test	
	Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test	
2 years	Sign test		Sign test		Sign test		Sign test	
	Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test	
3 years	Sign test		Sign test		Sign test			
	Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test		Wilcoxon Matched Pairs Test			

Source: Own.

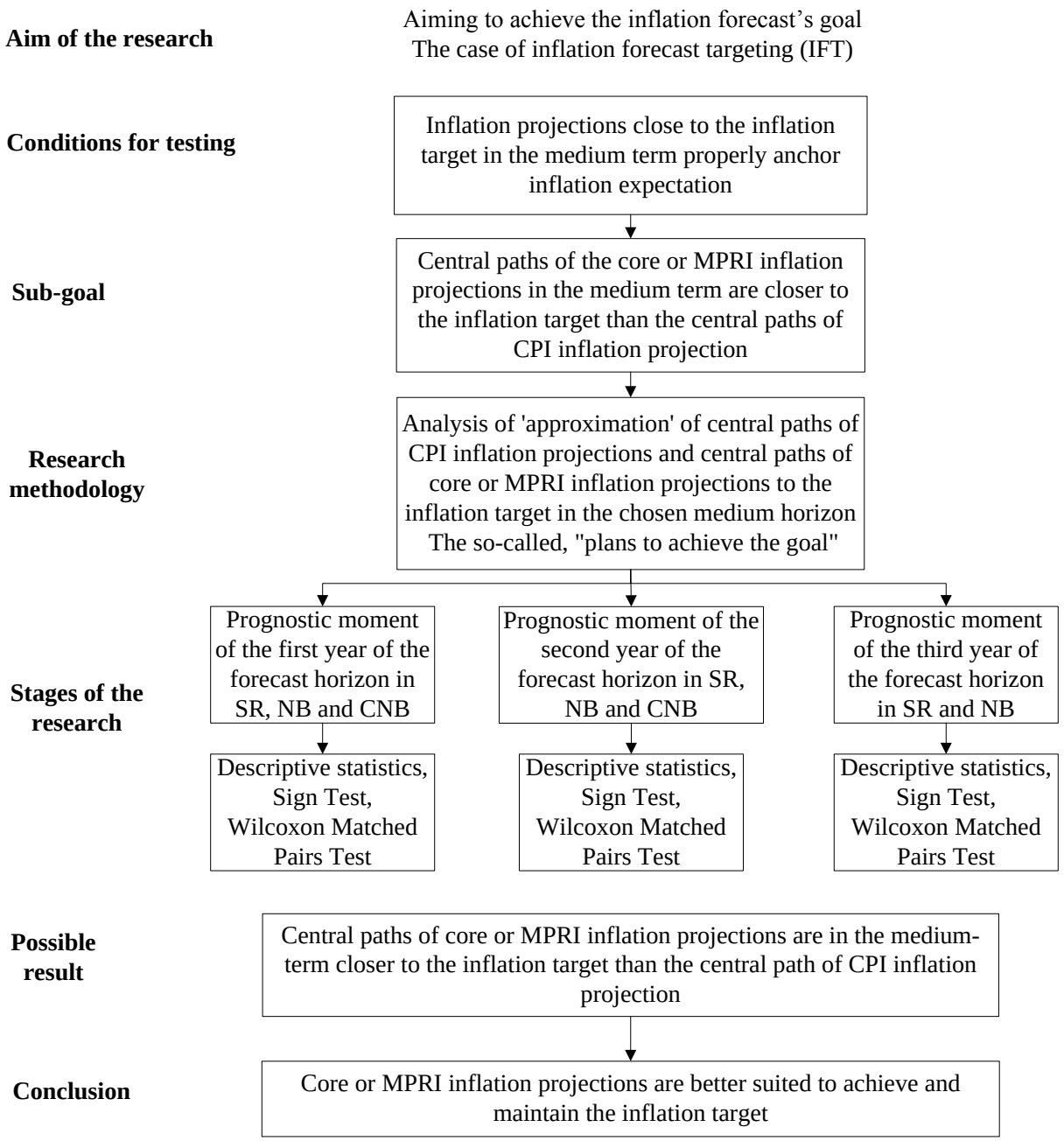


Figure 1. Four steps of the research

Source: Own.

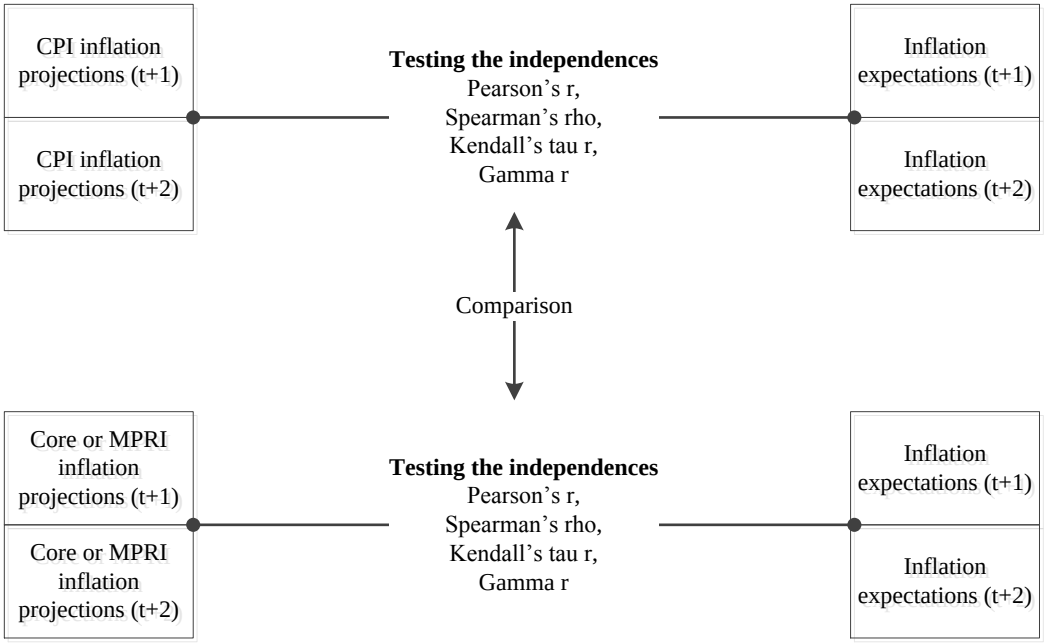


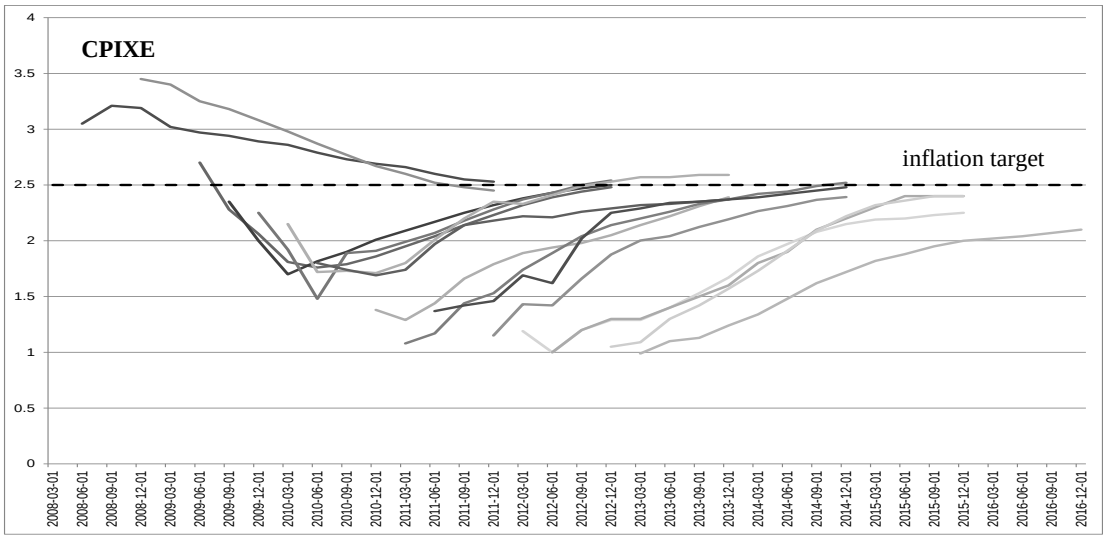
Figure 2. The fifth step of the research

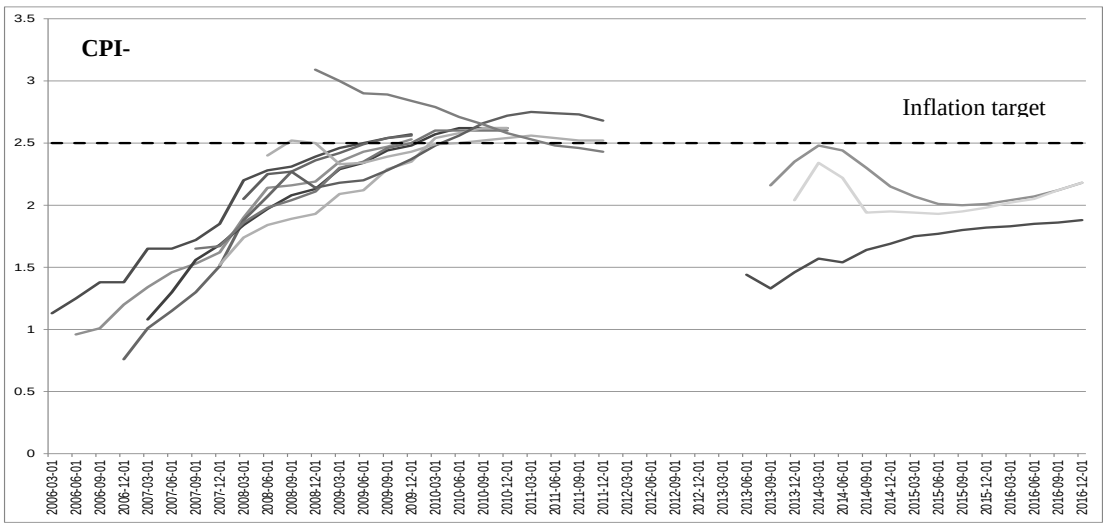
Source: Own.

Table 8. Detailed information on the inflation projections in the research

	The Central Bank of Norway, Inflation Report: 2006-2013			**Swedish National Bank, Inflation Report: 2007-2013**			**Czech National Bank, Inflation Report: 2008-2013**	
	CPI Projection	**Core inflation projection**		**CPI Projection**	**Core inflation projection**		**CPI Projection**	**MPRI Projection**
		CPI-ATE	**CPIXE**		**CPIX**	**CPIF**		
Years	2006-2013	2006-2008; 2013	2008-2013	2007-2013	2007-first report of 2008	2010-2013	2008-2013	2008-2013
Measure description	Consumer Price Index	CPI adjusted for tax changes and excluding energy products	CPI adjusted for tax changes and excluding temporary changes in energy prices.	Consumer Price Index	CPI excluded from mortgage interest expenditure and effects of indirect taxes and subsidies	CPI with a fixed mortgage rate	Consumer Price Index	Headline inflation adjusted for first-round effects of changes in indirect taxes
Number of projections per year	4			3			4	
Main assumption	Endogenous instrument rate							
Horizon	3 years						2 years	

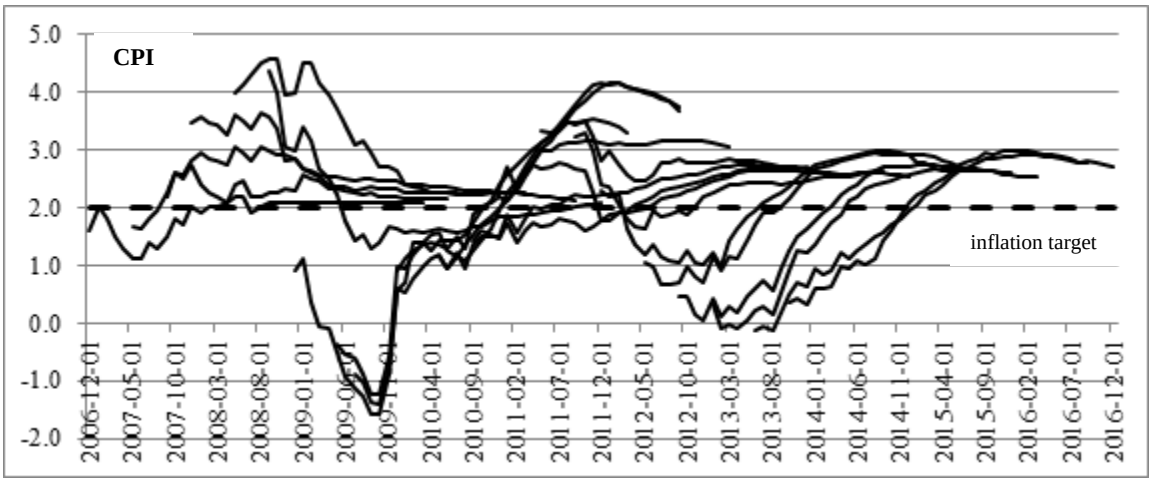
Source: (Giavazzi and Mishkin, 2006); (*Monetary policy in …,* 2010); (*UND1X changes its…,* 2007).

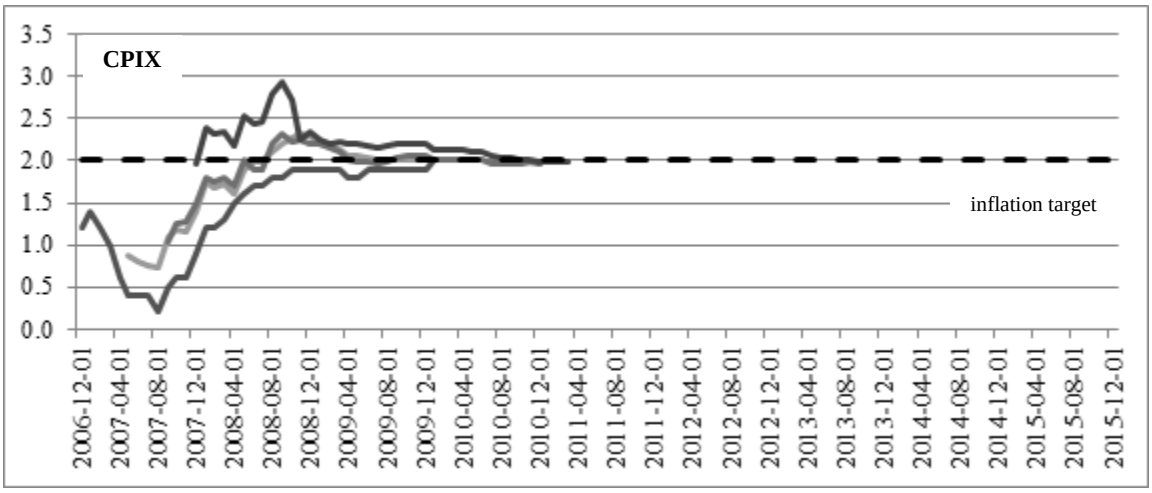


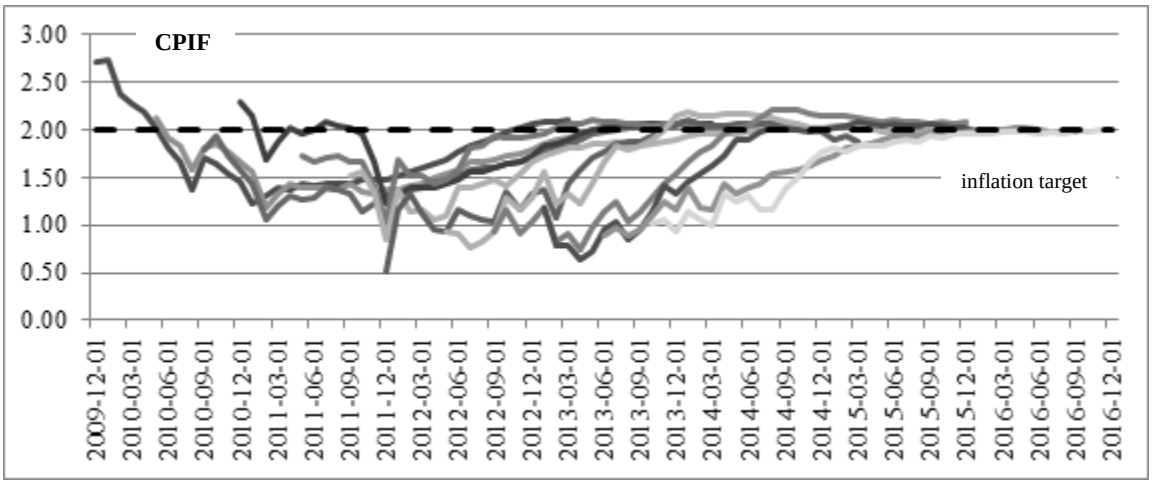


Figures 3-5. Central paths of the CPI, CPIXE and CPI-ATE inflation projections in NB

Source: Own calculations.

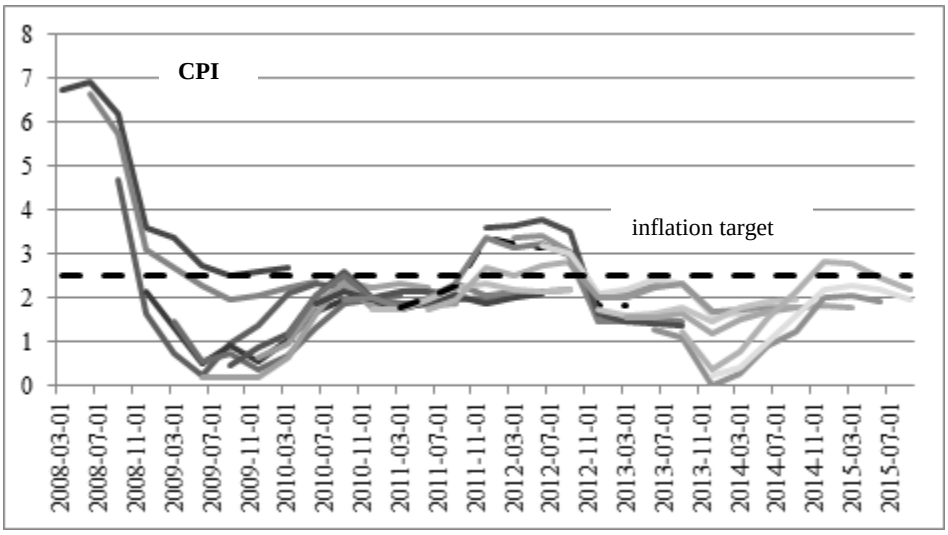


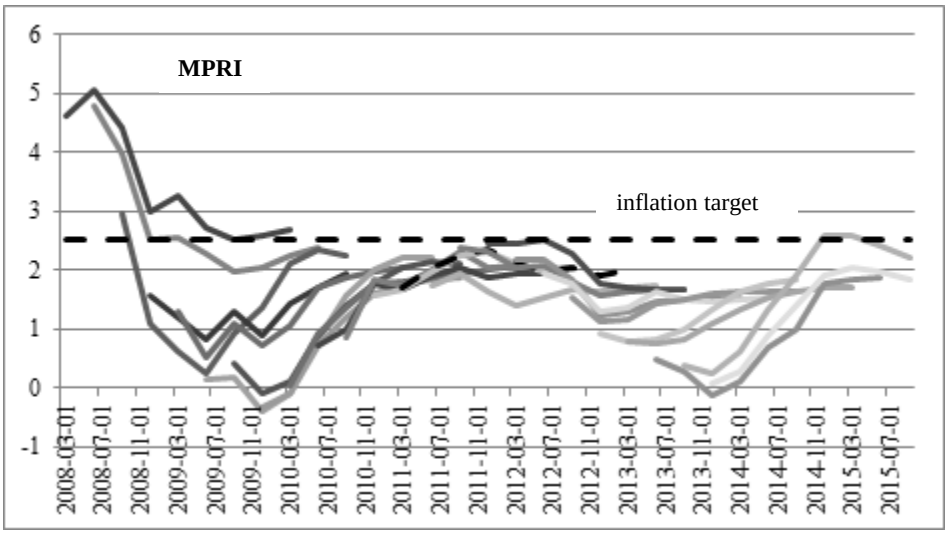




Figures 6-8. Central paths of the CPI, CPIX and CPIF inflation projections in SR

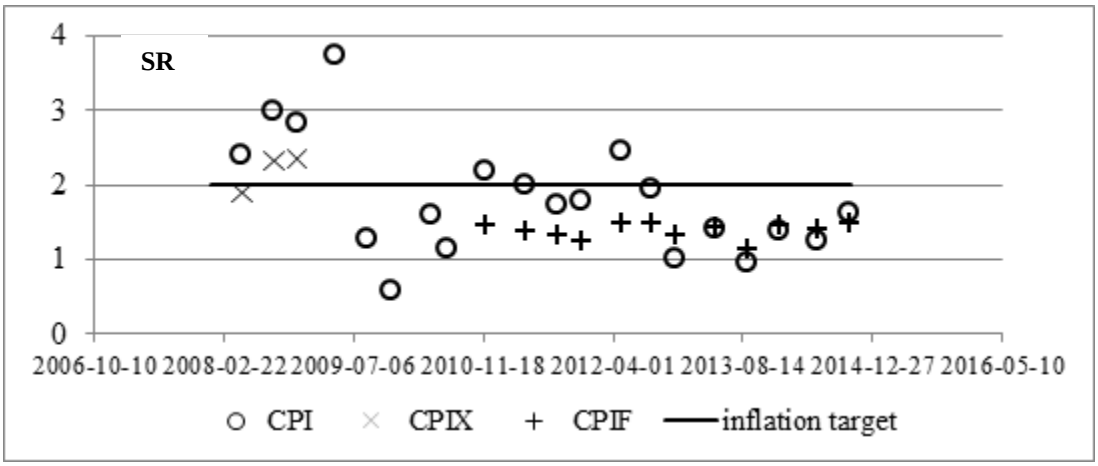
Source: Own calculations.

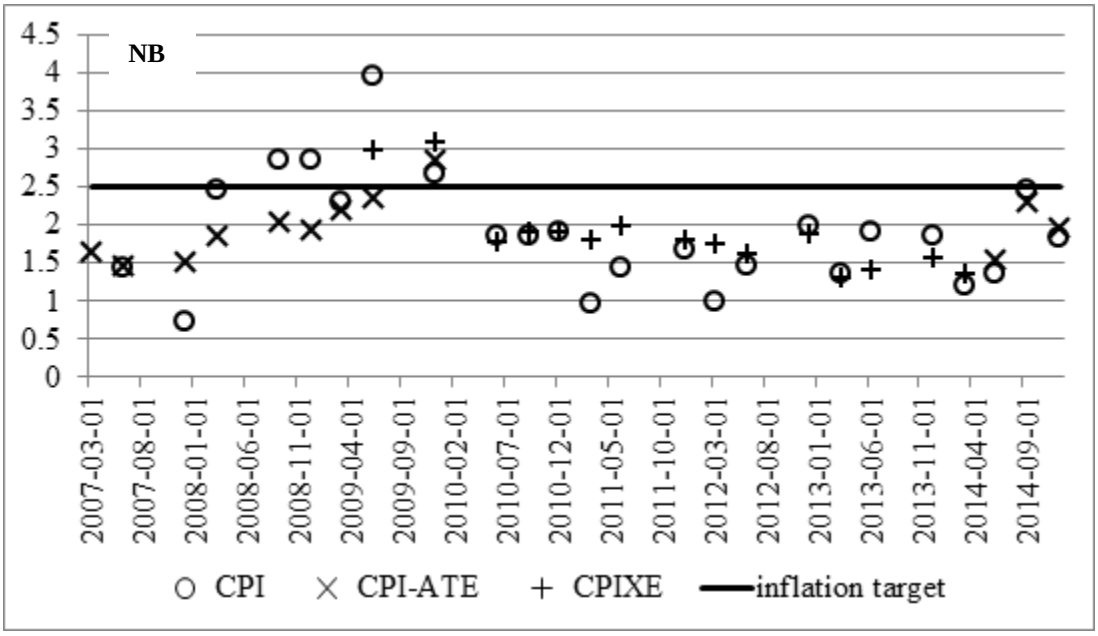


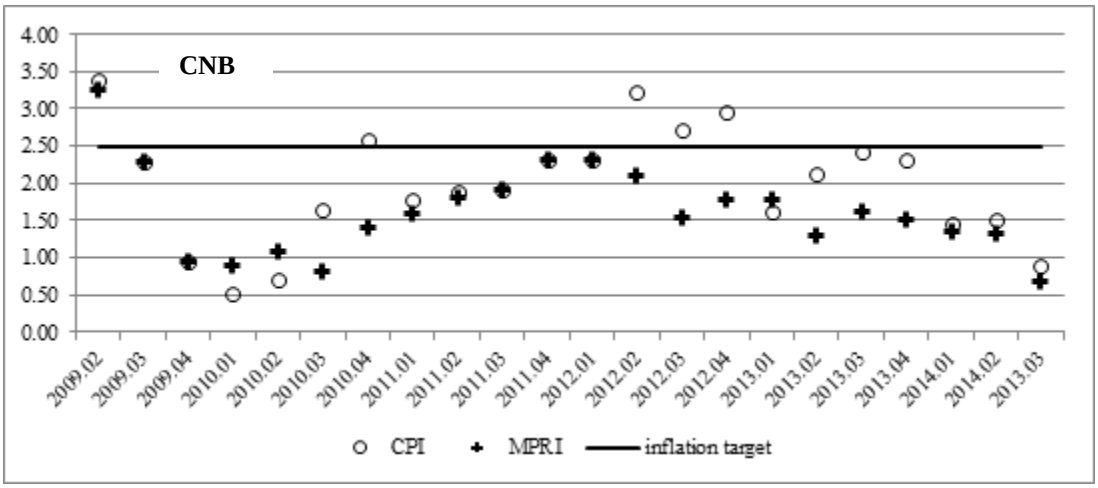


Figures 9-10. Central paths of the CPI and MPRI inflation projections in CNB

Source: Own calculations.

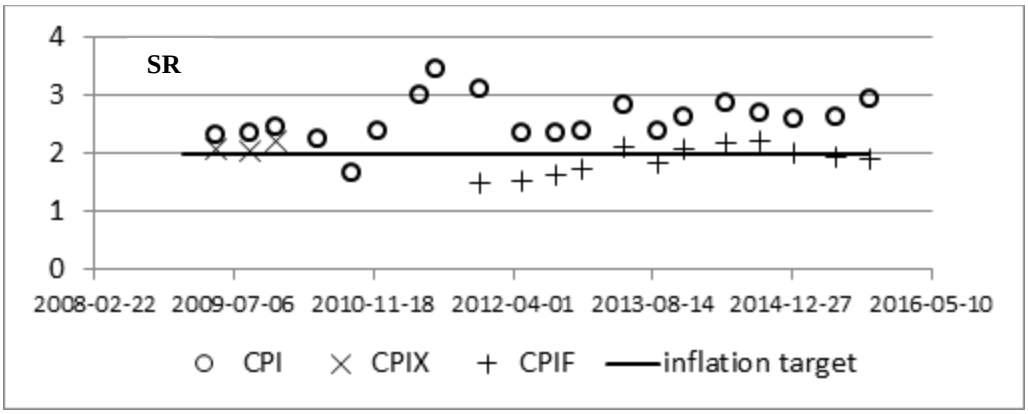


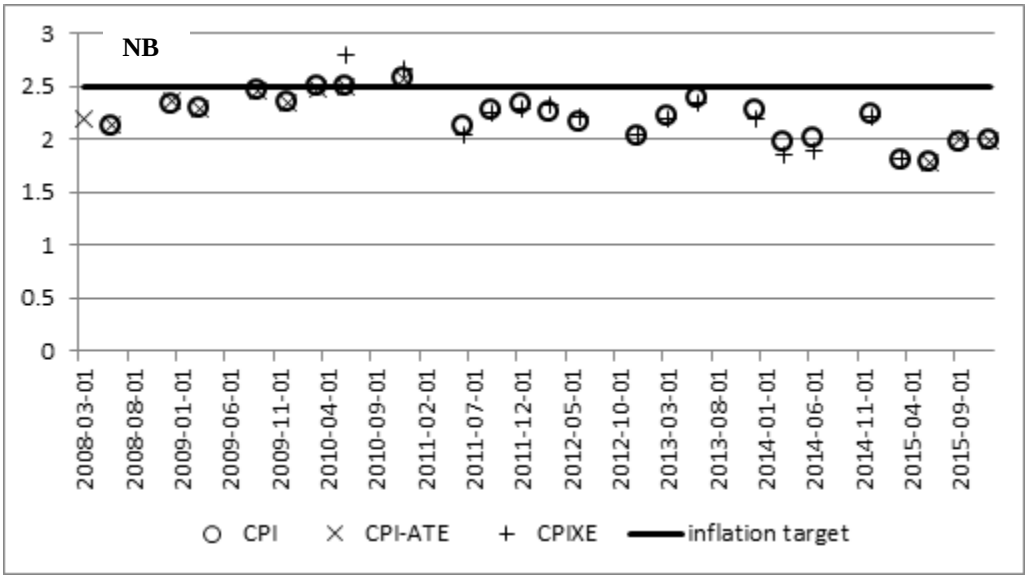


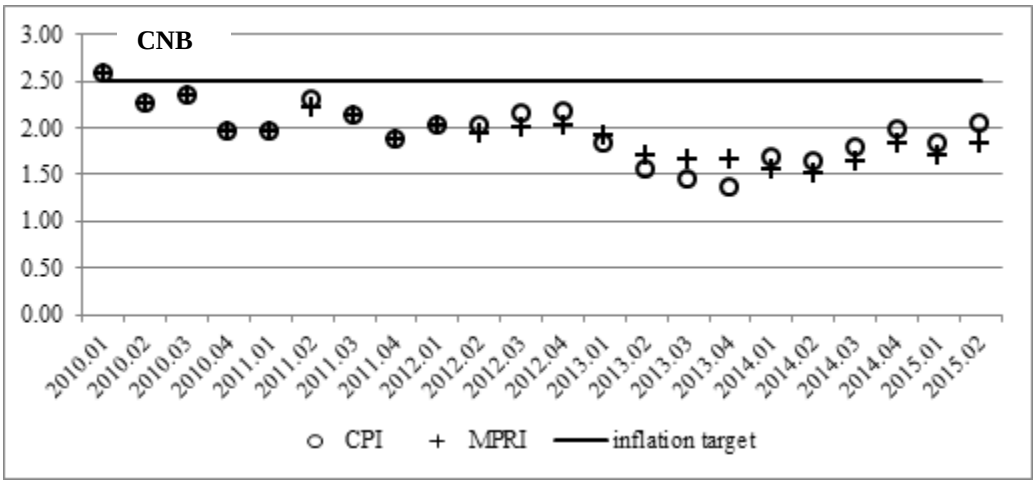


Figures 11-13. The values of the central paths of CPI inflation projection, core and MPRI inflation projections at the prognostic moment of the first year of the forecast horizon in SR, NB, CNB

Source: Own calculations.







Figures 14-16. The values of the central paths of the CPI inflation projections and core inflation projections at the prognostic moment of the second year of the forecast horizon in SR, NB and CNB

Source: Own calculations.

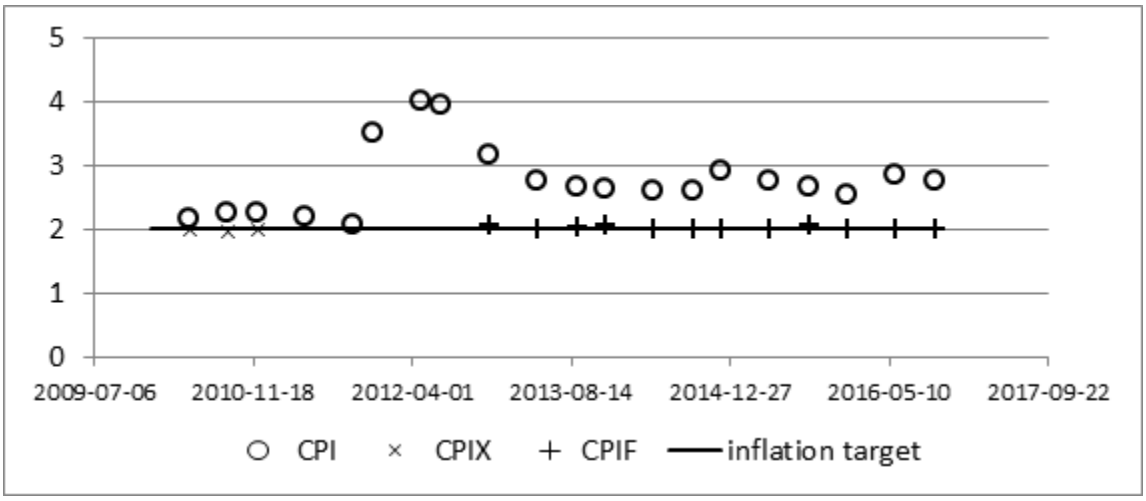


Figure 17. The values of the central paths of CPI inflation projections and central paths of core inflation projections at the prognostic moment of the third year of the forecast horizon in SR

Source: Own calculations.

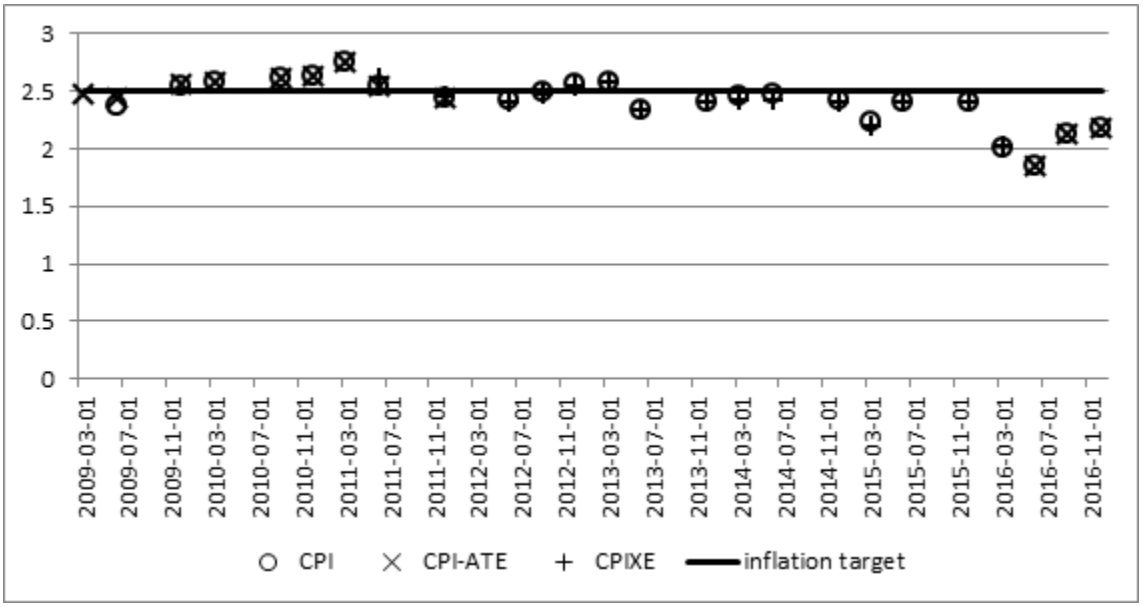


Figure 18. The values of the central paths of CPI inflation projections and core inflation projections at the prognostic moment of the third year of the forecast horizon in NB

Source: Own calculations.

Table 9. Relationships between the central paths of CPI and core or MPRI inflation projections and inflation target in central banks of Sweden, Norway and Czech Republic

Forecast horizon	Feature	Swedish National Bank		The Central Bank of Norway				Czech National Bank	
		CPI inflation projections	CPIF inflation projections	CPI inflation projections	CPI-ATE inflation projections	CPI inflation projections	CPIXE inflation projections	CPI inflation projections	MPRI inflation projections
One year	Data	2010-2014		2007-2009; 2014		2009-2014		2009-2014	
	Relationship	Different		Different		Different		Different	
	Achieve the inflation target	No	No	No	No	No	No	No	No
Two years	Data	2011-2015		2008-2010; 2015		2010-2015		2010-2015*	
	Relationship	Different		Similar		Similar		Similar*	
	Achieve the inflation target	No	Yes	Yes	Yes	No	No	No*	No*
Three years	Data	2012-2016*		2009-2011; 2016*		2011-2016*			
	Relationship	Different*		Similar*		Similar*			
	Achieve the inflation target	No*	Yes*	Yes*	Yes*	Yes*	Yes*		

*The end of the forecast horizon.

Source: Own calculations.

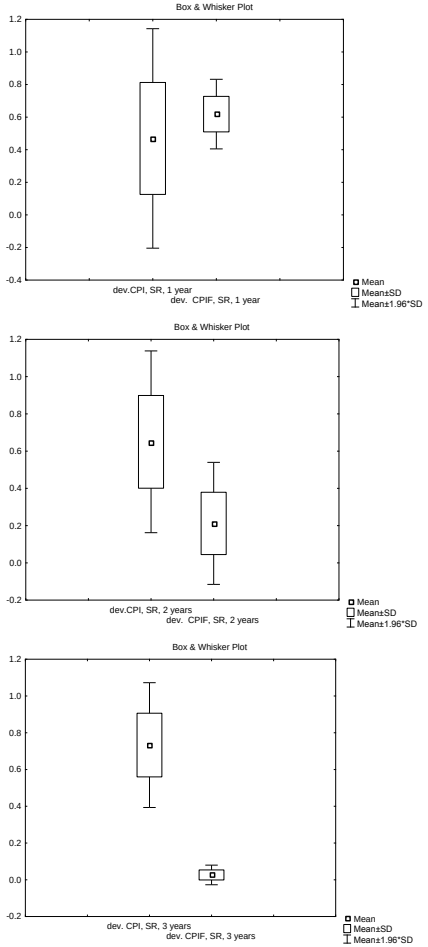
Table 10. Deviations of the central paths of the CPI and core inflation projections from the inflation target at the prognostic moments of the first, second, and third year of the forecast horizon in Sweden, Norway and Czech Republic- descriptive statistics and differences tests

Time horizon	Statistics	Swedish National Bank		The Central Bank of Norway				Czech National Bank	
		CPI	CPIF	CPI	CPI-ATE	CPI	CPIXE	CPI	MPRI
1 year	Data	2010-2014	2010-2014	2007-2009, 2014	2007-2009, 2014	2009-2014	2009-2014	2009-2014	2009-2014
	Sample	12	12	11	11	15	15	22	22
	Mean	0.4692	0.6183	0.6627	0.5682	0.9176	0.7722	0.7375	0.9510
	Median	0.4250	0.5900	0.3500	0.5500	0.8400	0.7100	0.6733	0.9305
	Min	0.0100	0.5100	0.0400	0.1600	0.1500	1.5500	0.0655	0.1724
	Max	1.0500	0.8600	1.7700	1.0400	0.4700	1.2100	1.9732	1.8303
	Std. Dev.	0.3437	0.1090	0.6075	0.3147	0.4190	0.2343	0.5707	0.4825
	Sign test	p=0.7728		p=1.0000		p=0.7893		p=0.3588	
	Wilcoxon Matched Pairs Test	p=0.1823		p=0.9292		p=0.2719		p=0.0642	
2 years	Data	2011-2015	2011-2015	2008-2010, 2015	2008-2010, 2015	2010-2015	2010-2015	2010-2015	2010-2015
	Sample	12	12	11	11	15	15	22	22
	Mean	0.6500	0.2119	0.2591	0.2500	0.3036	0.3512	0.5592	0.5874
	Median	0.6400	0.1650	0.1800	0.1500	0.2700	0.2900	0.5347	0.5749
	Min	0.3600	0.0200	0.0000	0.0000	0.0000	0.1600	0.0797	0.0797
	Max	1.1200	0.5200	0.7300	0.7300	0.7100	0.6800	1.1319	1.0029
	Std. Dev.	0.2490	0.1671	0.2481	0.2429	0.1899	0.1736	0.2857	0.2528
	Sign test	p=0.04331*		p=0.6171		p=0.1213		p=0.1814	
	Wilcoxon Matched Pairs Test	p=0.0060**		p=0.1441		p=0.0409*		p=0.3967	
3 years	Data	2012-2016	2012-2016	2009-2011, 2016	2009-2011, 2016	2011-2016	2011-2016		
	Sample	12	12	11	11	15	15		
	Mean	0.7331	0.0264	0.1982	0.1936	0.1183	0.1292		
	Median	0.7084	0.0200	0.1200	0.1000	0.0800	0.1000		
	Min	0.5300	0.0000	0.0400	0.6500	0.0100	0.0300		
	Max	1.1500	0.0700	0.0400	0.6500	0.5000	0.4800		
	Std. Dev.	0.1732	0.0273	0.1889	0.1907	0.1237	0.1176		
	Sign test	p=0.0015**		p=0.4795		p=0.5465			
	Wilcoxon Matched Pairs Test	p=0.0022**		p=0.6547		p=0.0559			

*Significant at 0.05 level.

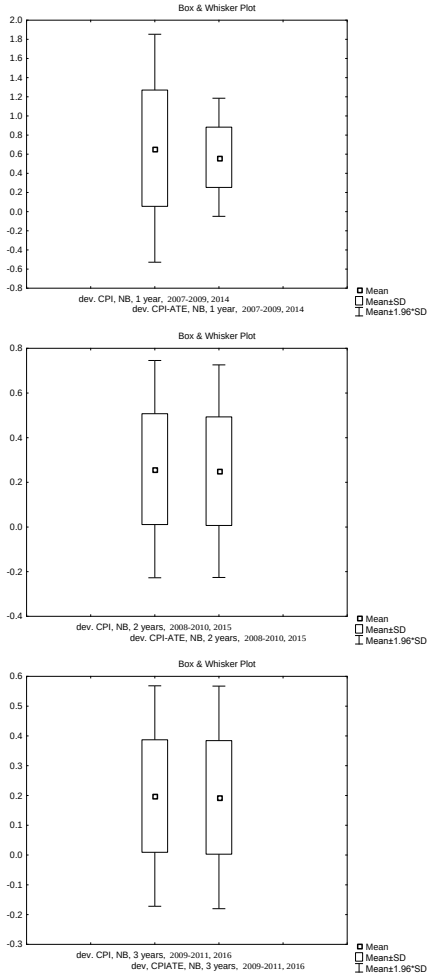
** Significant at 0.01 level.

Source: Own calculations.



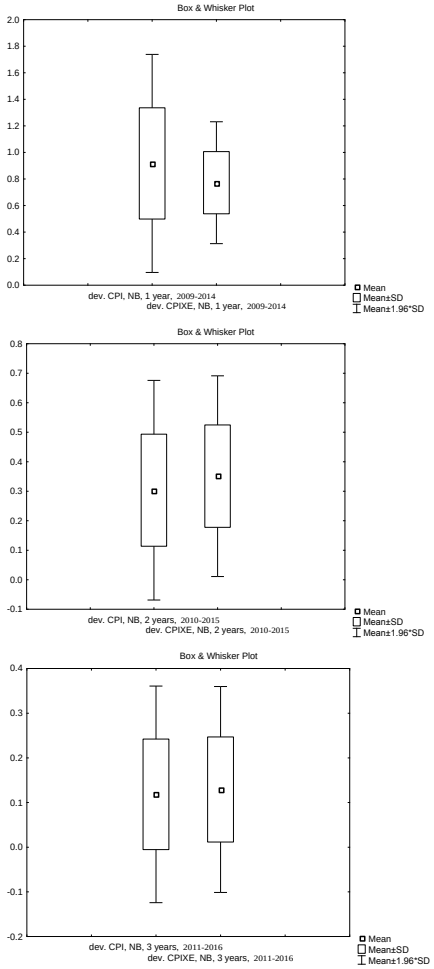
Figures 19-21. Box & Whisker plots for deviations of CPI and CPIF forecasts from inflation target in SR

Source: Own.



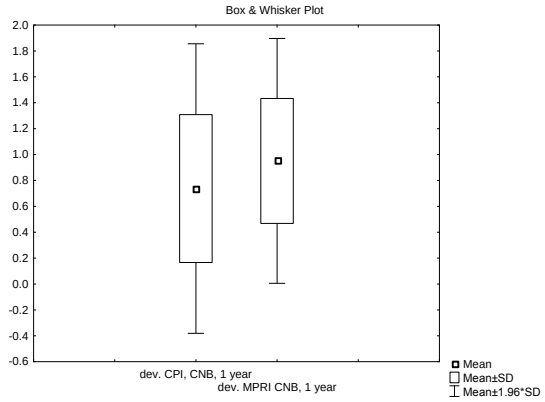
Figures 22-24. Box & Whisker plots for deviations of CPI and CPI-ATE forecasts from inflation target in NB

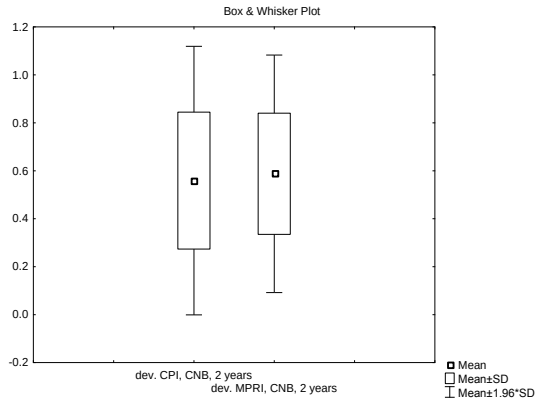
Source: Own.



Figures 25-27. Box & Whisker plots for deviations of CPI and CPIXE forecasts from inflation target in NB

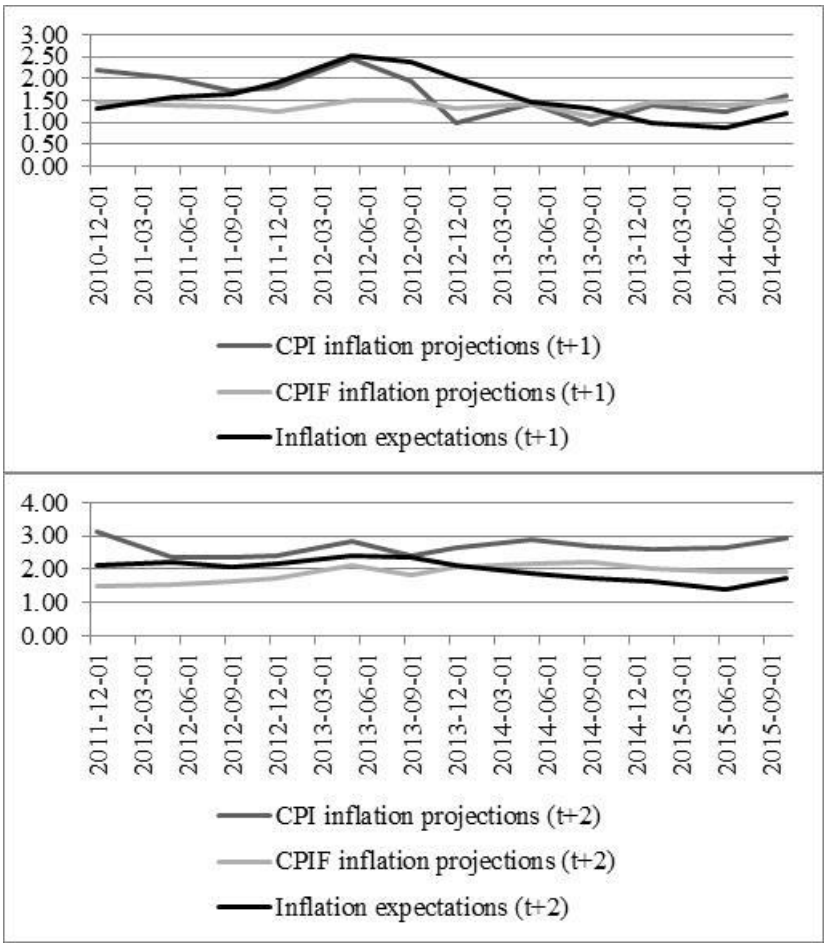
Source: Own.





Figures 28-29. Box & Whisker plots for deviations of CPI and MPRI forecasts from inflation target in Czech Republic

Source: Own.



Figures 30-31. Inflation projections of CPI and CPIF at the prognostic moment of first and second year forecast horizon and inflation expectations one and two years ahead in Sweden

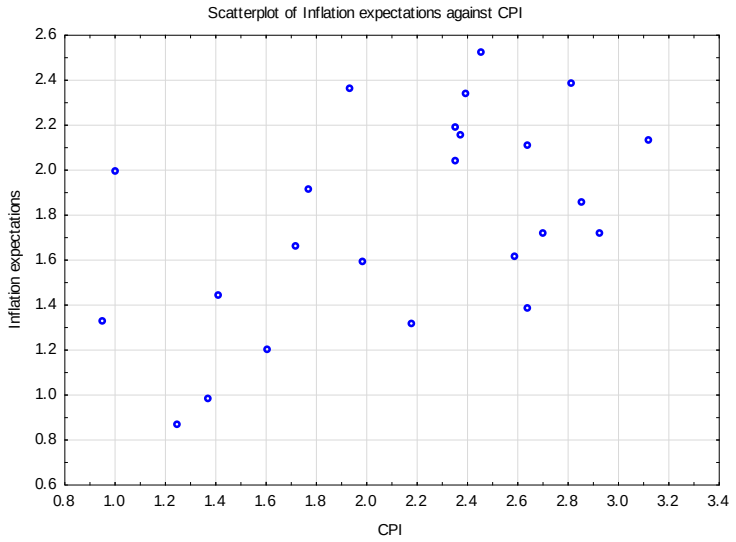
Source: Own caclulations.

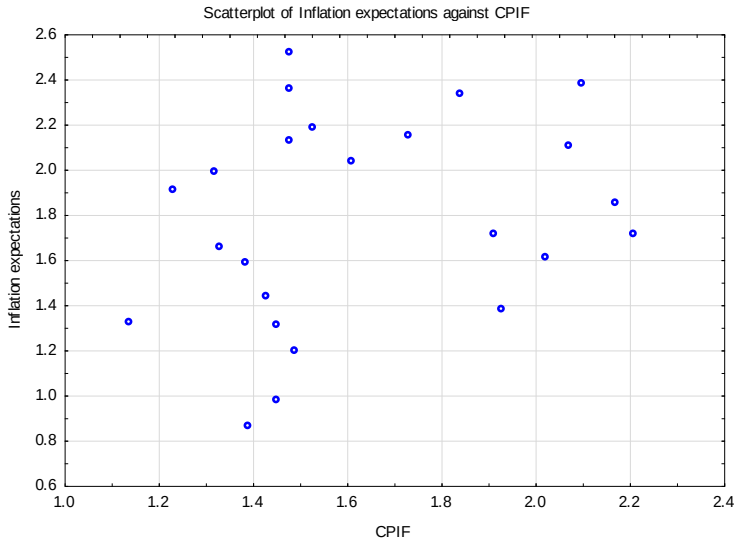
Table 11. CPI and CPIF inflation projections versus inflation expectations- correlation coefficients

Coefficient	Inflation projections versus inflation expectations (t+1 and t+2)	
	CPI	CPIF
Pearson product-moment correlation coefficient	0.51*	0.26
Spearman's rank correlation coefficient	0.47*	0.33
Kendall rank correlation coefficient	0.35*	0.19
Goodman and Kruskal's gamma rank correlation coefficient	0.34*	0.19

*Significant at 0.05 level.

Source: Own calculations.





Figures 32-33. Scatterplots of inflation expectations against the CPI and CPIF inflation projections in Sweden

Source: Own calculations.

Original citation: Tura-Gawron K. (2016). What is the central bank effectively targeting in practice? Svensson's concept of inflation forecast targeting and measures of inflation projections - the experiences of selected European countries. GUT FME Working Papers Series A, No 8/2016(38). Gdansk (Poland): Gdansk University of Technology, Faculty of Management and Economics.

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