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CNB CZECH NATIONAL BANK

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The Exchange Rate as an Instrument at Zero Interest Rates: The Case of the Czech Republic

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Abstract

This study examines the use of the exchange rate by the Czech National Bank as a monetary policy instrument at the zero lower bound on interest rates. It provides a review of the economic literature on unconventional monetary policy instruments and particularly on the possibility of using the exchange rate. It explains the CNB's reasons for further easing monetary policy and for choosing the exchange rate instrument and its specific level, and discusses its expected benefits in the case of the Czech Republic. It also explains why the CNB ultimately decided to transparently declare a one-sided exchange rate commitment with potentially unlimited foreign exchange interventions. The article concludes by assessing the impacts of the exchange rate weakening on the Czech economy to date, as compared to what the CNB had expected, and by describing the public debate of the CNB's action and related changes in its communication strategy.

JEL Codes: E31, E37, E58, F31.

Keywords: Asymmetric exchange rate commitment, deflation, exchange rate, foreign exchange interventions, inflation expectations, monetary policy, unconventional instruments, zero lower bound.

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We devote this paper to the memory of Kateřina Šmídková, who started working on it but did not live to see its completion.

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Nontechnical Summary

On 7 November 2013, the Czech National Bank (CNB) started to use the exchange rate as an instrument within its inflation targeting regime in the form of a publicly declared, one-sided exchange rate commitment. The CNB took this step after its monetary policy rates had hit the zero lower bound (ZLB) in autumn 2012 and the need to ease the monetary conditions further had gradually increased, with observed and forecasted inflation both heading well below the central bank's two per cent target and the Czech economy experiencing the longest recession in its independent history. The CNB's analyses were indicating that inflation would turn negative in early 2014 and there was a danger that this would turn into long-term deflation with all its adverse impacts on the economy.

The use of the exchange rate as an instrument to escape a liquidity and deflation trap is already recommended in the economic literature dating from the early 2000s in response to the Japanese experience. For example, McCallum (2000) showed that a central bank in an open economy can devalue the domestic currency to stabilise inflation and the real economy at the ZLB. Svensson (2001) proposed a "foolproof" way of escaping from a liquidity trap for an open economy. His recipe consists of a price-level target path, a devaluation of the currency and a temporary exchange rate peg, followed by a return to floating exchange rate and a switch to standard price-level or inflation targeting. This, he concludes, "will jump-start the economy and escape deflation by a real depreciation of the domestic currency, a lower long real interest rate, and increased inflation expectations". Turning to more recent studies, exchange rate policy and massive exchange rate interventions are mentioned as a possible form of unconventional monetary policy at the ZLB in Borio and Disyatat (2010) and Stone et al. (2011), for example.

From a terminological perspective, the use of foreign exchange interventions can be defined as an approach where the size of foreign currency purchases in the market is specified but the impact on the exchange rate is uncertain and depends on market conditions. By contrast, the use of the exchange rate as an instrument at the ZLB can be defined as an approach where the central bank chooses – and possibly also publicly declares – the specific exchange rate level it wants to attain and is prepared to intervene in the foreign exchange market in unspecified and unlimited amounts to attain that level. The CNB's choice in the form of the declaration of an asymmetric exchange rate commitment falls into the latter category and therefore differs fundamentally from the use of standard foreign exchange interventions.

However, practical experience with the use of the exchange rate as an instrument of unconventional monetary policy is limited. The central banks of Israel and Chile used foreign exchange interventions in 2008–2009, but did not reach the ZLB. The Swiss National Bank de facto set a minimum exchange rate (floor) for the franc in 2011 after a series of none too successful ad-hoc interventions. However, its primary motive was to respond to the strong appreciation caused the franc's safe haven status, not to hit the inflation target. With its action, the CNB is therefore creating a unique experience, and the aim of this study is to share that experience with the academic community and other central banks that might be considering using the same instrument in the future.

First, the CNB's experience shows how useful it is to have a structural general equilibrium model, as such models make it possible to take into account the change in the behaviour of the economy and quantify the impacts of using the exchange rate as an instrument at the ZLB. In an environment of zero interest rates, the strength of the pass-through of the exchange rate weakening to prices increases

(as does the strength of the response of the economy to other types of shocks), because the monetary policy authority does not react to the weaker exchange rate by raising interest rates as usual. Moreover, a weakening of the exchange rate by the central bank is not a short-term shock but rather a long-term change in its key monetary policy instrument. This significantly strengthens the expectations channel and thus also the total impacts on prices. This fact is difficult to take into account with non-structural models based solely on observed data series. On the other hand, the structural models used by central banks usually contain a relatively strong assumption that inflation expectations are anchored in the long term by the central bank's target, hence these models may underestimate the risk of long-term deflation. It is therefore useful to apply other analytical approaches in parallel.

Second, the developments to date show that a publicly declared, asymmetric exchange rate commitment, i.e. the exchange rate level below which the CNB will not let the currency appreciate, using potentially unlimited foreign exchange interventions to this end, was the right choice. This exchange rate commitment quickly established a high degree of credibility. Interventions to support it have so far been needed only in the first few days after it was announced.

Third, the exchange rate weakening sparked a very lively public debate. This debate required the central bank to explain the main building blocks of monetary policy, such as the definition of price stability, the inflation target level, the costs of excessively low inflation or even deflation caused by insufficient demand, and the functioning of the monetary policy transmission mechanism. The CNB responded by making its communication procedures faster and more direct and by strengthening institutional communication relative to presentation of the Bank Board members' individual views. This debate at the same time demonstrates that an exchange rate weakening is an effective tool for breaking deflation expectations and lowering real interest rates, which is a key condition for success of the chosen strategy corresponding to the recommendations made in the economic literature. In particular, most critics – probably inadvertently – helped to anchor inflation expectations sufficiently far from deflation, which led to a decline in ex ante real interest rates, thus halting the rise in the saving rate and boosting consumption and investment.

At the time of writing, the risk of protracted deflation in the Czech Republic is a virtually closed topic and foreign trade and domestic demand are recovering even faster than the CNB expected when it decided to act. Going forward, this should mean that the domestic economy will start to generate sustained inflation pressures, allowing the CNB to start considering exiting the use of the exchange rate as a monetary policy instrument. However, more disinflationary developments in the euro area and a drop in administered prices have led to lower observed inflation, a slower expected return of inflation to the target over the forecast horizon (without the originally intended exceeding of the target in 2015) and to the postponement of the expected exit until 2016. However, it is too early to properly assess the evolution of the economy since the announcement of the exchange rate commitment.

1. Introduction

The global financial and economic crisis and the ensuing economic contraction and decline in inflation forced many central banks to start using extraordinary (non-standard or unconventional) monetary policy instruments. The Federal Reserve, the Bank of England (BoE) and the European Central Bank (ECB) purchased securities and injected massive amounts of liquidity into the economy in 2007–2013. In September 2011 the Swiss National Bank (SNB) announced a minimum exchange rate (floor) of the franc against the euro backed by interventions in the foreign exchange market.

In 2007–2012, the Czech National Bank (CNB) got by with standard monetary policy tools. Between August 2008 and November 2012 it cut its policy rates by almost 4 percentage points.[1] From mid-2008 onwards, the monetary policy easing was also strongly aided by a spontaneous depreciation of the Czech koruna in response to a contraction in both external demand and the domestic economy. The exchange rate at that time proved its ability to act as an automatic adjustment mechanism, a mechanism available to the Czech economy thanks to its independent monetary policy.[2]

So, it was not until November 2013 that the CNB resorted to using an extraordinary instrument. That instrument was the exchange rate of the koruna (previously, at the end of 2012, it had also used strengthened "forward guidance"). The CNB took this step after it had eased the monetary conditions as far as it could by lowering monetary policy rates to "technical zero" level, at a time when the impacts of the global financial and economic crisis and the subsequent European debt crisis were subsiding only slowly. The CNB's forecasts and supplementary analyses were meanwhile making it increasingly plain that this easing would not be sufficient to keep inflation on target and reduce the risks of deflation. The CNB therefore announced that it would (if necessary) intervene in the foreign exchange market to weaken the koruna so as to maintain the exchange rate close to CZK 27 to the euro. The CNB also stated that it was resolved to intervene in the FX market in such volumes and as long as needed to achieve the desired exchange rate level with the aim of smoothly hitting its inflation target in the future.

The decision to use the exchange rate of the koruna as a monetary policy instrument was preceded by a series of internal discussions. Those discussions started at the general level back in 2009 and became increasingly specific between 2012 and autumn 2013 (including intensive work on seeking a suitable way of modelling the zero lower bound on interest rates). In these discussions, CNB experts considered how the CNB should react to the potential risk of a protracted undershooting of the inflation target or even the onset of deflation in a situation of zero interest rates. They assessed all the options discussed in the literature in the context of zero rates: forward guidance, quantitative and qualitative easing, and foreign exchange interventions or the exchange rate. Given the high openness of the Czech economy, with its well researched exchange rate transmission, long-term liquidity surplus in the banking sector and relatively shallow markets for private debt instruments, the CNB eventually opted to use the exchange rate of the domestic currency coupled with intensive communication to anchor inflation expectations in the long term.

[1] In addition, the CNB in 2009 introduced liquidity-providing repo operations to prevent banks from experiencing liquidity problems and to support the functioning of the government bond market. Such operations can of course be viewed as supplementing the CNB's standard instruments.

[2] It is important to emphasise that the CNB made no interventions in the foreign exchange market between autumn 2002 and November 2013.

This study aims to provide the academic community[3] with more details about the content of those discussions, starting from theoretical foundations (section 2) through analyses indicating a need for the CNB to further ease monetary policy (section 3) to a description of the strategy finally chosen in November 2013 (section 4). This description shows that in addition to the specific features of the Czech economy, the CNB took into account the theoretical literature and the experience of other countries that have used foreign exchange interventions at the zero lower bound (ZLB). The Czech strategy differs from that of Switzerland and Japan and identifies new ways of dealing with the situation of zero rates. The study also assesses the experience to date with the Czech approach to using the exchange rate as a monetary policy instrument at the ZLB (section 5). Its findings (summarised in section 6) may be useful to other countries considering using a similar tool either now or at some point in the future (see also Alichi et al., 2014).

The CNB's experience may be valuable in at least three areas. The first is the approach chosen to creating monetary policy scenarios, using a structural DSGE model to characterise the change in the behaviour of the economy at the ZLB, and the discussion of the risks of such scenarios with the use of satellite models. The second is the experience gained during the CNB's internal debate on how to use the exchange rate as a monetary policy instrument at the ZLB and how transparent that instrument should be. This eventually led to the public declaration of an exchange rate commitment, which then quickly gained strong credibility among financial market participants. The third area is the public debate that followed the central bank's decision. This debate required the CNB to very actively explain "axiomatic" elements of its monetary policy regime and led to a change in some features of the CNB's communication strategy. In addition, the Czech central bank's future experience of the exit from the use of the exchange rate as a monetary policy tool can be expected to be valuable. The exit strategy was considered during the debate on entering the new regime. However, it was not possible to assess this aspect at the time of writing.

2. Theoretical Foundations, Literature Review and Experience of Other Countries

2.1 The Zero Lower Bound in the Economic Literature

When deciding on the use of foreign exchange interventions and the exchange rate at the ZLB, the CNB considered the debate in the academic literature. The current ZLB literature is based on an earlier debate of monetary policy options at the ZLB. That debate was inspired mainly by developments in Japan in the decade preceding the economic crisis (Krugman, 1998a; McCallum, 2000; Coenen and Wieland, 2003; Svensson, 2006). However, it was also motivated by the situation in the USA at the start of the millennium (Eggertsson and Woodford, 2003), when the stabilisation of inflation at very low levels during the "Great Moderation" made it possible for interest rates to decline to near-zero levels.[4] The literature therefore examined whether low interest rates reduce the effectiveness of monetary policy and increase the risk of deflation.

[3] The general public can find information in CNB (2014).

[4] More recently, given the recent crisis and the ZLB, Blanchard et al. (2010) and Ball (2013) have suggested considering higher inflation targets.

The problem of a binding ZLB constraint arises primarily in a situation of extremely subdued aggregate demand.[5] This situation requires significantly negative real interest rates in order to stabilise the economy close to its potential and avert disinflationary tendencies (Krugman, 1998a).[6] Given the existence of the ZLB on nominal interest rates, negative real interest rates can only be achieved through significantly positive inflation expectations. If, in normal times, those expectations are well anchored by the central bank's inflation target (be it explicitly announced or implicit), the value of the target (with a negative sign) constitutes the de facto lower bound on negative ex ante real interest rates. Krugman (1998a) therefore argued that the central bank's key instrument for escaping a liquidity trap – or the ZLB constraint – is to convince economic agents that it will target slightly positive, not zero, inflation going forward. In his words, the central bank must credibly promise to be irresponsible.

If the situation requires an even more negative real interest rate than that corresponding to the opposite value of the inflation target, conventional monetary policy cannot deliver the required monetary easing. The economy then sinks further into a negative output gap, which in turn pushes inflation further below the declared target. The movement of inflation below the target is itself highly undesirable, because its subsequent pass-through to inflation expectations implies a shift of ex-ante real interest rates to less negative values, i.e. in the opposite direction to what the economic situation requires.[7] The negative output gap thus widens further, further increasing the disinflationary tendencies. In the extreme case, the situation can develop into a deflation trap, even further undermining aggregate demand as a result of a rising real value of debt ("debt-deflation" – see Fischer, 1933), a stronger tendency of households to defer consumption (Hori and Shimizutani, 2005; Cargill and Parker, 2004) and a preference for cash holdings over productive investment (Keynes, 1936).

However, a consensus that there are ways of easing the monetary policy conditions as needed at the ZLB and avoiding the aforementioned negative developments had started to form even before the recent economic crisis erupted (e.g. Eggertsson and Woodford, 2003 and 2004; Bernanke and Reinhart, 2004; Jung et al., 2005; Woodford, 2012). Most of these options work by lowering ex ante real interest rates through a combination of a reduction in long-term nominal interest rates and an increase in inflation expectations (in many cases above the long-term inflation target). Specific attention was then paid to the options available to central banks in open economies, which can also use a weakening of the exchange rate to ease the monetary conditions and increase inflation expectations (McCallum, 2000; Svensson, 2001; Bernanke et al., 2004).

Economists have meanwhile pointed out that when the monetary policy conditions need to be eased at the ZLB, expectations play an important role and so unconventional instruments can only be effective if they are credible in the eyes of financial markets and other economic agents. This applies above all to the "forward guidance" communication strategy (Woodford, 2012 and 2013; see below),[8] but even

[5] We leave aside the situation where disinflation in the economy is driven by favourable supply-side factors and the central bank chooses not to respond to it under flexible inflation targeting. In such case, the ZLB constraint is effectively non-binding.

[6] The whole of the following discussion is based on the usual assumption that aggregate demand is a declining function of the real interest rate.

[7] This problem has recently been termed "lowflation" in the debate about the very low inflation in the euro area – see Moghadam et al. (2014).

[8] "But an important limit to the effectiveness of such 'forward guidance' is the fact that people need to be given a reason to believe that policy will in fact be conducted differently in the future, and not simply that the central bank

expanding a central bank's balance sheet will only have an effect if a clear signal is sent out that such expansion will be as large and permanent as necessary (Krugman, 1998a; Svensson, 2006). This signal will then imply that the central bank is prepared to issue unlimited amounts of money or, in the case of use of the exchange rate instrument, to purchase unlimited quantities of foreign currency. In this regard, the potential financial losses that the central bank may suffer in the future if its balance sheet expands sharply have been discussed. For example, Cargill (2005) concluded that the Bank of Japan had in practice overemphasised its financial results in its decision-making on unconventional monetary policy, at a cost of weakening the credibility of its quantitative easing, thus leading to sub-optimal policy outcomes. On the other hand, Jeanne and Svensson (2007) argued in their theoretical model that in the context of a liquidity trap, concerns about financial losses may provide a way for the central bank to commit credibly to a permanent increase in the price level, as such concerns imply an incentive for the central bank not to allow a nominal exchange rate appreciation in the future, so that it avoids revaluation losses on its foreign exchange reserves.[9]

The 2008–2009 financial crisis and the subsequent significant monetary policy easing on the global scale sparked a new wave of interest in ZLB issues in the literature. Compared to the previous debate, which had peaked in 2004–2005, the new post-crisis literature looked at a wider range of monetary policy tools offering an alternative to rate cuts at the ZLB and considered the effectiveness of those tools (Borio and Disyatat, 2010; Stone et al., 2011).

An important part of the debate focused on how to capture the ZLB situation in macroeconomic models so that those models can be used, for example, to estimate the effectiveness of monetary policy at the ZLB, to estimate the probability of hitting the ZLB and to predict economic developments at the ZLB. However, the options for capturing the ZLB in macroeconomic models remain a subject of debate not only in central banks, which use the models to forecast inflation, but also in the academic community. An empirical analysis of how current modelling techniques are unable, for example, to realistically predict ZLB events can be found in Chung et al. (2012). One reason why it is so difficult to reach a consensus is that there have been few sufficiently long episodes of economies being at, or repeatedly close to, the ZLB. This makes it difficult to validate specific modelling techniques.[10]

All the standard modelling techniques have been used in the literature to model economies at the ZLB. These techniques include both structural DSGE models (among them the CNB's core prediction model) and, more generally, general equilibrium models (currently one of the main forecasting techniques employed by central banks) and statistical time series models.

As regards research based on structural models, there are many academic articles on the construction of DSGE models with an explicit ZLB (Eggertsson and Woodford, 2003, being one of the first).[11]

currently wishes them to believe this." However, there is no consensus among economists about the effectiveness of such guidance, even when assessing a single specific country, for example Posen (2013) versus Woodford (2013) in the case of Canada.

[9] More recently, the links between unconventional monetary policy and the financial performance of central banks were discussed, for instance, by Archer and Moser-Böhm (2013).

[10] There is a similar problem with modelling the onset of a deflationary spiral in DSGE models, which imply a return of the economy to equilibrium, i.e. to a positive inflation target in the case of inflation.

[11] Not all central banks use structural DSGE models as their main forecasting tool. For example, the FRB/US model used at the Federal Reserve is a different type of model. ZLB effects in this model are discussed in Reifschneider and Williams (2000).

These models have the advantage of being more resilient to the Lucas critique. This means they can also be used to simulate scenarios which have yet to be observed in the data and which involve significant changes in monetary policy conduct. However, the ZLB represents a non-linearity in the model, so the standard techniques for solving such models are not appropriate. The solution is to use methods based on non-linear model solving techniques – see, for example, Fernández-Villaverde et al. (2012). In practice, however, central banks still use linearisation to solve their core prediction models.

On the one hand, time series models are computationally simpler – they can model the ZLB non-linearity quite easily. On the other hand, they have all the disadvantages of non-structural models, most notably vulnerability to the Lucas critique. This is a key issue in ZLB modelling, as a shift in rates to the ZLB represents from a model point of view a clear "regime change" (i.e. a structural break), so analysing the ZLB regime using a model estimated on data for the period when rates were above zero can be highly imprecise. The models used to model economies at the ZLB have included Markov-switching VAR (Fujiwara, 2006), censored VAR (Iwata and Wu, 2006) and time-varying parameter VAR (Kimura et al., 2003; Nakajima et al., 2009).

2.2 Monetary Policy Tools at the ZLB

In a situation where the economy is experiencing persisting disinflation driven by insufficient demand and where monetary policy has hit the ZLB, unconventional monetary policy tools can be introduced. These tools include, for example, quantitative easing, qualitative easing, explicit interest rate commitments and exchange rate weakening (Borio and Disyatat, 2010).[12] An extreme variant is a temporary or permanent change in monetary policy regime, such as a switch to price-level targeting or nominal GDP targeting, which are discussed in the literature as alternatives to the currently dominant inflation targeting regime. The following review describes the types of possible instruments and their effect on the economy (with the exception of the use of the exchange rate, to which a separate section 2.3 is devoted).

Quantitative easing is activity undertaken by the central bank that leads to intentional – and as a rule significant – growth in the size of its balance sheet while holding constant the average liquidity and riskiness of the asset portfolio in its balance sheet. The central bank buys long-term government bonds (or other high-quality assets). In such operations, liquidity in the financial system increases (quantitative effect) while the price of the purchased asset rises and its yield falls (price effect). The central bank simultaneously sends out a signal to the economy that it intends sooner or later to achieve price growth by issuing money. The main channel of effect is therefore an effort to reduce long-term nominal interest rates and increase inflation expectations, thereby stimulating investment and demand through lower long-term ex ante real interest rates. Reducing the liquidity constraints on banks, where such constraints are binding and there are enough viable projects, can also support new lending. Investors' interest in other categories of financial and real assets with higher yields than government bonds may also increase. This can generate demand for a wide range of financial and real assets and have positive impacts on economic growth. Quantitative easing also usually fosters a

[12] Another tool in the unconventional monetary policy toolkit is the "helicopter drop of money", which involves the central bank printing money and distributing it directly to economic agents.

weakening of the domestic currency, hence acting through the exchange rate transmission channel (see below).

Qualitative easing involves the central bank conducting operations intended to change the composition of its balance sheet away from government debt securities towards riskier and less liquid assets, holding constant the size of its balance sheet (see, for example, Buiter, 2008). The financial sector can transfer risky and illiquid assets to the central bank and thereby obtain more liquid and less risky instruments to cover its needs. This results in a decline in the risk premium (with higher liquidity in the markets concerned), which in turn boosts investment in riskier projects. The final result is a rise in economic activity and inflation.

Credit easing represents a mixture of the above two approaches. The central bank expands its balance sheet so that average liquidity decreases and/or the riskiness of its assets increases. This activity is aimed at affecting the cost and availability of loans, and such measures are usually targeted at a specific, non-functional market segment.

The Federal Reserve, the BoE and the ECB have employed quite a wide range of unconventional tools. When the financial crisis began, these mostly took the form of liquidity facilities. In later stages of the crisis, a combination of quantitative and qualitative easing was used. At the start of the crisis, the Federal Reserve responded to the shortage of liquidity in the financial system by creating new liquidity programmes provided to a broad range of recipients, i.e. not only to financial institutions, but also directly to borrowers and investors on credit markets. It later started purchasing agency debt securities, mortgage-backed securities and government bonds, which became part of its portfolio (Large Scale Asset Purchases – LSAPs). It conducted these operations in several waves and in large amounts. The securities purchases were financed mostly through the creation of new liquidity. The BoE purchased mostly 5Y–25Y government bonds from non-banks, financing these purchases in the same way as the Federal Reserve. Simultaneously, although in smaller amounts, the BoE purchased corporate bonds and short-term commercial paper and financed them by issuing Treasury bills, which at the ZLB can be regarded as a close substitute for liquidity. The ECB, like the Fed, started by implementing measures aimed at providing liquidity to, and stabilising, the financial sector. It subsequently adjusted the tools by relaxing the conditions for the provision of liquidity and expanding the range of eligible collateral. The ECB's main unconventional tools were Long-Term Refinancing Operations (LTROs) with 6M, 12M and 36M maturities performed at a fixed rate and with full allotment. Other, more marginal instruments included the Covered Bond Purchase Programme (CBPP) and fully sterilised (until June 2014) purchases of government bonds of euro area countries in the secondary market (Securities Market Programme – SMP).

Cúrdia and Woodford (2011) analyse unconventional instruments in a New Keynesian model. The authors conclude that quantitative easing, unlike credit easing, which is targeted at certain types of assets, is ineffective. There also are numerous empirical studies quantifying the impacts of non-standard instruments on the financial and macroeconomic variables of the countries concerned. In the case of the Federal Reserve's measures, which have so far been studied the most, there is a consensus (e.g. Bauer and Rudebusch, 2011; Christensen and Rudebusch, 2012; Doh, 2010; Gagnon et al., 2011) that the LSAPs reduced long-term interest rates by 90–200 basis points. Likewise, Lenza et al. (2010), for example, found that the ECB's liquidity providing operations led to a marked decline in money market rates. Similarly, the later SMP resulted in a decrease in the liquidity premium and the level and volatility of government bond yields and subsequently also in long-term interest rates in general

(Manganelli, 2012; Eser and Schwaab, 2013). At the same time, the debate in the literature regarding the appropriate exit strategy for unconventional measures such as quantitative easing has recently intensified (Rudebusch; 2010; Kohn, 2013; Turner, 2014).

Monetary policy can also be eased with the aid of an *explicit commitment* (forward guidance) about future monetary policy interest rates (Eggertsson and Woodford, 2003; Walsh, 2009, Woodford, 2013), for example in the sense that the central bank intends to maintain the policy rate at a certain level for a certain time or until the economic conditions change.[13] The objective is to lower expected monetary policy rates and thereby reduce long-term nominal interest rates and increase inflation expectations, which, taken together, will bring down long-term ex ante real interest rates.

If the above measures are not considered effective enough in the given situation, the central bank can opt for a temporary or permanent change of monetary policy regime. The main option offered in the literature for this situation is price-level targeting (see Svensson, 1999, and Evans, 2010; Böhm et al., 2011, provide a detailed literature review on this topic). Provided that it is credible, this regime delivers an additional easing of the monetary conditions through higher inflation expectations compared to standard inflation targeting. An undershooting of the inflation target in one year is offset in the following period by easier monetary policy and a temporary overshooting of the long-term (implicit) inflation target in order to ensure that the targeted price level is attained.[14] For example, Eggertsson and Woodford (2003) argue in favour of this approach, as it links the commitment to create subsequent inflation with a commitment to keep nominal interest rates low. The advantages of price-level targeting are evident in macroeconomic models that work with the ZLB, as this regime allows more negative ex ante real rates to be achieved in a deflationary situation, despite the fact that nominal interest rates are at zero. These models indicate that in the case of price-level targeting the ZLB is less likely to be reached and that if such a situation does arise it will not last as long (see Malovaná, 2014, where this type of model is applied to the Czech Republic). The above approach has not yet been verified in practice, however, as no country has ever applied explicit price-level targeting in a ZLB context.

2.3 The Exchange Rate as an Unconventional Instrument at the ZLB – Literature Review

Foreign exchange interventions or exchange rate are among the tools available to an open economy for ending deflation and escaping the ZLB. Their use as an extraordinary monetary policy instrument was proposed by McCallum (2000) and Svensson (2001) in the debate on Japan's experience with deflation and the difficulties it had in dealing with it. These authors pointed out numerous advantages

[13] In the case of the Federal Reserve the guidance is that rates will be kept at the current – low – level at least as long as the unemployment rate remains above 6.5%, the inflation outlook remains no more than 0.5 pp above the longer-run goal (2%) and longer-term inflation expectations are well anchored. The BoE originally tied its guidance to the unemployment rate, stating that the key interest rate would not be raised while the unemployment rate remained above 7%. However, it later switched to evaluating a broader range of indicators.

[14] Another option is to switch to nominal GDP targeting (Taylor, 1985). In this regime, if nominal GDP is below the targeted path the central bank should pursue very easy monetary policy in the following periods to achieve significantly higher inflation and/or real GDP growth so that nominal GDP returns to the targeted path. This should lead to economic agents increasing their inflation expectations, which, in turn, will boost consumption and investment via lower real interest rates. However, there are numerous practical problems with implementing this regime (see Holub and Král, 2013), so we do not examine it in any more detail here.

of using the exchange rate as an unconventional monetary policy tool. As this is the type of measure that the CNB ultimately chose, we examine it in more detail in this section.

From a terminological perspective, the use of *foreign exchange interventions* as a monetary policy instrument is defined as an approach where the size of foreign currency purchases in the market is specified[15] but the impact on the exchange rate is uncertain and depends on market conditions. The direction in which the central bank is trying to shift the exchange rate is thus clear (the depreciation direction), but the size of the shift is not. Many central banks use such policy even away from the ZLB. By contrast, the use of *the exchange rate as an instrument at the ZLB* is defined as an approach where the central bank chooses – and possibly also publicly declares – the specific exchange rate level it wants to attain and is prepared to intervene in the foreign exchange market in unspecified and potentially unlimited amounts to attain that level. The CNB's choice in the form of the declaration of an asymmetric exchange rate commitment falls into the latter category and therefore differs fundamentally from the use of "conventional" foreign exchange interventions. That said, various approaches lying between these two extremes can be found in the literature and in practice.

Using a small macroeconomic model, McCallum (2000) showed that at the ZLB a central bank in an economy open to foreign trade can successfully apply a policy rule that adjusts the rate of depreciation of the domestic currency to stabilise inflation and the real economy. In his approach, the exchange rate is an operating target of monetary policy and the exchange rate path corresponding to the policy rule is secured by central bank interventions in the foreign exchange market. The author concluded that this instrument can be very effective in achieving monetary policy objectives.

Svensson (2001) suggested a "foolproof way" of escaping from a liquidity trap in an open economy. His recipe consists of a price-level target path, a devaluation of the currency and a temporary crawling exchange rate peg, which is later abandoned in favour of a floating exchange rate and a switch to a standard monetary policy regime (i.e. standard flexible price-level or inflation targeting) when the price-level target has been reached. He concluded that this "will jump-start the economy and escape deflation by a real depreciation of the domestic currency, a lower long real interest rate, and increased inflation expectations". Svensson (2001) emphasises the crucial role of inflation expectations and says that the temporary peg offers a credible way of implementing Krugman's proposal (i.e. the promise to be irresponsible) using operations in the foreign exchange market, where the central bank can demonstrate its resolve to hit its targets. In his model, the said way of pegging the exchange rate is de facto equivalent to price-level targeting, with the current undershooting of the long-term inflation target implying a need to overshoot the target in the future and therefore also implying a rise in inflation expectations.[16] At the same time, Svensson (2001) highlights the fact that unlike McCallum's (2000) proposal, his strategy does not rely on the magnitude of the portfolio-balance channel of foreign exchange interventions.

[15] Together with that, the central bank also controls the size of the growth in its balance sheet, which increases the amount of liquidity in the banking system. This has similar impacts as the "quantitative effect" of quantitative easing (see above). In contrast to quantitative easing, however, it is the net foreign assets of commercial banks, not the amount of government bonds in their balance sheets, that decreases in the first step.

[16] It should be emphasised, though, that in his model Svensson (2001) abstracts from foreign inflation and shocks to the equilibrium real exchange rate. Generally, however, pegging the nominal exchange rate and targeting the price level are not equivalent if the foreign central bank itself does not target the price level and/or the real equilibrium exchange rate based on the CPI is not constant. This fact is clearly evident in the Czech Republic – see section 5. In such case, a simultaneous commitment regarding the domestic price level and the nominal exchange rate may be impossible for the central bank to fulfil.

In more recent papers, exchange rate policy and/or massive foreign exchange interventions are mentioned as a possible form of unconventional monetary policy at the ZLB in Borio and Disyatat (2010) and Stone et al. (2011), for example. Beneš et al. (2013a) also offers a relevant contribution to the debate, modelling the use of sterilised interventions as a monetary policy instrument with a Taylor-type rule specified not only for interest rates, but also for the exchange rate. When the ZLB is reached, the exchange rate represents a possible alternative instrument even for countries that do not usually use foreign exchange interventions (see Beneš et al., 2013b).

The first advantage of using the exchange rate as a monetary policy instrument at the ZLB is that it represents a commitment that the public can understand and the central bank can implement (using quantitatively unlimited foreign exchange interventions), and thus a credible commitment to achieving growth in the price level. This results in an increase in economic agents' inflation expectations. With nominal interest rates "parked" at the ZLB, this in turn means a decline in real interest rates (see section 2.1) with stimulating effects on household consumption and investment activity. This brings us to the second advantage: when the exchange rate weakens, the real interest rate transmission channel and the standard exchange rate transmission channels act on the ZLB in the same direction. These effects (inflation expectations, real interest rates and the standard exchange rate transmission channels) then amplify each other, giving the central bank's action the credibility it vitally needs.

The standard effect of a weakened exchange rate of the domestic currency runs initially via growth in prices of imported consumer goods, which, in a small open economy, very quickly increases overall inflation. In the longer run, prices of domestic goods also go up, as imported inputs are used to produce them. A weakening of the nominal exchange rate also leads to a temporary depreciation of the real exchange rate, thereby strengthening the price competitiveness of domestic producers. This manifests itself as growth in exports and also in a partial redirection of household consumption from imported goods to domestic goods.[17] The result is an improvement in net exports, which usually outweighs the negative income effect of the higher import prices. This leads to an increase in economic activity, employment and wage growth, and, with a lag, growth in inflation pressures from the domestic economy.[18]

In normal times, however, the central bank usually responds to a sudden weakening of the exchange rate by raising nominal interest rates in order to avoid a future overshooting of the inflation target, thereby counteracting the depreciation and its effects on the economy. In the process, it also anchors inflation expectations close to the target. Empirical studies quantifying the size of the pass-through of short-term changes in the exchange rate to consumer prices in countries with credible monetary policy thus mostly conclude that the effect of exchange rate dynamics on final consumer prices is

[17] In the very short run, conversely, households may buy imported goods to increased extent before prices go up fully following the weakening of the exchange rate. This effect was seen in the Czech Republic in late 2013. From the long-run perspective, however, it is negligible.

[18] This does not necessarily apply in economies where some sectors have high levels of foreign currency debt. In such economies, a weakening of the exchange rate can be associated with a strongly negative wealth effect and lead to a sharp contraction in investment (Krugman, 1998b) and/or household consumption. However, this is not the case for the Czech Republic. At the same time, the positive effect of the currency weakening on exporters may be temporarily dampened by hedging against exchange rate risk. According to a CNB survey, around one-third of Czech exports are hedged using financial instruments, primarily by large firms. The dampening effect of hedging thus exists but is not sufficiently strong to reverse the overall positive effects of exchange rate depreciation on the Czech economy.

highly limited and decreases over time (Campa and Goldberg, 2005; Gagnon and Ihrig, 2004). Accordingly, the available studies for the Czech Republic show that the effect of the exchange rate on prices declines significantly along the production chain and its effect on consumer prices is quite weak. The latest studies estimate the pass-through of the exchange rate to consumer prices at just 10%–15% of the size of the exchange rate shock (see Babecká-Kucharčuková, 2009; Vašíček, 2011; Franta et al., 2014; Babecká-Kucharčuková et al., 2013).

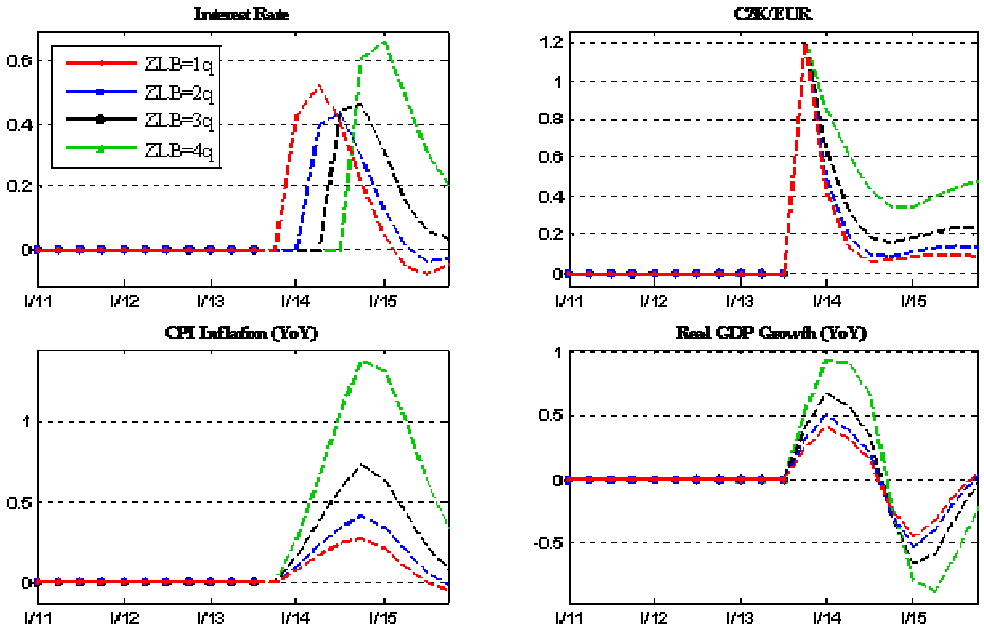
In the case of attempts to escape a liquidity trap or the ZLB, however, there is no such interest rate response and the pass-through of the weaker exchange rate to inflation and the real economy is thus greater than in normal situations (Lízal and Schwarz, 2013). This idea is illustrated in Figure 1 with the aid of the g3 core prediction model, which has been used by the CNB since 2008 (see Andrle et al., 2009, and Brůha et al., 2013). The structural nature of g3 makes it a suitable tool for performing such analyses (even though it is a linear model which does not explicitly take into account the existence of the ZLB).[19] The simulations illustrate that the impact of a weakening of the exchange rate on inflation increases with the length of stay at the ZLB. The same goes for the positive impact on GDP growth in the year following the exchange rate shock as the stimulating effect of the decline in real interest rates on household consumption and investment increases. This increase in the pass-through of the exchange rate rises progressively with every quarter of stay at the ZLB. A similar conclusion in the context of a DSGE model calibrated for the Czech economy was reached by Malovaná (2014), who shows that the presence of the ZLB amplifies the responses of the economy to macroeconomic shocks, including shocks to the nominal exchange rate.

The above simulation results depend on whether economic agents expect nominal interest rates to stay at the ZLB (as assumed by Figure 1[20]) or not. If interest rates are expected to remain constant, the pass-through of the depreciation in the exchange rate to the price level is naturally stronger. This shows the importance of the expectations channel, through which the central bank can influence the pass-through of changes in the exchange rate to prices using forward guidance.

[19] The simulations in Figure 1 are the work of our colleagues František Brázdik, Tibor Hlédik, Zuzana Humplová and František Kopřiva.

[20] This simulation was also performed for variants of unexpected shocks to interest rates and a combination of expected and unexpected shocks. In these variants, the effect of the expectations channel was naturally weaker and the impulse responses to the exchange rate shock were consequently less pronounced. The choice of expected shocks in Figure 1 is nevertheless motivated by the fact that economic agents in practice recognise and understand the existence of the ZLB and so are not surprised that interest rates stay at zero even when the exchange rate is weakened.

Figure 1: Response of the Economy to a Fully Expected 5% Weakening of the Exchange Rate for Different Lengths of Stay at the ZLB



Note: "ZLB=1q" means that the ZLB constraint is binding – and so interest rates do not respond to the weakening of the exchange rate – for a period of one quarter etc., up to "ZLB=4q", where it is binding for one year.

Source: CNB calculations

Another reason why the expectations of economic agents are crucial at the ZLB is that a weakening of the exchange rate by the central bank does not represent a one-off shock, as Figure 1 assumes for the purposes of comparability with the standard empirical literature on the exchange rate pass-through, but rather a long-term change in the main monetary policy instrument. This is very important for price formation in the economy. For example, Taylor (2000) postulates that the degree of pass-through of cost shocks to prices in firms depends on the expected persistence of such shocks. If the exchange rate weakens at the ZLB, it is therefore vital for the central bank to communicate credibly that the exchange rate weakening will be sustained and that interest rates will stay at the ZLB for some time. This, in turn, increases the probability that firms will reflect the changes in import prices in final prices. In this context, Hurník (2013) argues that in order to model the expectations channel adequately, it is necessary to incorporate the central bank's intervention policy directly into the structure of the model, while moving the exchange rate solely by means of exchange rate shocks underestimates the effects of expectations in the model simulations.[21]

The above analysis only covers the second part of the transmission mechanism running from the change in the exchange rate level to the price level. If, however, the central bank decides to use foreign exchange interventions rather than the exchange rate directly, the part of the transmission mechanism running from the interventions to the change in the exchange rate must also be considered, as the parameters of this part of the transmission mechanism can be key to the overall

[21] On the other hand, incorporating intervention policy directly into the model structure means an implicit assumption that economic agents perfectly understand the change in monetary policy regime right from the outset and adjust their expectations to it immediately, whereas in practice the change in regime may be associated with a learning phase lasting several years.

success of using foreign exchange interventions. Neely (2008) and Menkhoff (2013) show that surprising and strong interventions are the most successful ones. Other key attributes for successful intervention include consistency with fundamentals, with market trends, and with monetary and fiscal policy, as well as the availability of substantial resources and a reputation for past success.

The transmission of foreign exchange interventions generally involves three channels: an interest rate channel (the growing liquidity lowers interest rates, which in turn affect the exchange rate), a non-interest rate channel (e.g. a portfolio or order-flow channel) and an expectations or signalling channel. These channels and their empirical relevance are reviewed, for example, in Cavusoglu (2010). However, the interest rate channel is practically switched off at the ZLB – growth in the money supply does not lead to a significant decrease in money market rates. This may limit the effectiveness of interventions. For example, by estimating a non-linear VAR model, Iwata and Wu (2012) show that, due to the zero level of interest rates, the foreign exchange interventions in Japan in the 1990s had no major effect on the yen-dollar exchange rate or, consequently, on prices and the real economy.[22] At the ZLB, the size of the impact of foreign exchange interventions on the exchange rate is based on other channels, primarily the expectations channel, whose strength should therefore be maximised. From this perspective, Svensson's (2001) fully transparent approach based on an explicit exchange rate commitment seems more suitable than McCallum's (2000) recommendation to use more or less standard foreign exchange interventions.

2.4 Practical Experience with Foreign Exchange Interventions at the ZLB

Practical experience with the use of foreign exchange interventions or the exchange rate as a tool in a ZLB context is unfortunately limited, although less so than in the above case of price-level targeting, where the debate is still purely theoretical. Only Switzerland and Japan have experience with foreign exchange interventions at the ZLB. However, the primary aim was to stop excessive appreciation of their currencies, which were regarded as safe havens. Also of some relevance to the Czech situation are the interventions in small open inflation-targeting economies such as Israel and Chile, especially those in 2008–2009. Those interventions, though, cannot be regarded as an unconventional instrument at the ZLB, as the monetary policy rates of the relevant central banks had not reached the zero bound. The main motive for these interventions, i.e. a response to large exchange rate movements coupled with an effort to boost foreign exchange reserves preventively, can also be viewed as different from the CNB case.

The Swiss experience is valuable because the intervention took the form of a one-sided exchange the rate commitment. This means it shares some features with the strategy chosen by the CNB. The Swiss National Bank (SNB) introduced an exchange rate floor of CHF 1.20 to the euro on 6 September 2011 following a series of none too successful ad-hoc interventions[23] and other measures aimed at stopping the strong appreciation of the franc. The franc depreciated almost immediately

[22] Chaboud and Humpage (2005), for example, also found that interventions had had only a limited effect on the exchange rate of the yen. References to other empirical studies can be found in the above-mentioned articles.

[23] These interventions were conducted between March 2009 and August 2011 and caused the SNB's foreign exchange reserves to increase by an equivalent of around CHF 200 billion. However, the only period that can be regarded as relatively successful in terms of influencing the exchange rate was that up to the end of 2009, when the exchange rate was held at CHF 1.50 to the euro, which the market viewed as a shadow floor. Subsequently, the interventions and the other actions taken by the SNB failed to stop the franc from strengthening by more than 25%.

beyond the floor. The credibility of the commitment was not questioned by the markets (except for a very short episode when the rate dropped below CHF 1.20 to the euro, mostly for technical reasons) and the exchange rate floor has been successfully maintained for more than two and half years now. The foreign exchange reserves have gradually doubled in size (from CHF 200 billion in July 2011 to CHF 445 billion at present). Importantly, however, a large part of this increase occurred in the second quarter of 2012, i.e. more than six months after the floor had been announced,[24] and was linked with the euro area sovereign debt crisis and a flight to "safe" assets. In other words, it was not a sign of a loss of market confidence in the floor. Annual inflation kept falling after the announcement of the exchange rate commitment (from 0% to -1%), owing to the lagged effects of the previous sharp appreciation and additional anti-inflationary pressures, and is not expected to turn positive until 2015. The introduction of the exchange rate floor has not significantly affected the results of inflation expectations surveys. By contrast, there has been an acceleration in property prices (of around 20% between September 2011 and the present) and other asset prices.[25]

Comparing the Czech situation and the Israeli experience, the key difference is that the monetary policy rates of the Bank of Israel (BoI) not only stayed above zero, but also remained at their minimum of 0.5% for only five months (April–August 2009). The BoI intervened in ex ante unspecified amounts during 2008 (when the shekel appreciated by around 15% year on year) and in 2009 it announced a fixed daily amount of foreign exchange purchases (Flug and Shpitzer, 2013). The shekel depreciated dramatically against the dollar during the interventions (from ILS 3.2 to ILS 4.2, i.e. by around 30%).[26] Immediately after the exit from the interventions in August 2009 it started to appreciate strongly, eventually almost returning to its original level (ILS 3.4 in July 2011), where the BoI intervened again, although in a situation of significantly higher interest rates (3.25%). This led to a gradual depreciation to ILS 3.8. It is not clear how much the interventions affected inflation expectations. Although expectations (one year ahead) increased during the interventions, the BoI itself attributed this mainly to expected GDP growth and increased commodity prices.[27]

Following several interventions aimed at strengthening the domestic currency in 2001 and 2002 (related to the crisis in Argentina), the Central Bank of Chile (CBC) launched depreciation interventions in 2008 and 2011. In April 2008, in a context of strong appreciation of the Chilean peso (by as much as 20% year on year against the dollar), it launched an intervention programme with a publicly declared target of accumulating foreign exchange reserves of USD 8 billion during 2008. The programme was suspended in September following the collapse of Lehman Brothers with accumulated reserves of USD 5.75 billion. The peso depreciated against the dollar from its strongest level of CLP 433 in April 2008 to around CLP 540 (followed by a spontaneous depreciation to CLP 670 during the financial crisis). After the acute phase of the crisis, the peso gradually firmed to CLP 470, where the CBC announced a new programme of reserves accumulation with a purchase target of USD 50 billion. By the end of 2011, the reserves had climbed by more than USD 40 billion,

[24] Swiss National Bank: Monthly Statistical Bulletin, May 2014.

[25] Swiss National Bank: Quarterly Bulletin, 1/2014 (March).

[26] However, it should be added that the currencies of numerous other comparable economies – even those which did not intervene in the foreign exchange market – depreciated against the dollar in the same period. For example, the CZK/USD rate weakened from 14.9 in July 2008 to 22.3 in February 2009 (i.e. by around 50%), the HUF/USD rate from 145 in July 2008 to 240 in February 2009 (i.e. about 35%) and the POL/USD rate from 2.05 in July 2005 to 3.6 (i.e. around 25%). This suggests that the depreciation of the shekel cannot be attributed unambiguously to foreign exchange interventions.

[27] Bank of Israel, Inflation Report 2009 (April–June).

equivalent to around 17% of GDP (Claro and Soto, 2013). Despite a temporary depreciation during 2011 (to CLP 520), the value of the peso against the dollar was virtually the same at the end of the year as it had been at the start.

Finally, there is also the Czech intervention experience in the initial years of inflation targeting. The last intervention period was 2001–2002, when the CNB tried to halt a dramatic appreciation of the currency. Empirical studies (e.g. Geršl and Holub, 2006; Égert and Komárek, 2006; Disyatat and Gelati, 2007; Scalia, 2008) are mixed in their assessment of the short-term effectiveness of these interventions, but the appreciation trend of the Czech koruna did halt in mid-2002. However, these interventions – as in the cases of Israel and Chile described above – were not carried out in a ZLB context and are therefore of limited relevance to such a situation.

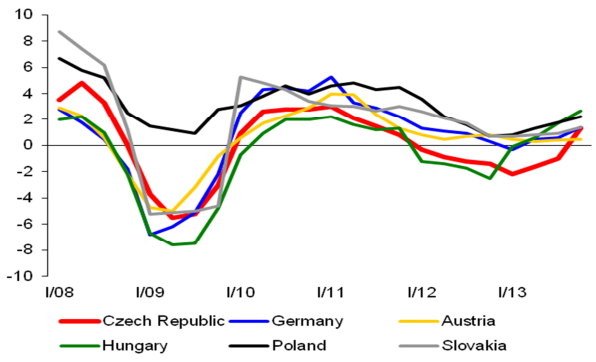
3. The Czech Case: Analyses Preceding the Decision to Use the Exchange Rate

3.1 Stylised Facts About the Czech Economy Before the CNB's Intervention

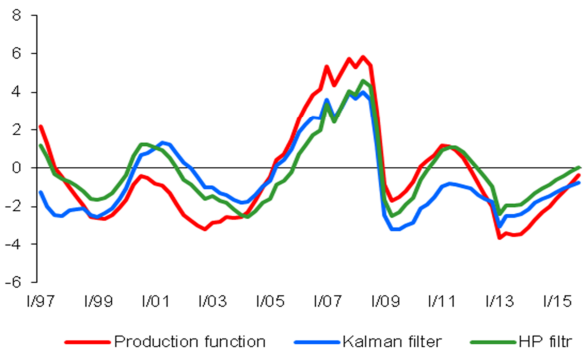
The Czech economy slowed sharply in 2008 as a result of the global financial and economic crisis. The following year the economy shrank by more than 4%. This was followed by two years of gradual recovery, after which the economy contracted again in 2012 and 2013. The Czech Republic lagged significantly behind its major trading partners from 2012 (see Figure 2a), as the downturn in the Czech economy was due not only to slower external demand resulting from the European debt crisis, but also to very weak domestic demand. Among other things, the weak demand reflected highly restrictive fiscal policy in 2010–2013 and low consumer and business confidence, especially in 2012. As a result, the estimated negative output gap widened to 2%–4% in the first half of 2013. An estimate based on the production function, for example, reached the most negative output gap since the start of inflation targeting in the Czech Republic, i.e. since 1998 (see Figure 2b). Moreover, the CNB's November 2013 forecast indicated that the output gap would not close before the end of 2015 even under the unrealistic assumption of negative interest rates. These economic developments naturally gave rise to growth in unemployment and cuts in average working hours. Wage growth in the business sector also slowed significantly, culminating in a year-on-year decline in wages at the end of 2013 (even when adjusted for extraordinary effects). Combined with fiscal restriction, this led to a decline in household income and consumption. Corporate profits and investment also fell sharply.

Figure 2: Czech Economic Growth by Regional Comparison and the Output Gap

a) Annual GDP growth (%)



b) Output gap (% of potential output)

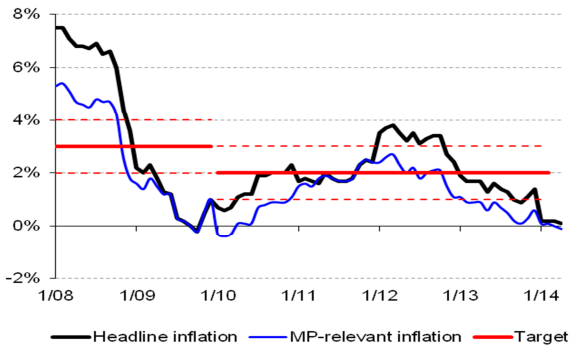


Source: Eurostat; CNB calculations

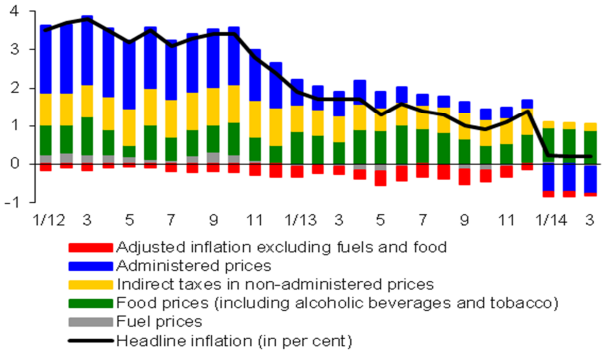
The anti-inflationary effect of the domestic economy naturally fed through to prices and gradually increased the need to further ease monetary policy. In 2012, inflation was above the CNB's target (see Figure 3a) due to an increase in indirect taxes, administered prices and food prices (see Figure 3b), i.e. non-fundamental factors of a cost-push nature. However, it then started to fall significantly, reaching the lower boundary of the tolerance band around the CNB's target during 2013. Monetary-policy relevant inflation, i.e. inflation adjusted for the first-round effect of tax changes, fell well below this tolerance band, all the way to zero. Adjusted inflation excluding fuel prices, i.e. the indicator of core inflation used by the CNB, had been negative since 2009. It was dragged into the deflation zone for most of this period by a decline in prices of tradable commodities. In autumn 2013, however, growth in prices of non-tradable commodities halted for the first time in recent Czech history. This was yet another indicator of the anti-inflationary effect of the domestic economy.[28] Prices in most major production sectors also recorded year-on-year decreases in this period – prices in construction and market services had been declining for some time, and now they were joined by falling prices in manufacturing and agriculture.

Figure 3: Inflation in the Czech Republic – Comparison with the CNB Target and Inflation Structure

a) Annual inflation and CNB target



b) Structure of annual inflation (contributions in pp)



Source: CZSO; CNB calculations

The CNB responded by making full use of its main monetary policy instrument and gradually lowered interest rates to "technical zero" level (0.05% for the two-week repo rate and the discount rate and 0.25% for the Lombard rate), which was reached in November 2012 (see Figure 4a). At the same time, the CNB pledged in autumn 2012 to leave interest rates at this level for as long as needed, i.e. until inflation pressures increased significantly. It also announced in autumn 2012 that it was ready to use additional instruments should further monetary policy easing become necessary. The mere announcement by the CNB that it was prepared to use the exchange rate to this end caused the koruna to weaken in late 2012/early 2013. This softened the overall monetary conditions.

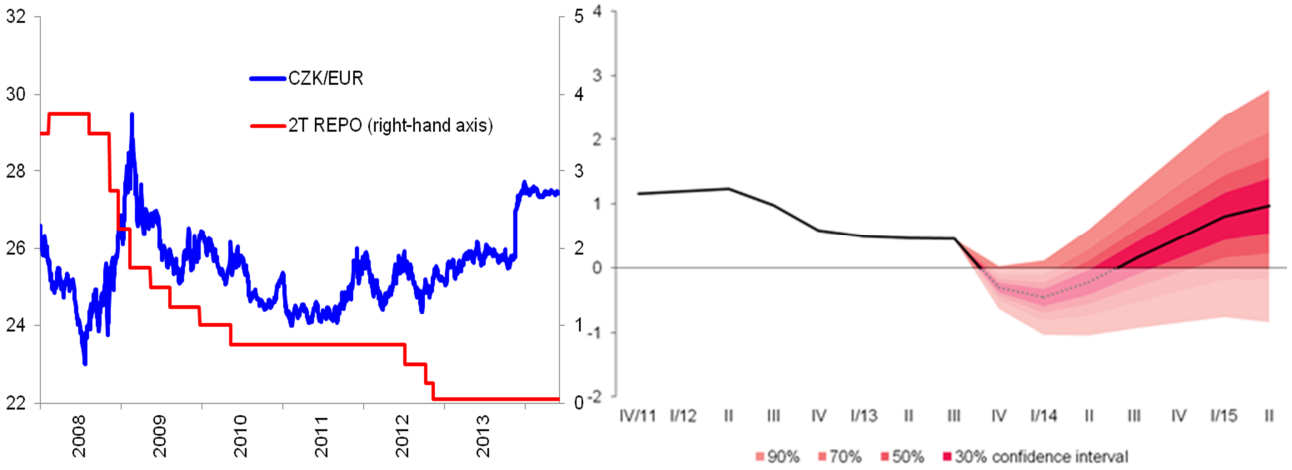
In the spring forecast (Inflation Report II/2013), however, a continued decrease in inflation and the inflation forecasts, coupled with a deepening economic recession, implied that the forecast pointed to

[28] The structure of inflation was important from the perspective of diagnosing whether the low inflation and impending deflation primarily reflected weak demand or was a result of favourable supply-side shocks, whose primary impacts the central bank does not have to respond to in the flexible inflation targeting regime. This issue subsequently played a significant role in the public debate of the CNB's action (see section 5.4).

a need for hypothetically negative monetary policy interest rates for the first time in Czech history. At the same time, the exchange rate of the koruna weakened (see Figure 4a). This reflected the unfavourable evolution of the Czech economy and also CNB communication indicating that the central bank was still ready to use foreign exchange interventions if further monetary policy easing was needed. At the time, the weaker koruna was thus partly offsetting the fact that interest rates could not be lowered into negative figures. However, it became clear that the recession and the labour market downturn were fading only very slowly and their anti-inflationary effects, coupled with falling prices of commodities and energy, were leading to a further decrease in both observed and forecasted inflation. The need to further ease the monetary conditions thus increased further. This was reflected in the forecast in Inflation Report II/2013, on the basis of which the Bank Board voted on the use of the exchange rate as a tool for further easing monetary policy at its monetary policy meetings in August and September. Although this move was not yet approved, the Bank Board communicated that the probability of using foreign exchange interventions had increased.[29]

Figure 4: The CNB's Monetary Policy Rates and the Market Rate Path in the IR IV/2013 Forecast

a) 2W repo rate (%) and CZK/EUR exchange rate b) 3M PRIBOR path in IR IV/2013 (%)



Source: CNB

The Inflation Report IV/2013 forecast pointed to a need for clearly negative levels of the 3M PRIBOR market rate (see Figure 4b). Given the existence of the money market premium, this would imply a negative repo rate of around -0.9%. The central bank could no longer ignore the need to ease the monetary conditions, but economic and legal constraints meant that the easing could not be delivered by lowering monetary policy rates.

[29] The difficulty of deciding on this measure stemmed among other things from its discontinuous, "zero-one" nature. One reason is that the subsequent exit from using unconventional monetary policy instruments is potentially difficult. The CNB was aware of this fact.

3.2 Assessment of the Costs of Passive Monetary Policy in the Core Prediction Model

In this situation, the CNB needed to assess the costs and risks associated with passive monetary policy. The CNB's outlook pointed to an increasing risk of deflation. Prices of many consumer basket items (consumer goods in particular) had been declining for some time and there was a danger of generally falling prices being incorporated into households' and firms' expectations and into wage growth.[30] This would have led to postponement of consumption and investment and to a longer decline in domestic economic activity. For this reason, in addition to the baseline forecast scenario in Inflation Report IV/2013 a passive monetary policy scenario was drawn up allowing a hypothetical decline of nominal interest rates below the ZLB (see Figure 4b above). This was available to the CNB Bank Board at its meeting in November.[31] This scenario was prepared in two versions. These differed in the strength of the exchange rate appreciation (see Figure 5).

In this scenario, monetary policy does not continue to ease the monetary conditions after the ZLB is reached. In terms of fulfilment of the CNB's target, rates would stay at "too high" levels, i.e. at technical zero, and this, in turn, would cause the nominal exchange rate to strengthen (see Figure 5, black solid lines).[32] In addition, an even more significant strengthening of the koruna could be fostered by disappointed expectations and the closing of positions by financial market participants if the CNB were not to start intervening in the foreign exchange market despite its previous communication and the further clear increase in the need to ease the monetary conditions (see Figure 5, green solid lines).[33] Overall, this led to an even larger undershooting of the inflation target in the passive monetary policy scenario than in the baseline scenario with hypothetically negative interest rates. In this simulation, headline inflation remained negative for two to three quarters of 2014. There was also a clear downward impact on real economic activity in 2014. Looking at the components of GDP, household consumption recorded the biggest decline relative to the baseline scenario, mainly because of higher real interest rates. In addition, the stronger exchange rate in the simulation worsened exporters' competitiveness, leading to lower net export growth in the short run.

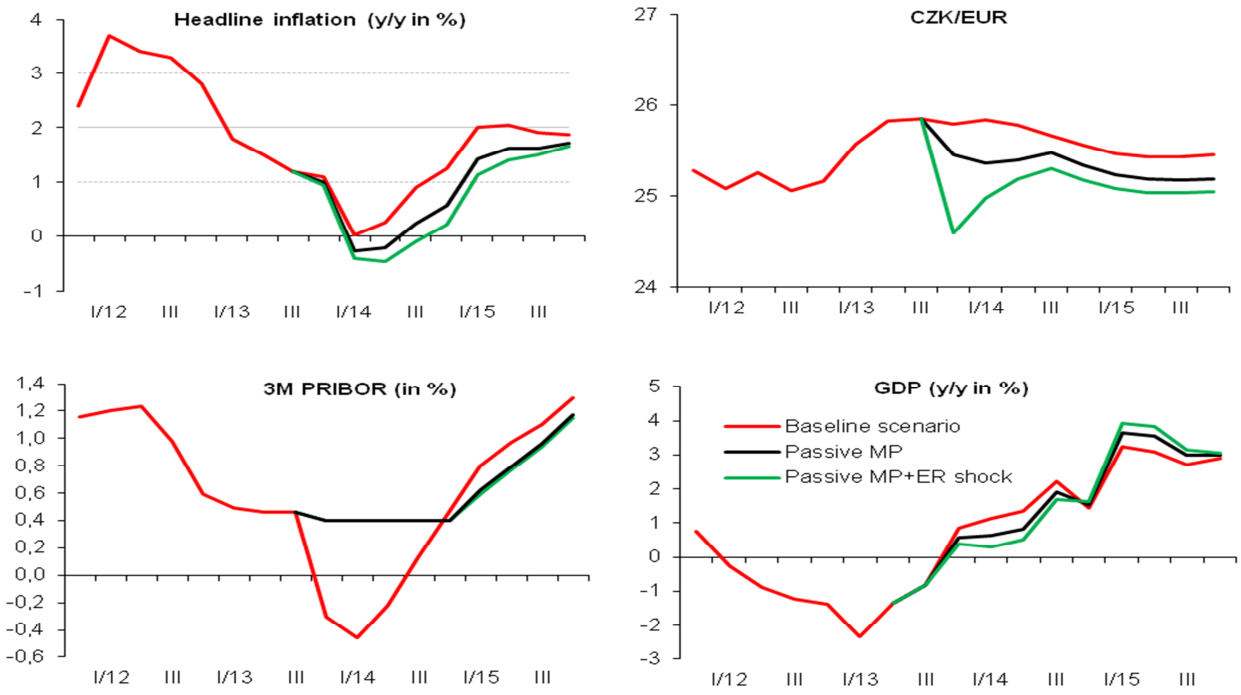
[30] The inflation expectations of financial market analysts one year ahead remained in positive territory but gradually declined to a historical low. The same applied to observed nominal wage growth in the business sector (which switched to a year-on-year decline in 2013 Q4, as revealed by data published after the CNB's November 2013 decision – see section 5.2).

[31] The use of the g3 core prediction model to draw up this scenario as well as the scenario of using the exchange rate as a monetary policy instrument presented in section 4.2 is the collective work of our colleagues František Brázdik, Jan Brůha, Tibor Hlédik, Zuzana Humplová, František Kopřiva, Jaromír Tonner and Jakub Ryšánek.

[32] Using a two country model, Cook and Devereux (2013) show that if the ZLB constraint is binding, growth in the home saving rate leads the home currency to appreciate, whereas away from the ZLB the same negative demand shock leads it to depreciate. This appreciation further increases the fall in inflation and economic activity. So, at the ZLB the exchange rate ceases to play the role of automatic stabiliser; on the contrary, it amplifies shocks to the economy.

[33] From the ex post perspective, it is also likely that the ECB's decision to lower its interest rates at its meeting on 7 November would have contributed to the appreciation of the koruna against the euro.

Figure 5: Passive Monetary Policy Scenario, November 2013



Source: CZSO; CNB calculations

The relatively brief deflation episode in the above scenario may have been due to the properties of the CNB's core prediction model (the problems of DSGE model dynamics are addressed in the Czech economic literature by Kodera and Van Tran, 2013), as the model does not contain some of the key mechanisms leading to a deflationary spiral (debt deflation and so on) and does contain a long-lasting strong "gravitational pull" of the inflation target on the long-term expectations of economic agents – see section 3.3. The CNB was thus concerned that the deflation episode would last much longer in reality than indicated by the above scenario. In this regard, it therefore viewed the core g3 model as a useful analytical tool while being aware of its limitations.

3.3 Assessment of Risks and Uncertainties in Satellite Models

Monetary policy by nature involves decision-making under uncertainty. Besides their "core" analyses, central banks tend to use numerous methods to assess the associated risks and uncertainties. As pointed out by Šmídková (2005), the variety of such methods is often broader than it may seem at first sight, as central banks do not usually communicate and explain them to the public. Similarly, the CNB prepared many analyses based on satellite models before starting to use the exchange rate as a policy instrument. The following section describes some of these analyses and partially rectifies the above-mentioned central bank communication deficit.

Overall, these analyses offered additional support for the use of the exchange rate as a monetary policy instrument. First, they mostly indicated a risk of longer-running deflation (see sections 3.3.1 to 3.3.4) and a need for easier monetary policy (see section 3.3.5) than the CNB's "core" predictions. Second, the ZLB and the threat of deflation probably represent the types of uncertainty that require a more pro-active response from central banks rather than the traditional smoothing of monetary policy

changes (see Srour, 1999, or Leiderman, 1999; for a categorisation of the types of uncertainty and their implications for optimal monetary policy see Šmídková, 2003).

3.3.1 The Effect of the "Gravitational Pull" of the Inflation Target in the g3 Model on Forecasted Inflation

The passive monetary policy scenario presented in section 3.2 assumed that economic agents expected monetary policy to take the said passive role, but only for the relatively short period of time for which the baseline forecast scenario with unbounded interest rates implied a negative interest rate level. In the simulation, these agents did not believe that the CNB would actually use unconventional monetary policy instruments in practice, but their confidence in the stabilisation role of monetary policy in the long run persisted implicitly. Long-term inflation expectations in the simulation therefore remained anchored close to the two per cent inflation target and there was no major endogenous strengthening of the exchange rate in reaction to the central bank's passive stance. However, this assumption is rather bold and the CNB feared that the "gravitational pull" of the inflation target (the credibility of the CNB and its monetary policy) might not be maintained. An unfortunate property of deflation is that it usually lasts longer than expected and is harder to cure than to prevent (as documented by the historical experience from the Great Depression of the 1930s as well as from Japan in the last two decades, and to some extent also from Switzerland since 2011 – see section 2.4). The costs of passive monetary policy might have been even higher in reality than indicated by the above scenario, i.e. deflation might have lasted much longer and inflation might not have returned to the target at the long end of the forecast.

A simple statistical analysis of the inflation forecasts produced using the g3 model offered similar conclusions. It set out to quantify to what extent inflation forecast errors are affected by the assumption of 2% targeted price growth. If the inflation forecasts for a specific horizon are unbiased in the long run, the forecast errors – defined as the difference between the forecast and the ex-post observed level – should be normally distributed around zero. This hypothesis, and the question of whether the distance between the forecast and the inflation target plays a systemic role in the error distribution, can be tested using the following linear regression:

$$F\_err_{t+h}^{h} = \alpha + \beta * F\_tar_{t}^{h} + \varepsilon_{t+h}, \qquad (1)$$

where $F\_err_{t+h}^{h}$ is the forecast error for monetary-policy relevant inflation at horizon *h* for a forecast published at time *t*, and $F\_tar_{t}^{h}$ is the absolute distance between the forecast and the inflation target. This simple statistical model was estimated by OLS on data covering the entire period of use of g3 (2008 Q1–2013 Q3). The results for various horizons are shown in Table 1.[34]

Statistically significant coefficient estimates imply that the inflation forecast errors are asymmetric around zero for a specific horizon. According to an F-test, the entire linear regression is statistically

[34] Strong autocorrelation of the residuals can be expected in model (1) due to the definition of the dependent variable; Figure 6 additionally suggests the presence of heteroscedasticity due to the presence of three outliers. The standard estimation errors are therefore adjusted for these factors. However, even if the outliers excluded, the estimated regression curve would remain positively sloped and statistically significant.

insignificant for horizons of less than one year and significant for outlooks of more than five quarters. This confirms the hypothesis that there is a relationship between the distance of the forecast from the target and the forecast error in the second half of the CNB's monetary policy horizon (4–5 quarters) and beyond. The interpretation of this relationship is illustrated for a horizon of five quarters in Figure 6. A larger absolute distance of the inflation forecast from the target is associated with a larger and positive error, i.e. the subsequently observed level is likely to be lower than the forecast. If, for example, the forecast is below the target, the subsequent observation will be even further below the target on average. The estimates of model (1) thus capture two phenomena: a) a systematic slight overestimation of the forecasts (i.e. undershooting of the target in reality if the forecasts are close to the target) for some forecast horizons in the period 2008 Q1–2013 Q3; b) the systemic role played by the distance between the forecast and the inflation target in the size of the forecast errors.

Table 1: Estimation of Model (1)

Horizon	α	β	F test (p-value)
h=1	0.14	-0.09	0.27
h=2	0.19	-0.01	0.93
h=3	0.43**	-0.12	0.35
h=4	0.43*	0.21	0.41
h=5	0.10	1.91***	0.00
h=6	0.41	1.68**	0.02
h=7	0.27	2.48***	0.01

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% levels.
Source: CNB calculations

Figure 6: Deviations of the Forecast from the Target versus Forecast Errors

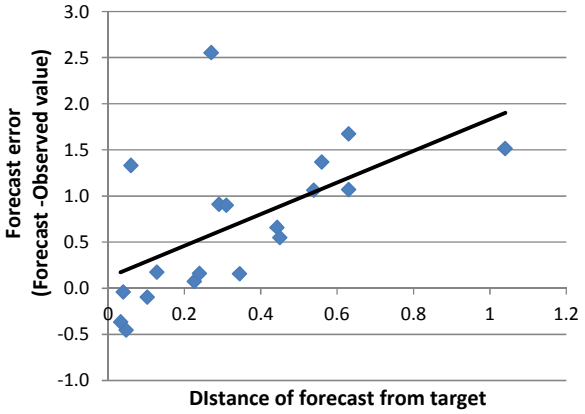
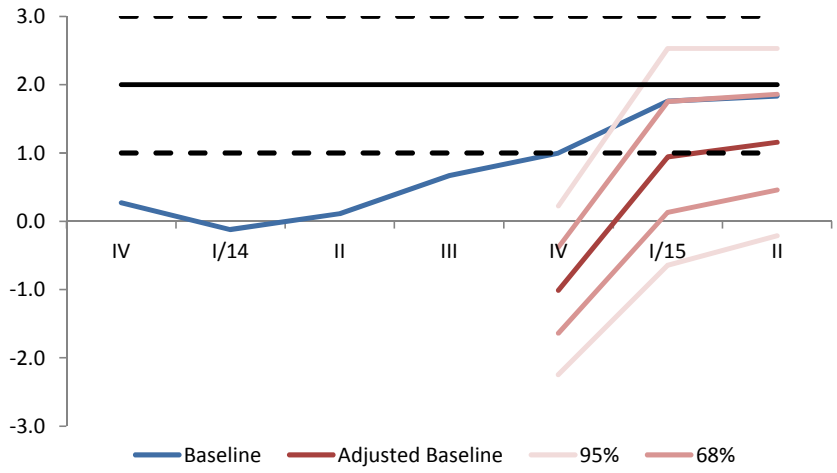


Figure 7 is based on the estimates of model (1) for the various horizons and subtracts the respective estimated forecast errors from the November 2013 forecast for monetary-policy relevant inflation in the unbounded rates scenario. Figure 7 shows that – under the unrealistic assumption of negative interest rates – the forecast for monetary-policy relevant inflation adjusted for the systemic error (adjusted inflation) would stay in the deflation zone until the end of 2014 and would not enter the tolerance band around the inflation target until 2015 Q2.[35]

[35] The undershooting of the inflation target, however, can also be analysed structurally using the core prediction model. The lower-than-forecasted inflation after the global economic crisis broke out in 2008 can be largely explained by wrong projections for foreign variables (the CNB normally takes these projections from the Consensus Forecast surveys and from market outlooks). The gradual downward revision of the outlooks for economic growth, inflation and interest rates in the euro area during the economic crisis led to revision of the forecasts for inflation and economic growth in the Czech Republic in the same direction. The effect of errors in the outlooks for external developments on the forecasts for domestic variables is regularly quantified in quarterly assessments of fulfilment of the inflation target and communicated in section III.1.1. of the CNB's Inflation Reports.

Figure 7: The November 2013 Forecast for Monetary-Policy Relevant Inflation and the Forecast Adjusted for the Systemic Error



Note: "Forecast" here means the baseline scenario with unbounded (i.e. negative) interest rates.
Source: CNB calculations

3.3.2 The Predictability of Deflation

The CNB traditionally monitors the expectations of financial market participants, firms and households in its Inflation Reports. In light of survey-based inflation expectations and the CNB's forecast itself (see Inflation Report IV/2013) the probability of the deflation scenario did not seem high at first sight – one-year-ahead inflation expectations stayed well within positive territory and analysts' expectations three years ahead remained firmly anchored close to the two per cent target. On the other hand, there were significant doubts about (i) the usability of the inflation expectations surveys as a leading indicator of deflation and (ii) the ability of the CNB's forecasting system alone to predict deflation with a sufficient degree of probability.

Financial market inflation expectations at the one-year horizon dropped below the inflation target at the start of 2013. In October 2013 they reached 1.4%, the lowest level since 1999. It is likely that the information contained in the CNB's Inflation Reports is an important determinant of such expectations (Filáček and Saxa, 2012). In this context, there was a tangible risk that the strongly anti-inflationary message of Inflation Report IV/2013 might further reduce these expectations. On top of that, there was a discrepancy between the inflation expectations results (for example, in October 2013) and the CNB's forecast – the analysts were simultaneously expecting a stronger exchange rate and higher inflation, and most of them were not expecting interventions. This indicates that the analysts had accepted the baseline scenario of the forecast (as presented in Inflation Report III/2013 and earlier) but did not realise that it was unrealistic, i.e. that it was conditional on negative interest rates (or that their forecast was based on different assumptions than the CNB forecast).

What is more, historical experience shows that large deviations of inflation from the target are not usually indicated in previous surveys. For example, the surveys at the start of 2007 did not identify the significant overshooting of the target which occurred at the beginning of 2008 (for both headline inflation and monetary-policy relevant inflation). But what is more surprising is that there were no increases in inflation expectations in the relevant surveys. The same goes for the zero inflation

episode in late 2009 and early 2010 – the surveys in late 2008 and early 2009 had not indicated any decline in inflation below the target. The fact that inflation expectations do not deviate significantly from the target can be seen as a good thing as regards monetary policy credibility. On the other hand, these surveys cannot be regarded as a solid alternative source of information on the possible future path of inflation.

Similarly, the 1990s deflation episode in Japan was not predicted by inflation expectations surveys; on the contrary, the surveys adjusted to deflation with a lag.[36] A more recent example of the difficulty in predicting deflation from the perspective of forecasts produced by central banks themselves and by financial market analysts is Switzerland. It fell into deflation at the end of 2011 and has been experiencing near-zero inflation ever since. The Swiss National Bank (SNB) had not predicted deflation in its forecasts published before this episode between the end of 2010 and late 2011. Only in its September 2011 forecast did a change occur. Even though the interest rates on which the forecast is conditional declined from 0.25% to 0%, i.e. an additional easing of monetary policy was predicted, the inflation forecast dropped significantly over the entire horizon and turned negative in 2012.[37] However, like the CNB's November 2013 simulation of passive monetary policy, the SNB's forecast indicated that the deflation episode would be very short-lived. This suggests that underestimation of the risk and/or duration of deflation may be a common property of the forecasting models used by the two central banks.[38] Subsequent SNB forecasts have gradually postponed the return of inflation into positive territory to the present – inflation is now at near-zero levels for the first time in two years (this was also seen as a risk in the CNB's situation). However, the SNB's September 2011 forecast was still a more accurate guide than the analysts' predictions. Specifically, the September 2011 Consensus Forecasts indicated average inflation in Switzerland of 0.7% in 2012 and none of the analysts' forecasts was in the deflation zone (the lowest figure given in the survey was 0%). Reliance on this inflation expectations survey as a leading indicator would therefore have led to even greater underestimation of the risk of deflation than that which occurred in the case of the SNB.

3.3.3 The Probability Distribution of the Inflation Outlook at the ZLB

Another supplementary analysis related to how the probability distribution of the inflation forecast changes near the ZLB. This analysis showed that the shift in the distribution depends on the assumption about how active or passive monetary policy is.

The following analysis is based on the methodology presented in Franta et al. (2014). The estimates of the probability distribution of the outlooks for the variables are based on a VAR model with four endogenous variables (real output, monetary-policy relevant inflation, 3M PRIBOR rates and the

[36] For example, Higo (2000) shows that inflation expectations were backward-looking in Japan, i.e. they dropped below zero in the year when the deflation actually started; in contrast, according to the author, a drop in asset prices was a significant early warning indicator for deflation. Antolin-Diaz (2014) shows, again using the example of Japan, that long-term expectations (from CF) are very sticky and completely uninformative as regards estimating the probability of future deflation, as experienced by Japan several times in recent decades. Siklos (2013) demonstrates, on a sample of Asian countries, that there is a bias towards higher, or positive, levels in SPF (Survey of Professional Forecasters) inflation forecasts.

[37] Swiss National Bank: Quarterly Bulletin, 3/2011 (September).

[38] Or of the assumptions incorporated into these models, as the Consensus Forecast predictions in recent years have significantly underestimated the strength of the deflationary tendencies in the euro area.

CZK/EUR nominal exchange rate) and three exogenous variables (external demand, inflation and the interest rate).[39] Compared to the g3 model, this is a much simpler, non-structural model which contains no forward-looking component reflecting agents' rational expectations. However, unlike the g3 model, it is completely estimated, not calibrated. The uncertainty of the economic outlook calculated using this model is made up not only of the uncertainty about future shocks, but also of the uncertainty about the correct coefficients of the model. Chung et al. (2012) show just how important a role the consideration of uncertainty plays in estimates of model parameters as regards capturing the probability of hitting the ZLB more realistically. They also argue that models that impose fewer theoretical constraints on the data may be suitable candidates for assessing the probability of the economy moving to the ZLB. The discussion in Chung et al. (2012) therefore suggests that even a greatly simplified non-structural model may be very informative in describing the uncertainty surrounding a forecast.[40] The model is estimated using data for the period 1998 Q1–2013 Q3. The text below assumes a 3M PRIBOR–2W repo interest rate spread of 0.45 percentage point, defining the de facto lower bound for the 3M PRIBOR.

The lower bound can be addressed in two ways:

i) By imposing zero whenever the implied repo rate is negative (passive monetary policy). In this approach, values of the interest rate below the ZLB are replaced by the value of the lower bound. Negative monetary-policy shocks and the impact of other shocks on interest rates are not considered in cases where rates might potentially move below the ZLB.

ii) By only considering shocks that do not lead to negative rates (active unconventional monetary policy). This approach is implemented on the basis of "soft conditioning" as described in Waggoner and Zha (1999). Shocks to the reduced-form model that do not result in sub-ZLB rates are considered. As regards structural shocks, only combinations of structural shocks that do not cause rates to decrease below the ZLB are considered. For example, a negative demand shock is included in the probability distribution simulation only if it occurs in combination with another shock (supplied in practice by monetary policy) that affects rates in the opposite direction and implies a resulting rate level above the ZLB (for instance, an exchange rate depreciation shock).[41]

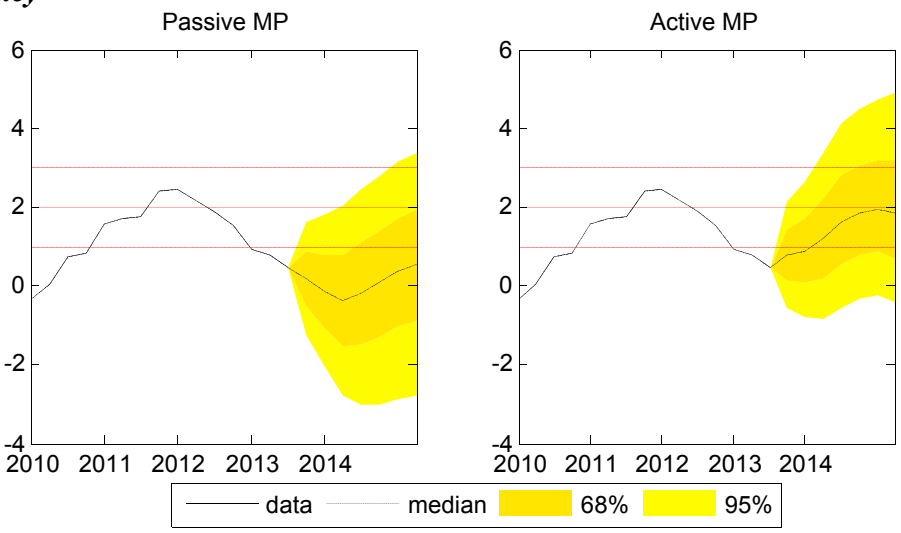
Figure 8 shows that the passive monetary policy approach shifts the probability distribution downwards, i.e. it indicates a fairly high risk of relatively protracted deflation. By contrast, the active monetary policy option implies a considerably higher inflation probability distribution consistent with hitting the central bank's target.

[39] Relevant endogenous variables are considered with lags of up to five quarters, while no lag is considered for exogenous variables. The VAR model is used because estimates of the probability distributions of outlooks based on DSGE models are computationally very demanding and some simplifying assumptions have to be made (see, for example, Coenen and Warne, 2013).

[40] However, it is important to take into account the fact that the Lucas critique mentioned in section 2.1 can be applied to the empirical model used to estimate the probability distribution of the inflation forecast at the ZLB. The applicability of such a model estimated on data for periods when the economy is away from the ZLB is lower.

[41] The situation can therefore be interpreted in such a way that monetary policy does not throw in the towel and responds with relevant shocks. For example, a greater number of depreciation shocks, as considered when creating the fan chart, can be interpreted as a shift to foreign exchange interventions. Similarly, positive demand shocks can be viewed as a consequence of the central bank affecting the long end of the yield curve, and so on.

Figure 8: Probability Distribution of the Inflation Outlook at the ZLB Depending on Monetary Policy



Note: The probability distributions are characterised by the median and the centred 68% and 95% of the posterior distribution forecast.

Source: CNB calculations

Table 2 presents quantitative estimates of the probability of deflation at horizons of one to seven quarters with passive and active monetary policy.

Table 2: Probability of Deflation

Horizon:	2013 Q4	2014 Q1	2014 Q2	2014 Q3	2014 Q4	2015 Q1	2015 Q2
Passive MP	0.39	0.55	0.62	0.55	0.46	0.39	0.34
Active MP	0.11	0.14	0.11	0.06	0.04	0.04	0.05

Source: CNB calculations

The above analysis shows clearly that the probability of deflation is strongly conditional on what monetary policy does or does not do. This indirectly implies that it may be misleading for a central bank to rely on the results of inflation expectations surveys. If economic agents' forecasts are conditional on the expectation that the central bank will fight the risk of deflation by whatever means at its disposal (i.e. if the inflation target remains credible), the probability distribution of their inflation outlooks will correspond to the active unconventional monetary policy scenario in Figure 8 and their inflation expectations will signal a low probability of deflation. However, if, on that basis, the central bank announces that it will not take any anti-deflationary measures, their expectations may shift towards the passive monetary policy scenario and the risk of self-fulfilling deflation expectations will increase considerably.

3.3.4 The Phillips Curve and the Negative Output Gap as the Main Disinflationary Factor

Unlike the previous QPM model, the g3 core prediction model does not work explicitly with the output gap. However, the output gap remains a useful analytical indicator for monetary policy, and estimates of the output gap based on several different methods are included in the CNB's Inflation Reports. These estimates showed that the output gap reached historical lows of between -3% and -4% in the second half of 2013 (see Figure 2b in section 3.1), indicating an extraordinary downturn in domestic economic activity. These figures were broadly in line with the OECD's estimate. Moreover, Oxford Economics, which provides data to Thompson Datastream, even estimated the output gap at -6%, i.e. as more negative than in neighbouring countries and similar to the level in crisis-hit Spain. The forecast from this source also indicated very slow closure of the domestic output gap until 2018. So, all these estimates suggested a strongly anti-inflationary domestic economy, perhaps even more so than the CNB's core analyses did.

The question was, then, to what extent was such a negative output gap affecting inflation and to what extent would affect it in the future. The logic of the Phillips curve can be applied to obtain an independent, non-g3 assessment of the extent to which real domestic economic activity affects inflation. Although the Phillips curve, which (even in its modern, generalised version) assumes a stable relationship between inflation and the business cycle, is a cornerstone of macroeconomics, the empirical evidence on this trade-off is unclear. The relationship between inflation and real activity is subject to three main uncertainties: (i) what the correct measure of real economic activity is, (ii) whether the relationship between inflation and economic activity is linear, and (iii) whether the trade-off between inflation and economic activity is subject to *permanent* shifts due to structural changes in the economy and monetary policy (for example, the hypothesis of a permanent flattening of the Phillips curve).[42]

One of the ways to address these uncertainties consistently and grasp the relationship between inflation and real economic activity is to estimate the (quasi-)Phillips curve using dynamic model averaging (DMA; Raftery et al., 2010). DMA marries the flexibility of a time-varying coefficient model (i.e. real activity can affect inflation with different intensity at each moment) with the possibility of model switching (i.e. the relevant variable best describing economic activity) in each period. So, the aim is to estimate the intensity of the relationship between inflation and domestic economic activity as measured by alternative variables. This may indicate to what extent domestic real economic activity will continue to be anti-inflationary in the future. The application of this approach is motivated by the observation that inflation reacts differently to different measures of economic activity over time and across countries (see Baxa et al., 2013, for the G7 countries).

The empirical methodology (described in detail in Baxa et al., 2013) consists in estimating a multivariate model where various measures of economic activity x_t (e.g. the output gap, short-term unemployment, unit labour costs) are used to explain the inflation gap. This gap is defined as the deviation of CPI inflation (at time $t+h$) π_{t+h} from the inflation trend τ_t, which by definition is determined by non-cyclical factors (e.g. the inflation target, persistent cost shocks). The aim, therefore, is to explain this *de facto* cyclical component of inflation using the following model (2) (Stock and Watson, 2010):

[42] The prevailing view is that the Phillips curve has levelled out in recent decades because of either globalisation (e.g. Borio and Filardo, 2007) or "good" monetary policy (Ball and Mazumder, 2011).

$$\pi_{t+h} - \tau_{t|t} = \gamma_t x_t + e_{t+h}, \quad \text{var}(e_{t+h}) = \sigma^2_{e,t+h}$$
$$\gamma_t = \gamma_{t-1} + \xi_t, \quad \text{var}(\xi_t) = \sigma^2_{\xi,t}, \text{cov}(e_{t+h}, \xi_t) = 0 \qquad (2)$$

where π_{t+h} is the annual inflation rate at time $t+h$,[43] $\tau_{t|t}$ is an estimate of the inflation trend at time t (obtained using an unobserved components model with stochastic volatility) and e_{t+h} is an error term.[44] We therefore focus on estimating the time-varying parameters γ_t, which measure the intensity of the reaction of the cyclical component of inflation $\pi_{t+h} - \tau_t$ to the individual measures of economic activity x_t and to the variables representing external inflation factors. The individual models (2) are estimated using a modified Kalman filter, and the DMA method (Raftery et al., 2010) is used to average the models over time in order to select the best models and economic activity variables for each moment.

Figure 9a represents the relative posterior probability of the model with the output gap from DMA, this model being one of the 13 alternative models explaining inflation. The figure shows that the importance of the output gap in explaining inflation starts rising significantly in 2008 (at the expense of other domestic economic activity variables and external factors, which are not shown in the figure for the sake of clarity).[45] Towards the end of the data sample (the end of 2012), the output gap was the most probable determinant of inflation, as the output gap model attains a probability of 0.5 out of a maximum of 1 (and no other variable attains a probability of over 0.1). The estimate of the output gap coefficient γ_t (using the Kalman filter) was statistically significant, taking a value of 0.6 from 2008 onwards (see Figure 9b).[46]

Taken together, then, the extreme values of the output gap in 2013, the assumption that the negative output gap would close only very slowly in the years ahead (despite modestly positive expected rates of GDP growth) and the strong impact of the output gap on inflation (see Figure 9) indicated that the domestic economy would remain strongly anti-inflationary.

[43] In the original analysis for G7 countries, h=4 was used. A model with h=1 works significantly better in the case of the Czech Republic, implying that the impact of economic activity on inflation is much faster in the Czech economy.

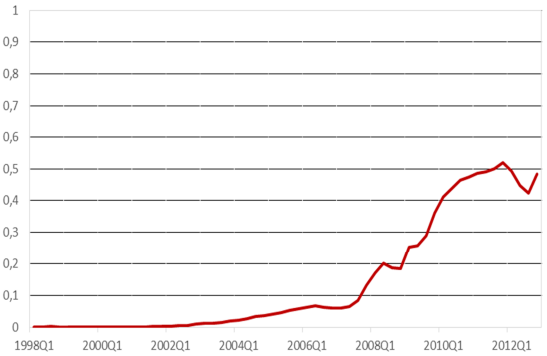
[44] The model assumes that the variance of the error term in both the first (observation) equation and the second (transition) equation can change over time (for details see Baxa et al., 2013).

[45] However, Brůha and Hlédik (2014) and Andrle and Brůha (2014) point out that time-varying parameters in empirical models do not necessarily reflect structural changes in the economy and may instead indicate insufficient characterisation of the effect of forward-looking information or general misspecification of the empirical model.

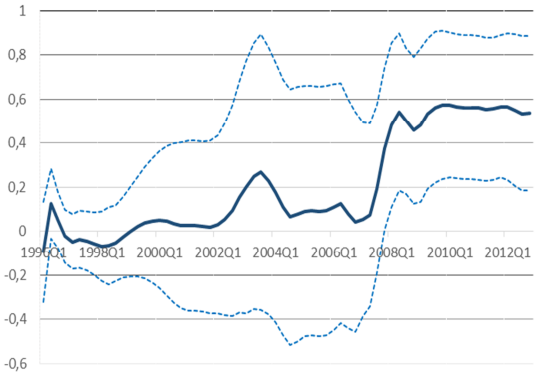
[46] The importance of the output gap is also unique by comparison with other countries (see Baxa et al., 2013, for the G7 countries), where labour market variables or external factors tend to dominate. In no other country does the output gap coefficient attain such a magnitude as in the Czech Republic (for the G7 it is usually around 0.2), nor, with the exception of the UK, does the output gap itself attain such negative values as in the Czech Republic.

Figure 9: Assessment of the Importance of the Output Gap for Inflation in the Czech Republic

a) Posterior probabilities of output gap model



b) Time-varying coefficient of output gap (with confidence interval)



Source: CNB calculations

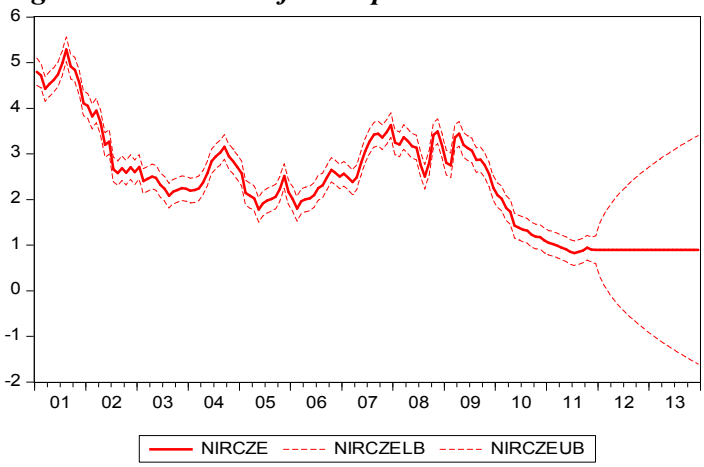
3.3.5 The Uncertainty About the Equilibrium Interest Rate After the Crisis

As discussed in section 3.1, in November 2013 the g3 model indicated a need for significantly negative monetary policy rates, at around -0.9%. In this model, the path of interest rates is determined using a forward-looking version of the Taylor rule taking into account the equilibrium level of interest rates and the deviations of inflation from the CNB's target over a horizon of four quarters (see Inflation Report II/2009, Box 3). There were two possible reasons why this rule might have underestimated the need to ease the monetary conditions. First, the version of the Taylor rule in the g3 model does not contain the output gap, which was estimated to be significantly negative (see section 3.3.4). Its explicit incorporation into the central bank reaction function might therefore have led to an even lower interest rate path over the whole forecast horizon.[47] Second, the equilibrium real interest rate might have been lower than in the g3 model.

Like other DSGE models, the g3 model views the equilibrium real rate as a truly steady-state rate which is constant over time and is calibrated at 1% (3% in nominal terms), even after the change in the steady-state settings in the g3 model in Inflation Report IV/2013 (see Box 2). Although this is understandable in the logic of the model, foreign empirical evidence (Belke and Klose, 2012; IMF, 2014, chapter 3) has identified a decrease in this variable over time. In a closed economy, a lower equilibrium real interest rate can be brought about, for example, by a change in households' consumption behaviour towards a stronger preference for future consumption over current consumption, by a decline in the return on capital or by negative demographic trends. In a model of a small open economy with perfect capital mobility, a reduction in the country risk premium in the uncovered interest rate parity equation can act in the same direction (whereas the slower equilibrium real appreciation of the exchange rate since the global economic crisis broke out acts in the opposite direction).

[47] The calculations for the Czech Republic indicated a repo rate as low as -2%. For the sake of comparison, Rudebusch (2010) estimates the need for monetary policy easing in the USA in 2008, which was used as the basis for determining the size of the QE programme, at around -5%.

Figure 10: Estimate of the Equilibrium Nominal Interest Rate with Confidence Intervals



Source: OECD data; CNB calculations

Unfortunately, there is no direct evidence regarding the effects of the above factors in the Czech Republic; the time-varying equilibrium real interest rate was estimated only indirectly in Horváth (2009) using the Taylor rule on data from before the global economic crisis. The author concluded that the policy neutral rate had declined gradually over the period under review to a level similar to that in the euro area. The CNB's internal calculations using more recent monthly data for the period from January 1998 to April 2013 suggested a further drop in the estimated equilibrium interest rate to 0.9% in nominal terms (see Figure 10). This is consistent with an equilibrium real interest rate of -1.1% (i.e. 0.9% minus the inflation target of 2%). Belke and Klose (2012), for example, arrived at a similar figure for the euro area in 2010, and it is likely that the developments observed since then have fostered a decrease further into negative territory. These calculations thus pointed to a possible need for even more negative interest rates compared to the baseline scenario of the CNB's November 2013 forecast.[48]

4. The Choice of the Exchange Rate as the ZLB Instrument in the Czech Republic

This section explains why the CNB chose the exchange rate as its ZLB instrument (section 4.1), which analyses it used to determine the intervention level (section 4.2) and why it eventually opted for a very transparent approach to the use of this instrument in the form of a publicly declared, one-sided exchange rate commitment (section 4.3).

4.1 The Choice of the Exchange Rate as the ZLB Instrument for the Czech Republic

The CNB Bank Board chose the exchange rate as a monetary policy instrument from the full range of unconventional instruments available. This decision was based on a debate that had been going on since 2009 on a hypothetical level and took concrete form in 2012.

[48] However, the estimate of the equilibrium rate using the Taylor rule has the disadvantage that the equilibrium rate level is inferred from the central bank's behaviour. One can therefore question whether this method can be used to judge whether the central bank's assumption about the equilibrium real interest rate is correct.

The outcomes of this debate were, first, that the CNB should fully exhaust the potential of interest rates by lowering them to the ZLB before using unconventional instruments, although on the other hand it was not appropriate to consider negative monetary policy interest rates in the Czech context. In addition to the fact that the benefits of negative interest rates are generally debatable and it is impossible to go below a particular threshold leading to a strong preference for cash,[49] there are legal constraints on introducing negative rates in the Czech Republic, as certain laws and by-laws define penalty interest as a multiple of the CNB discount rate. Strictly interpreted, negative rates would therefore mean that creditors would have to start paying money to debtors in arrears, and that would be directly at odds with the point of penalty interest.

Second, when lowering rates to the ZLB the CNB employed an element of forward guidance by following up on its practice of publishing the interest rate path consistent with its forecasts. Specifically, in November 2012 it announced that rates would be kept at technical zero "over a longer horizon until inflation pressures increase significantly".[50] This form of unconventional monetary policy probably contributed partly to the decline in long-term interest rates recorded in the Czech Republic in autumn 2012, but ultimately did not seem sufficiently effective to break the deflationary tendencies in the economy. It was therefore necessary to seek other ways of easing monetary policy and halting the decline in inflation expectations (see section 3).

Third, quantitative easing through government bond purchases, for example, did not seem a suitable instrument given the long-standing liquidity surplus in the banking sector[51] and the already low long-term government bond yields. Although the price effect of bond purchases (i.e. their impact on long-term interest rates) would probably have worked, it was not clear whether in the given conditions it would have been sufficiently long-lived to have the desired impacts on the real economy. Qualitative easing did not seem realistic either, because in the Czech Republic mortgage bonds are the only large-volume instrument in the category of corporate bonds and other bonds with similar risk. The markets in other riskier assets are too shallow in the Czech Republic to offer scope for large-scale purchases by the CNB and thus be suitable for implementing unconventional monetary policy. This limited the applicability of qualitative easing essentially to situations of disrupted monetary transmission in the area of mortgage financing and the property market, and those situations were not observed in reality.

Fourth, in the small open Czech economy, weakening the exchange rate of the koruna is an effective tool for increasing the domestic price level and stabilising inflation expectations close to the CNB's target. In addition, the impacts of exchange rate changes can be expected to be considerably stronger than usual if the exchange rate is used as a systematic monetary policy instrument at the ZLB (see section 2.3).

For these reasons, the CNB opted for an exchange rate weakening and started communicating its potential use as early as September 2012, i.e. before the ZLB had been fully reached. At the same

[49] Buiter (2009) proposes three very novel ways of resolving this problem. However, the only practical experience is with negative central bank interest rates of -0.2% or less (Sweden, Denmark and, since June 2014, the ECB).

[50] A more explicit form of forward guidance was also considered, for example a "0-3-3" commitment "to keep interest rates at zero for at least three years unless monetary-policy relevant inflation rises above 3% during this period" (3% is the upper boundary of the tolerance band around the inflation target). However, this was not adopted in the end, partly because of doubts about whether this type of forward guidance is realistic (see Singer, 2014).

[51] This surplus liquidity manifested itself, among other things, in banks making virtually no use of the CNB's liquidity-providing facility introduced in 2009, under which they had access to unlimited 14-day liquidity at an interest rate only 10 basis points above the two-week repo rate (i.e. only 0.15% p.a. as from November 2012).

time as lowering interest rates to technical zero in November 2012, the CNB Bank Board decided to suspend sales of income on its international reserves, as such operations might have clashed with monetary policy implementation at the ZLB. This also strengthened the signal that the CNB was ready to carry out foreign exchange interventions to weaken the koruna. The International Monetary Fund also recommended that the Czech Republic should use foreign exchange interventions if needed (IMF, 2013).

Fifth, the CNB preferred direct use of the exchange rate as a monetary policy instrument and regarded quantitatively unlimited interventions merely as a means of reaching the exchange rate level consistent with hitting the inflation target in the future. An alternative would have been to use fixed-size interventions as an instrument, like Israel and Chile have done in the past (see section 2.3). The IMF also formulated a recommendation to this effect (see IMF, 2013, p. 10).[52] However, the CNB rejected this approach for several reasons: (i) the small expected liquidity impact of the interventions, linked directly with their size (see above); (ii) the reliance conversely on the inflation expectations and real interest rate channel in combination with standard exchange rate transmission channels linked with the exchange rate level and its change over time; (iii) the impossibility of determining ex ante the appropriate intervention size delivering an exchange rate weakening consistent with hitting the inflation target; (iv) the related generally debatable effectiveness of this type of intervention in influencing the exchange rate.

4.2 Determining the Intervention Level

When deciding to use the exchange rate of the koruna as a monetary policy instrument, the CNB also needed to determine the appropriate intervention level for hitting the inflation target and exiting the ZLB in the future. An alternative forecast scenario assuming the use of the exchange rate as an additional monetary policy instrument was therefore drawn up using the g3 model (see Figure 11, blue solid lines). In this scenario, the impact of interventions was simulated using expected shocks to the exchange rate equation (a version of uncovered interest rate parity). This is a pragmatic, simpler option compared to extending the model by explicitly including the central bank's intervention reaction function along the lines of Beneš et al. (2013b) or Hurník (2013). The size of these shocks was derived[53] with respect to (i) observation of the ZLB constraint; (ii) the speed of return of inflation to the CNB target; (iii) the intuitive exchange rate path and the pattern of the interventions contained therein (e.g. no alternate interventions in opposite directions).

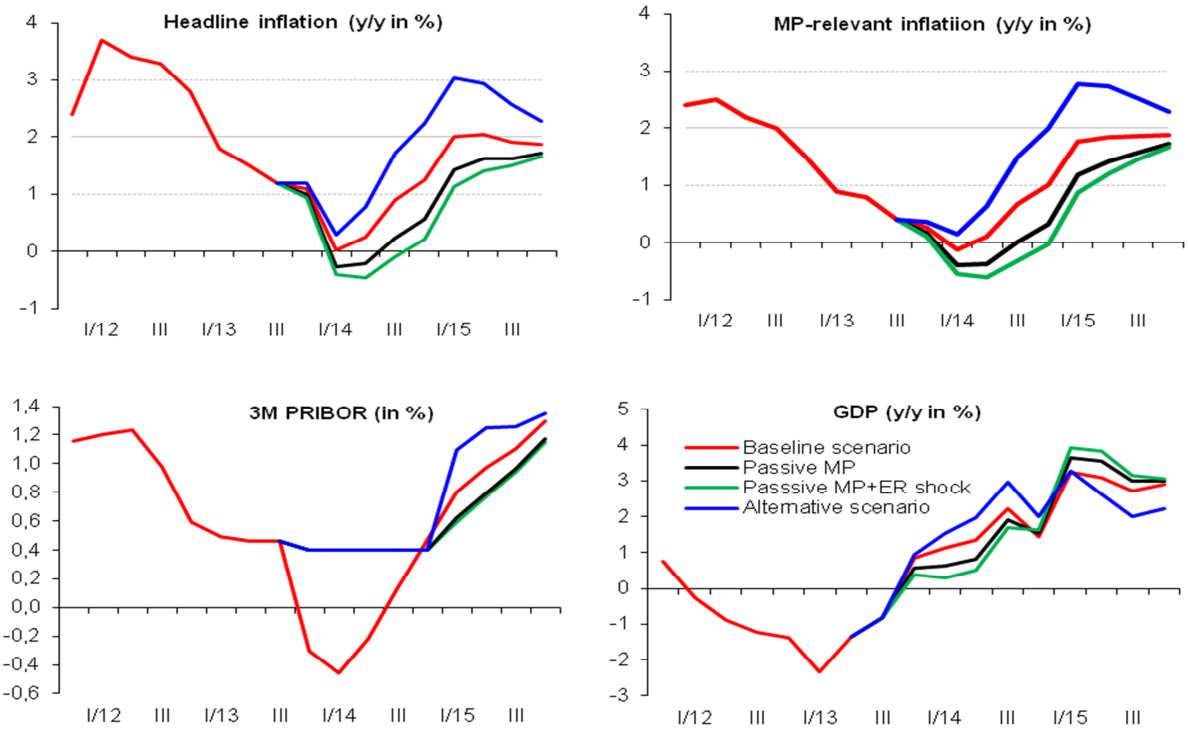
Several variants of this scenario were drawn up internally, differing mainly in the weight placed on the speed of attainment of the inflation target and the assumed moment of exit from the exchange rate instrument and the ZLB in the future. Expert judgement was used to select the variant best ensuring fulfilment of monetary policy objectives while respecting the recommendations made in the economic literature regarding the need to temporarily overshoot the inflation target in order to exit the ZLB and overcome the risk of deflation. Account was also taken of the fact that the change in the nominal exchange rate in the alternative scenario should be sufficiently large to influence the expectations of

[52] "For example, the use of pre-announced interventions of fixed sizes per period would be a good candidate in terms of market communication and ease of exit, while allowing sufficient flexibility to adjust as needed."

[53] The inspiration was the algorithm contained in Holden and Paetz (2012).

economic agents and also to ensure that the level of the exchange rate commitment will not have to be changed in the future if anti-inflationary risks occur to the ordinary extent.

Figure 11: Alternative Scenario of Using the Exchange Rate Compared to other Scenarios in November 2013



Source: CZSO; CNB calculations

In the chosen version of the alternative scenario, the exchange rate of the koruna thus moved close to CZK 27 to the euro and was therefore considerably (4%–5%) weaker than in the baseline scenario with negative interest rates. According to the alternative scenario, a weakening of the exchange rate to levels close to CZK 27 to the euro would deliver the necessary monetary policy easing. This would significantly lower the risk of deflation, accelerate the return of inflation towards the target, support a recovery in economic activity in 2014 and enable a more robust exit from the ZLB in early 2015. In this regard, it should be stressed that the relevant comparison for assessing the benefits of using the exchange rate as a further monetary policy instrument is that between the alternative scenario and the counterfactual passive monetary policy scenario (see Figure 11, black and green solid lines; see also Figure 5 in section 3.2.) and not that between the alternative and baseline with its unrealistic negative interest rates.

As regards inflation, the weaker exchange rate was gradually reflected in the first few quarters of the alternative scenario in a rise in import prices increasing both headline and monetary-policy relevant inflation, which thus reached very low but positive levels in early 2014. This was followed by a gradual resurgence of inflation pressures from the domestic economy, which took over the main role in inflation from import prices. Thanks to this, inflation in the alternative scenario returned to the CNB's target as early as 2014 H2. It subsequently moved into the upper half of the tolerance band around the target, and even towards its upper boundary, and then converged towards the target from

above during 2015. The temporary overshooting of the inflation target in this scenario offset the significant undershooting in 2014 and led overall to an average inflation rate for the two years of just under 2%, i.e. almost equal to the CNB's target.

This scenario thus implicitly contained an element of temporary price-level targeting (PLT), which is recommended in the economic literature as a tool for overcoming the risk of deflation and escaping the ZLB (see sections 2.2 and 2.3). Under PLT, past deviations from the target are not ignored, but offset by subsequent developments. This increases inflation expectations and fosters a quicker and more robust exit from the ZLB via a decrease in ex ante real interest rates. However, the chosen strategy incorporated this element of PLT without an explicit regime change, the ultimate ambition being to return to the standard inflation targeting regime, as the CNB's public commitment was made solely in terms of the nominal exchange rate as a monetary policy instrument, not in terms of the future price level. As stated in section 2.3, this choice is equivalent only from an ex ante perspective; ex post, the chosen nominal exchange rate level may turn out to be consistent with a different domestic price level than expected (especially if the path of the foreign price level differs from expectations and/or the equilibrium real exchange rate of the domestic currency changes unexpectedly). In this regard, the CNB's approach differed significantly from Svensson's (2001) recommendations, even though the latter were a significant source of inspiration from the economic literature.[54]

The alternative scenario also quantified the extent to which a weakening the exchange rate at the ZLB boosts domestic economic activity. The weaker exchange rate supports Czech exports, or rather the price competitiveness of Czech producers on foreign and domestic markets, as well as the profitability of those producers and hence also their willingness to invest. The purchasing power of households can be expected to drop temporarily owing to the increase in import prices (the income effect), but household demand will be redirected towards domestic goods on the Czech market owing to the weaker exchange rate (intratemporal substitution). Household demand is also supported by lower real interest rates as a result of higher inflation expectations (intertemporal substitution). This channel is exceptionally strong at the ZLB when deflation expectations are looming. The recovery in production then fosters a rise in employment and wages, which in the next stage increases the purchasing power of households. These favourable effects of the exchange rate weakening will emerge during 2014, when, thanks to the monetary policy easing, the Czech economy will grow more than one percentage point faster than in the passive monetary policy scenario. The GDP level will thus return to its equilibrium path substantially sooner than in the case of no easing of the monetary conditions.

4.3 Discussion of the degree of transparency and the declared exchange rate commitment

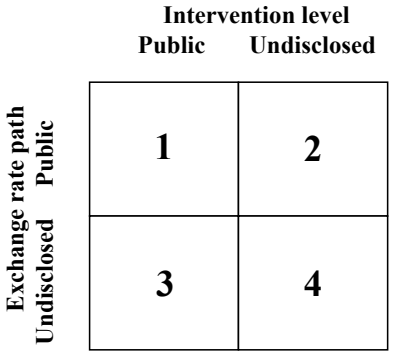
The CNB intensively – and in several rounds – debated the degree of transparency with which the exchange rate should be used as a ZLB monetary policy instrument. First, the CNB considered how to formulate and communicate the chosen intervention level and exchange rate commitment. Second, it had to decide whether to continue disclosing the exchange rate path from the alternative scenario of

[54] The CNB also weakened the exchange rate as a one-off action, in contrast to Svensson's (2001) recommendation to introduce a crawl, and announced that a future movement of the exchange rate to an even weaker level was possible in principle but would require very strong anti-inflationary risks.

using the exchange rate as a monetary policy instrument. It also had to take into consideration the fact that the exchange commitment level chosen by the CNB Bank Board might differ from the exchange rate path in the forecast scenario, as it generally holds that the forecast is the key, but not the only input to the Bank Board's decision-making and it is equally important to assess the risks going forward.

Overall, this led to the creation of four main communication strategy options with different degrees of transparency, as illustrated in Figure 12. The decision was based on three main criteria: (i) the strength of the signalling effect; (ii) the degree of monetary policy transparency; (iii) the market perspective and potential complications in monetary policy implementation.[55]

Figure 12: Transparency Options



As far as the signalling effect is concerned, the view eventually prevailed that this criterion is best served by option 3. Under this option, the publicly declared intervention level – representing a clearly communicated exchange rate commitment – could help the CNB achieve the required exchange rate level with a smaller volume of actual interventions (see Hurník, 2013, and section 2.3). The signalling effect of disclosing the exchange rate commitment is conditional on a clear and serious declaration that the central bank stands ready to intervene at the specified exchange rate levels to an unlimited extent. At the same time, option 3 enables a credible central bank to maximise the impacts on inflation expectations, as stressed by the economic literature (see Svensson, 1999 and 2001). Option 1 would also have a signalling effect. However, it could be confusing – and therefore counterproductive – to disclose two or more exchange rate levels if the final decision of the Bank Board were to differ from the forecasting scenario of using the exchange rate. The disadvantage of option 2 is the potential signalling of exchange rate levels other than the CNB Bank Board's intervention level. Option 4 in practice involves abandoning any signalling effect.

From the perspective of maintaining the CNB's high status in the field of monetary policy transparency, option 1 appeared to be desirable, as it would involve disclosing all relevant information on the exchange rate as a monetary policy instrument. On the other hand, maximum information disclosure does not necessarily imply the best understanding of monetary policy, because – as mentioned above – disclosing more than one exchange rate level could cause confusion. Since the emphasis was on this qualitative aspect of transparency, option 3 was ultimately chosen, as it gives preference to transparent disclosure of the Bank Board's monetary policy decision over

[55] The constraints generated by the various options for the exit phase were also considered as part of this process.

disclosure of the underlying analytical document (unlike option 2).[56] Option 4 is, naturally, the least transparent one.

The market criterion gave rise to arguments in favour of option 4, in that non-disclosure of the intervention level and the exchange rate path in the forecast scenario would lead to greater uncertainty among market participants about the CNB's future activities in the market, causing a decrease in their willingness to speculate. With the other options, by contrast, there is a risk of higher foreign exchange reserve purchases, which, moreover, would take place at less favourable levels. Following the logic of this argument, the CNB could maintain the required exchange rate level at lower cost if it did not disclose the intervention level. A similar view is taken by some economic studies explaining the effectiveness of foreign exchange interventions on the basis of information asymmetry in the market and the "order-flow" channel. Option 4 would also allow a more gradual future exit from the use of the exchange rate as a monetary policy instrument, thereby reducing the risk of future overshooting of the exchange rate on the appreciation side, which could again push the desired interest rates into negative territory. By contrast, with the public exchange rate commitment in options 1 and 3, a gradual exit is more difficult, because sooner or later a clear moment to exit the exchange rate commitment will necessarily arise (and there is no international experience with this in a similar context).

After taking into account all these arguments, the CNB Bank Board decided to start using the exchange rate as an additional instrument for easing the monetary conditions by adopting an explicit and publicly communicated exchange rate commitment. The commitment was defined as follows. The CNB will intervene in the foreign exchange market to weaken the koruna so as to maintain the exchange rate of the koruna against the euro close to CZK 27 to the euro. The CNB made it clear that it was resolved to intervene in such amounts and for as long as needed to achieve the desired exchange rate level with the aim of smoothly fulfilling its inflation target in the future. This means that the CNB expressed its readiness to prevent excessive appreciation of the koruna below CZK 27 to the euro by intervening in the foreign exchange market, i.e. by selling koruna and buying foreign currency. On the weaker side of the CZK 27 level, the CNB is allowing the koruna exchange rate to float according to supply and demand in the foreign exchange market. At the same time, it was decided to stop publishing the exchange rate path consistent with the forecast scenarios and to communicate the exchange rate assumptions of the CNB's forecasts only verbally.

5. Assessment of the Experience to Date

At the time of completion of this study, more than nine months had passed since the CNB started using a weakening of the koruna as an additional instrument for easing the monetary conditions. Although this is still too short a period of time to make definitive judgements, this section offers an initial assessment of the effects so far.[57]

[56] From the practical communication perspective, option 3 also resolves the dilemma about whether or not the desired exchange rate level in terms of hitting inflation targets should be regarded as a central bank commitment, and therefore results in clearer and simpler rules of external communication for CNB representatives.

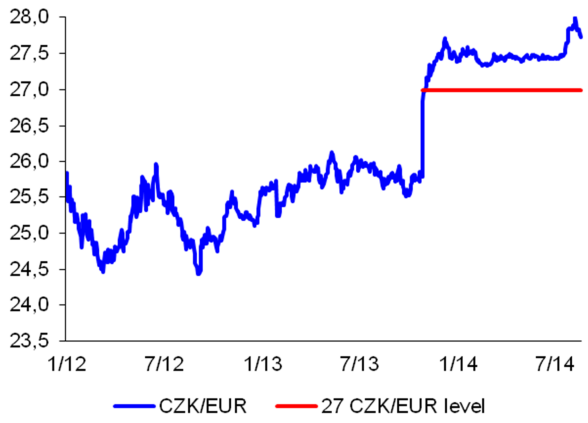
[57] It will be possible to use the g3 core prediction model to conduct a more rigorous analysis of the impacts of the exchange rate weakening.

5.1 The Evolution of the Exchange Rate and the Credibility of the Exchange Rate Commitment

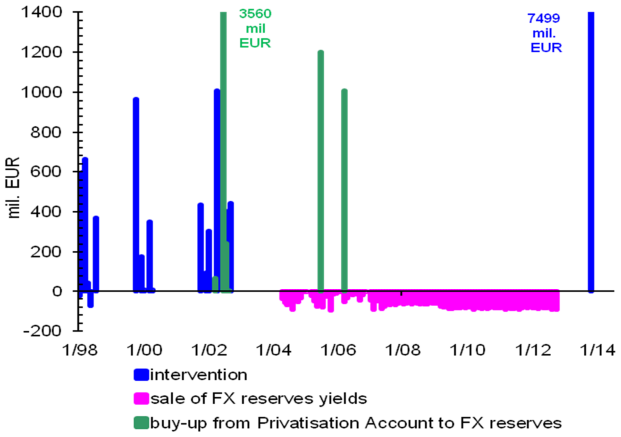
After the CNB decided in November 2013 to start using the exchange rate as an instrument for easing monetary policy, the koruna depreciated sharply against the euro towards the level of the exchange rate commitment (see Figure 13a). The exchange rate commitment had to earn credibility in the first few days. This is evident first of all from the massive intervention purchases that the CNB needed to carry out in a short period of time. These purchases totalled around CZK 200 billion, i.e. roughly EUR 7.5 billion (see Figure 13b).[58] The second indirect evidence is the fact that the "real money" clients of financial institutions were selling foreign currency and buying koruna even before the exchange rate commitment level of CZK 27 to the euro was reached (i.e. at a rate which, with the benefit of hindsight, was unfavourable for them), probably due to concerns that the CNB would be unable to attain this level or would only maintain it for a very short time. Third, comments made in the media by some financial market analysts also sent out a message that the CNB would only be able to maintain the declared intervention level for a few weeks, despite the central bank's communication that its exchange rate commitment was relatively long-term in nature and its intervention capacity on this side of the market was in principle unlimited.

Figure 13: CZK/EUR Exchange Rate and the CNB's Foreign Exchange Transactions

a) CZK/EUR rate and CNB commitment



b) CNB forex transactions under inflation targeting



Source: CNB

This notwithstanding, the exchange rate subsequently broke through CZK 27 to the euro and has stayed above that level ever since (see Figure 13a). This has been achieved without the need for further foreign exchange interventions (see Figure 13b). In other words, the CNB has not been operating directly in the foreign exchange market for more than nine months now. This indicates that its exchange rate commitment quickly started to be seen by the markets as fully credible. This is corroborated by a marked decline in the implied exchange rate volatility derived from option prices. The expected signalling effect of an explicit exchange rate commitment supported by an unlimited intervention mandate has thus been confirmed.

[58] The CNB's huge interventions on 7 November 2013 were complicated by the ECB's announcement of a reduction in its interest rates the same day. This sparked a sharp response from the euro-dollar exchange rate and thus also heavy trading activity on the global foreign exchange market. The fact that so many trades were executed in the foreign exchange market in a short space of time gave rise generally to a problem with limited credit lines between banks. However, a detailed account of these manifestations of imperfections in financial markets, which proved relevant to the implementation of the CNB's decision, is beyond the scope of this study.

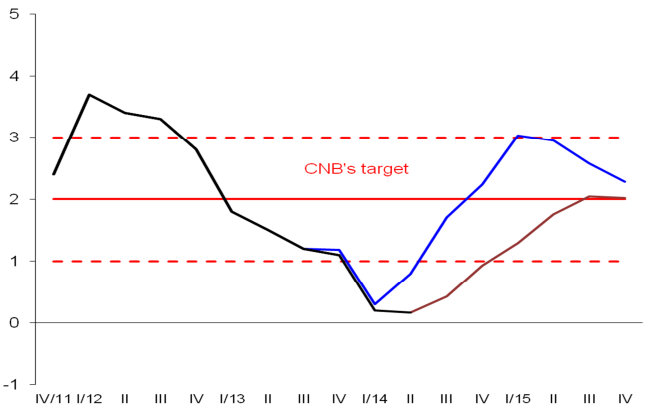
At its meetings during 2014 the Bank Board still viewed the chosen exchange rate commitment of CZK 27 to the euro as appropriate. However, given anti-inflationary developments it gradually made it known that the economy would stay in the regime of using the exchange rate as a monetary policy instrument for longer than originally anticipated. At its meeting in late July, it stated specifically that the CNB would not discontinue the use of the exchange rate as a monetary policy instrument before 2016. This was consistent with its previous communication to the effect that a shift in the level of the commitment was possible in principle, but would require a truly fundamental and dramatic change in the economic conditions. If the future economic outlook requires a further easing of monetary policy to the usual extent, the Bank Board has stated a preference for maintaining the exchange rate commitment at CZK 27 to the euro for a longer time rather than changing that level.

5.2 Inflation and the Pass-Through of the Exchange Rate to Prices

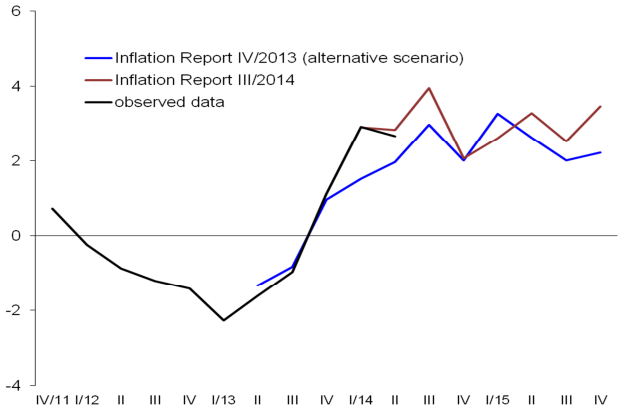
So far in 2014, annual headline inflation has dropped sharply to very low – but positive – values. The average of 0.2% for 2014 Q1 was only 0.1 pp lower than the figure for the same period in the alternative scenario taking into account the weakening of the koruna in November 2013. In 2014 Q2, however, inflation stayed at this level on average, whereas the November scenario of using the exchange rate had expected it to rise to 0.8%. The medium-term inflation outlook has also decreased, as the current forecast indicates that – assuming the use of the exchange rate as a monetary policy instrument until 2015 Q3 – inflation will return to the two per cent target in 2015 H2 but will not significantly exceed it, whereas the November 2013 scenario had for 2015 contained a temporary rise in inflation to the upper boundary of the tolerance band around the target (i.e. to 3%; see Figure 14a). The intentional temporary overshooting of the inflation target ex ante contained in the scenario of using the exchange rate as a monetary policy instrument in order to increase inflation expectations may therefore be fulfilled to only a small extent from the ex post perspective (although this does not necessarily mean that it would not affect ex ante inflation expectations and hence also domestic demand).

Figure 14: Assessment of the Fulfilment of the November 2013 Alternative Scenario to Date

a) Headline inflation (y-o-y, %)



b) GDP (y-o-y, %)



Source: CNB

The drop in observed inflation below the expected levels and the decrease in its outlook reflect a deeper decline in administered prices in early 2014 and in the forecast for 2015, due mainly to the abolition of regulatory fees in health care and the fall in electricity prices on European exchanges observed during 2014. Euro area price developments are also more anti-inflationary, as industrial producer prices – which are of more direct relevance to Czech import prices than consumer prices – decreased noticeably year on year, much more so than expected in the November 2013 outlook.

Overall, we can say that the CNB's action to weaken the koruna is outweighing the even stronger deflationary tendencies than those predicted in the November 2013 forecast scenarios, partly confirming the risks perceived at the time (see section 3.3). By nature, this largely involves factors changing the outlook for the foreign price level downwards and also affecting the equilibrium real CPI-based exchange rate.[59] A lower path of the domestic price level can thus be consistent with an unchanged – or even slightly weaker (see the movement of the exchange rate above the exchange rate commitment level in Figure 13a above) – level of the nominal exchange rate of the koruna, confirming that the setting of a floor on the nominal exchange rate is not equivalent in practice to price-level targeting (in contrast to the model used by Svensson, 2001). So, if the CNB had adopted a commitment not only for the nominal exchange rate, but also for the domestic price level, it would currently be facing the dilemma of which of these two commitments to adhere to and which to abandon, a situation that would be highly undesirable from the perspective of monetary policy credibility.

By contrast, the weakening of the koruna alone is so far passing through to prices in line with expectations, as adjusted inflation excluding fuels has returned to positive figures (and annual tradables price inflation has turned positive for the first time since 2001). The estimated impact of this measure to date is at least 1 percentage point. Without this effect, inflation would have been significantly negative in the first two quarters of 2014, even more so – and for an even longer period of time – than the CNB's analyses were indicating in November 2013. The direct exchange rate effect via import prices[60] has been dominant so far, whereas the secondary impacts on inflation relating to the economic recovery and wage growth should start to be felt in 2014 H2. It is therefore too early to assess their effectiveness at the time of writing (all we can say for now is that the domestic economy has stopped having a clearly anti-inflationary effect, as predicted).

5.3 Developments in the Real Economy

The rate of growth of the Czech economy at the close of 2013 exceeded all previous estimates. GDP grew by more than 1% year on year on the back of an extraordinarily large quarterly increase in economic activity. Positive annual growth was recorded for the first time in almost two years, reflecting a bottoming-out of the domestic economy in the course of 2013. The growth was due to all

[59] For example, the abolition of regulatory fees in health care is reducing the level of consumer prices and thereby leading to depreciation of the real exchange rate of the koruna on the CPI-basis without having any apparent impact on the relative price competitiveness of Czech producers. It is thus reasonable to assume that this measure is pushing the equilibrium real exchange rate of the koruna to a weaker level. Changes to indirect taxes, for example, may be having a similar effect.

[60] In Inflation Report I/2014 (Box 1), on the basis of an input-output analysis, the strength of the direct exchange rate channel running via prices of imported consumption goods was estimated at 1.2%, and at 1.6% overall taking into account also imported semi-finished products for the manufacture of domestic consumption goods.

demand components except inventories, which shrank year on year (despite the strong one-off effect of cigarette frontloading ahead of the January 2014 hike in excise duty).

The GDP figures in the first two quarters of 2014 indicated a further year-on-year acceleration in Czech economic growth (to 2.7% in Q2). In quarter-on-quarter terms, economic activity rose by 0.8% at the start of 2014 and maintained this higher level in Q2, despite being dampened significantly by the sale of the cigarette stocks frontloaded at the end of last year. Overall, then, the economy is recovering substantially faster than the central bank had been expecting in November 2013 (see Figure 14b).

In line with the CNB's expectations, the weakening of the koruna fostered a brisker and more robust economic recovery. High nominal export growth (over 15% year on year on average in the first two quarters of 2014) confirms that the weaker exchange rate is having the expected positive impact on Czech exporters' cash flows through both growth in export prices (of 4.5% year on year in the same period) and stimulation of real export growth (10.5% year on year). Real exports are being supported by a recovery in the euro area, but their growth rate is several percentage points higher than the level consistent with the dynamics of external demand alone. This can be attributed largely to the weakening of the koruna. At the same time, growth in household consumption and fixed investment was already visible at the end of 2013, due partly to expectations of rising prices following the weakening of the koruna. Consumption and fixed investment continued to grow in the first two quarters of 2014, showing that the concerns that the weaker exchange rate would have a negative income effect on domestic demand are not being confirmed. On the contrary, the effect of lower real interest rates (intertemporal substitution) and the increase in the confidence of firms and households in future economic developments are dominant, as predicted by the CNB. The observed recovery in domestic demand should therefore be sustained in nature, helping to return inflation to levels close to the CNB's target in the future.

5.4 The Public Debate and Changes in the CNB's Communication Strategy

The public reaction to the CNB's decision was very strong and mostly critical. The criticism came from practically all sides, including from those economic agents that would benefit relatively rapidly from a weakening of the koruna. There are various possible explanations for this.

First, the central bank's decision was, for the most part, not expected by financial market analysts and other domestic economic agents, despite the fact that the possibility of weakening the exchange rate had been signalled with increasing intensity for more than a year (see Lízal and Schwarz, 2013, for an explanation for the academic community) and all relevant news agencies had written about it. Most analysts did not believe that the necessary majority for taking this extraordinary action would be found in the CNB Bank Board and were thus expecting the same outcome as at the meetings in August and September 2013, when the Board had voted on the use of the exchange rate as a monetary policy instrument but had not approved it. This fostered a perception that the CNB's action was surprising and illogical. Those arguing against the CNB's measure emphasised the negative income effect of the weaker exchange rate on household consumption, questioned the risk of deflation (Klaus, 2014) or attributed the potential deflation to favourable supply-side effects.

Second, the initial comments made by some analysts and financial market participants suggested that the central bank would only be able to maintain the chosen intervention level for a few weeks, despite the fact that the CNB had communicated from the outset that it was ready and able to intervene to weaken the koruna in unlimited amounts. As a result, some representatives of exporting firms regarded the exchange rate weakening purely as an element of uncertainty causing financial losses on existing exchange rate risk hedging and increasing prices of imported inputs without offering a sufficiently long-term increase in the price competitiveness of domestic production. Corporate sector perceptions did not start to shift until the exchange rate commitment had earned sufficient credibility, the CNB had succeeded in communicating the medium-term nature of the commitment, and the positive effects on operating profits had started to be felt.

Third, the media interpretation of the CNB's action rapidly homed in on "rising prices", even before the central bank had had an opportunity to explain the reasons for and expected benefits of its decision from the perspective of price stability and the real economy. This naturally bolstered the negative reaction of the Czech public, which is traditionally conservative and savings-oriented.[61] Some media outlets greatly overestimated the expected impacts of the weakened exchange rate on inflation, especially in price categories such as food and holidays abroad. It also became apparent just how deeply entrenched were expectations that prices of some goods would fall in the future. The discovery that the CNB works systematically to hit the two per cent inflation target came as a big surprise to many economic agents (despite the fact that the earlier series of interest rate cuts to technical zero had also been motivated by an effort to increase inflation to the target and had thus been also communicated). So, deflation expectations had been probably much more deeply ingrained in the economy than indicated by the inflation expectations survey, confirming the minimal ability of such surveys to serve as a leading indicator of deflation (see sections 3.3.2 and 3.3.3 above).

In this situation, the CNB was forced to start communicating intensively even on monetary policy issues that are usually regarded as axiomatic. While central banks do explain such issues as part of their long-running efforts to educate the public on monetary policy, they are not usually the subject of communication following each and every monetary policy decision. The most important of them was the existence of the CNB's 2% target and the fact that this target – and not zero inflation or even negative inflation – embodies the central bank's statutory mandate to maintain price stability. Linked with this was clarification of the fact that the CNB views its inflation target as symmetrical, i.e. a long-term undershooting is as undesirable and, from the perspective of economic growth, as costly as an overshooting, and that deflation caused by insufficient demand is not a positive phenomenon increasing the real wealth of society, but rather is a threat to the country's economic development and financial stability. It was also necessary to explain the functioning of the exchange rate transmission channels, including the fact that in the Czech Republic – given the absence of foreign currency loans to households and only partial hedging of exports against exchange rate risk – the pro-growth effects of an exchange rate weakening outweigh the negative impacts (see CNB, 2014).

[61] A report by Newton Media entitled "Analysis of the media view of the CNB's foreign exchange market intervention", prepared for the central bank for the period 7–21 November 2013, states, among other things: "A large majority of media outlets (91%) provided interpretations of the CNB intervention. Balanced interpretations were observed only in 3% of articles (67). Right from the start (1 p.m. on 7 November), the media had a very strong tendency to interpret the CNB's intervention as meaning growth in prices… As regards headlines, it is evident that the initially balanced language used in the reports issued on 7 November, inspired by a Czech News Agency article, soon disappeared, and an emphasis on price growth started to dominate on the day the interventions were announced. Positive headlines in the price context were a rarity (6) and always related to consumption. Probably the harshest criticism of the CNB was voiced in connection with the loss of value of savings, wages and bonds."

The experience of the public debate on the use of the exchange rate as a monetary policy instrument at the ZLB prompted the CNB to change its communication strategy. First of all, it turned out that the standard rule – which had worked well in calm times – to refrain from communicating for a period of about one week after a monetary policy decision and the following press conference, i.e. to keep out of the media until the Inflation Report and the minutes of the Bank Board meeting are published, is counterproductive in such a situation. The publication of answers to expected questions from the public on the central bank's website on the morning of Friday 8 November changed nothing about this. The CNB therefore started communicating its decision actively through the media on the day following the monetary policy meeting. In the months that followed, it organised a series of meetings in the regions with interest groups, students and so on. At the start of 2014, written "Statements of the Bank Board" were launched. These are presented by the CNB Governor at the press conferences following monetary policy meetings (now broadcast live on Czech television and on the CNB website) and then published in Czech and English on the CNB website. The statements help the central bank to more actively influence media reporting on the outcomes of monetary policy meetings and they further strengthen the institutional element of the central bank's communication relative to presentation of the Bank Board members' individual views. The CNB had intentionally chosen this approach even before deciding to use the exchange rate, among other things by deciding that for this instrument – in contrast to the voting on interest rates – it would not disclose the individual votes of the Bank Board members or the ratio of the votes cast. The CNB also set up a blog on its website containing occasional contributions by the governor, other Board members and central bank experts. The most recent of the many communication changes include decisions to publish the summary of the Inflation Report and the table of key macroeconomic indicators containing details of the CNB forecast earlier and to bring forward the regular meeting with financial market analysts.

Overall, the public debate of the CNB's decision was unpleasant from the point of view of short-term confidence in the central bank,[62] but essentially helpful with regard to the objective of the action taken. Whether arguing that there was never any danger of deflation in the Czech Republic or exaggerating the expected impacts of the exchange rate weakening on prices, the critics probably inadvertently helped to anchor inflation expectations sufficiently far from deflation, which is what the economic literature regards as crucial in such a situation. This in itself contributed to averting the threat of self-fulfilling deflation expectations, led to a decline in ex ante real interest rates and a halt in growth in the saving rate, and supported consumption and investment. By the start of 2014, even though inflation had reached an extremely low level, hardly anyone was talking any more about the risk of future deflation in the Czech Republic (whereas in the euro area, for example, deflation was a hot topic at that time, even though inflation there was in fact slightly higher than in the Czech Republic).

[62] According to a poll conducted by the Public Opinion Research Centre (CVVM), the confidence of Czech citizens in the CNB fell to 38% in December 2013, whereas in previous polls it had been fluctuating around 60% or higher. In the CVVM's June 2014 poll, confidence in the CNB increased to 50%. A survey conducted for the CNB by STEM/MARK in December 2013 on a sample of 511 respondents concluded that less than half of people (48%) had confidence in the CNB's decision. Only a third (34%) of people felt that the weakening of the koruna would ultimately have a positive impact on the economy, and just 15% expected it to have a positive impact on the man in the street.

6. Summary

This study describes the CNB's experience with using the exchange rate as a monetary policy instrument since November 2013 after reaching the zero lower bound in a situation of growing risks of deflation due to insufficient demand. It puts this experience into the context of the economic literature – including Svensson's (2001) "foolproof way" – and offers some practical findings that might be inspiring to other central banks that get into a similar situation in the future and are considering using the exchange rate as an additional monetary policy instrument.

The CNB's experience demonstrates, among other things, the advantages associated with the use of structural economic models in the preparation of future economic scenarios at the ZLB, as such models enable the change in the behaviour of the economy at the ZLB to be taken into account (although correct characterisation of this non-linear constraint is still a subject of academic debate). At the same time, however, it also outlines some of the limitations of these models, for example the excessive "gravitational pull" of the inflation target. These limitations may lead to underestimation of the risk of deflation and highlight the importance of using as broad a range of satellite approaches to assessing the probability of deflation as possible. On the other hand, the usefulness of inflation expectations measurements for assessing the risk of deflation seems to be minimal based on the Czech experience. The same was true, for example, for Japan in the past.

The most interesting aspects of the CNB's experience also include the debate on how to use the exchange rate as a monetary policy instrument at the ZLB and on how transparent it should be. This debate eventually resulted in the choice of a publicly declared, one-sided exchange rate commitment, i.e. the exchange rate level below which the CNB will not let the currency appreciate, using potentially unlimited foreign exchange interventions to this end. Looking back, it is clear that this exchange rate commitment quickly established a strong degree of credibility – as in Switzerland in 2011. Interventions to support it have so far been needed only in the first few days after it was announced.

The CNB's experience also reveals that the use of this type of instrument may meet with strong criticism from experts and the general public, criticism that will force the central bank to explain even those elements of the monetary policy regime which are normally regarded as axiomatic (such as the definition of price stability, the inflation target level, the costs of deflation caused by insufficient demand and the functioning of the monetary policy transmission mechanism). This debate was unpleasant from the point of view of the short-term perception of the central bank's activities by the public and forced the CNB to change its communication procedures towards shorter delays following monetary policy meetings, more direct communication with various groups in society and stronger institutional communication relative to presentation of the Bank Board members' individual views. From the perspective of the objective of the CNB's action, however, the debate revealed that before the weakening of the koruna, actual ("manifested") expectations had evidently been below the CNB's target and below the results of the inflation expectations survey, and at the same time de facto helped the central bank to avert the risk of self-fulfilling deflation expectations.

At the time of writing, the risk of deflation in the Czech Republic is a virtually closed topic and foreign trade and domestic demand are recovering even faster than expected by the CNB. Going forward, this should mean that the domestic economy will begin to generate moderate but sustained inflation pressures, allowing the CNB to start considering exiting the use of the exchange rate as a

monetary policy instrument. However, unexpectedly strong disinflationary developments in the euro area and a drop in administered prices have led to lower observed domestic inflation, a slower expected return of domestic inflation to the target (without the temporary overshooting of the target originally planned for 2015 in order to stimulate inflation expectations) and to the postponement of the expected exit until 2016. The exit and its form were already considered during the debate on entering the regime of using the exchange rate. However, a detailed discussion of this issue is beyond the scope of the study.

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