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The Czech National Bank and Inflation Targeting as an Instrument of Maintaining Price Stability

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Introduction

The monetary policy is a powerful tool that can stabilize the economy and secure long-term economic growth with low inflation and low equilibrium unemployment. On the other hand, when performed poorly, it can have drastic effects on the economy.

One of the most important questions in economics is whether the monetary policy authority (usually the central bank) should strictly follow some policy rule or it should act discretionary. In light of Kydland and Prescott (1977) and Barro and Gordon (1983b), mainstream economics promote the policy rule to be the better option. Although both monetary policy regimes dispose of advantages and disadvantages, the key property of the monetary policy rules is that they can be incorporated into the rational expectations of agents. This incorporation decreases errors in key economic decisions over investment and consumption and as such stabilizes economic development.

Nowadays, the most common monetary policy rule of the central banks is inflation targeting. The main purpose of this rule is to prevent the economy from high inflation and its volatility which seriously distorts economic and legal relationships.[1] In this regime, the central bank uses its policy rates or other monetary policy instruments to keep inflation at some targeted level, usually set as 2 % constant. Many economists consider inflation targeting to be the most efficient monetary policy rule that enhances price stability and stable economic growth (Svensson, 2010; Woodford, 2012).

As documented by Taylor (1993) or Clarida, Galí, and Gertler (2000), inflation targeting of the central banks can be approximated by a simple interest rate rule in which the central bank sets its policy rates in response to the policy-neutral rate in the economy, the inflation gap and facultatively other relevant variables.[2]

Although the central bank follows some monetary policy rule, there is still room for discretion which can seriously damage the rational expectations and the stability of the economy itself. In the inflation targeting interest rate rule, the central bank has some preferences over the targeted variables.[3] If the preferences unexpectedly change then they are not expected by the agents and work as an exogenous shock to the economy. Such changes in the preferences of the central banks are documented in many papers, see Judd, Rudebusch, et al. (1998); Clarida et al. (2000); Kim and Nelson (2006); Baxa, Horváth, and Vašíček (2014).

One of the sources of changes in bank board preferences are the personnel changes in an environment of insufficiently secured personal independence. With the current Czech legislation, the consistency of the monetary policy decisions with the previous bank board is easily disrupted, as the Czech President holds

[1] The problem with inflation is that it causelessly favours one party of the contract over another. For example in a debtor-creditor relationship, the lower purchasing power of the money caused by inflation makes the creditor worse off, as he *ceteris paribus* receives the lent principal which has a lower purchasing power.

[2] The specification of this interest rate rule depends on the main targets of a central bank. Usually, it contains an inflation gap, output gap and sometimes also exchange rate and other relevant variables.

[3] These preferences are defined by the interest rate smoothing parameter, inflation gap parameter and other relevant parameters that are included in the simple interest rate rule.

the exclusive authority to appoint and relieve the bank board members. Also, there are only weak requirements that the candidate for the bank board mandate must satisfy.

In this thesis, I provide a detailed analysis of the role of the monetary policy of a central bank and its monetary policy instruments. I open the monetary policy rules vs. discretion debate and analyse the advantages of the given monetary policy rules. The main focus is put on the inflation targeting rule, which was adopted by the Czech National Bank in December 1997.

Further, I provide a discussion on the importance of the independence of the Czech National Bank as it is one of the potential sources of unexpected changes to bank board preferences. I discuss that institutional independence, functional independence, financial independence and budgetary independence are quite well enforced by current legislation. In contrast, personal independence is amended in the Czech legislation rather poorly. The main problem is in the appointment process of the bank board members when the Czech President is completely independent in this decision. Following the monetary policy theory (Friedman and Schwartz (1963)), the monetary policy can have a drastic effect on well being of economic agents when it is performed poorly. A monocratic decision of a person that even does not have to be economically educated can, therefore, be a serious threat to price stability and to long-term stable economic growth. Similarly problematic is the legislation of bank board member relief which is possible only for serious misconduct and in case the bank board member no longer fulfils the requirements of the bank board members. This makes bank board members irresponsible for intentional decisions that breach the legal duties of the Czech National Bank. Also, personal independence is not completely secured as the bank board member might be influenced in his decision seeking reappointment or the appointment to the Governor's mandate or to the Governor's Deputy mandate.

Following the problems in the personnel composition of the bank board, I shed some light on the importance of maintaining price stability to ensure long-term economic growth. This discussion emphasizes the problem in the current legislation of personal independence even more.

Using this theoretical background, I empirically study the interest rate rule of the Czech National Bank by the Generalized Method of Moments on the data range of 1996 Q3 - 2021 Q2. This analysis aims to test two separate topics. Firstly, it detects, whether the Czech National Bank truly maintains price stability as its main monetary policy target. Secondly, it maps how the preferences of the bank board changed over the two subsamples that identify different periods of the Czech National Bank's inflation targeting.

The empirical results suggest that the bank board truly determined its policy rates with respect to the inflation gap only. This is in accordance with the Czech National Bank's constitutional duty of maintaining price stability. Furthermore, the results show that the preferences of the bank board changed significantly over the subperiods 1996 Q3 - 2008 Q4 and 2009 Q1 - 2019 Q4.[4]

Following the results, I discuss the bank board's monetary policy decisions

[4]For the sake of a lower prediction error, the Covid-19 pandemic period was dropped from the model. The empirical model that I use is not built to account for unexpected production shutdowns.

over the Czech National Bank's history. The results from the empirical analysis help to understand why the bank board reacted as it did in the given period. In this analysis, I find some inconsistent reactions of the Czech National Bank's governing body, especially in times of the 2008 Great recession and 2022 personnel changes in the bank board.

The main contribution of this thesis is that it shows how problematic current legislation of personal independence is and that it provides *de lege ferenda* suggestions to legislation changes that could prevent potential discretion arising from the changes in preferences caused by improper security of personal independence of the bank board.

The thesis is structured as follows. In Chapter 1, I analyze the role of a central bank and monetary policy with a focus on the Czech National Bank. In Chapter 2, I discuss the importance of central bank independence and critically evaluate current legislation on the Czech National Bank's independence. In Chapter 3, I determine the phenomenon of inflation and the importance of price stability. In Chapter 4, I estimate the empirical model and discuss the results. Finally, in Chapter 5 I provide an analysis of the dynamics of key variables in the Czech economy and evaluate the monetary policy of the Czech National Bank.

1. Central Bank

A central bank is a legal entity, holding a key role entrusted by the state, in performing the monetary policy, maintaining financial stability and, usually, supervising financial markets, emitting cash and securing monetary transactions.

A central bank uses policy tools to achieve some policy targets, usually price stability. The policy targets and tools that are used for achieving it differ across countries based on their experience, beliefs and specifics of the economy.

In this chapter, I analyse the role of the central bank's monetary policy and its instruments and their legislation and present the types of monetary policy rules that the central bank can follow. Furthermore, I discuss the transmission mechanism of the key policy instrument of many central banks - the policy rates.

1.1 Monetary policy

Monetary policy is a useful and powerful instrument which is able to secure price stability, long-term economic growth and low unemployment. On the other hand, when performed poorly, it can deeply damage the economy and increase business cycle fluctuations. As an example of the drastic effects of improper monetary policy, we can discuss the actions of the Fed during the 1929 Great Depression. During this crisis, the Fed performed restrictive monetary policy instead of executing monetary expansion that would help the economy to face the recession. As a result, the recession spread worldwide and the economy faced massive unemployment. According to monetarists, the Fed's improper policy prolonged the crisis and magnified its negative effects (Friedman & Schwartz, 1963).

1.1.1 Monetary policy rules vs. discretion

"When we do have the prerequisite understanding of the business cycle, the implication of our analysis is that policymakers should follow rules rather than have discretion. The reason that they should not have discretion is not that they are stupid or evil but, rather, that discretion implies selecting the decision which is best, given the current situation. Such behavior either results in consistent but suboptimal planning or in economic instability" Kydland and Prescott (1977), p. 487

The question of whether the central bank should act with discretion or rather follow some policy rule when conducting monetary policy has been frequently discussed by many economists, especially, in the previous century. The discretionary policy was preferred by Keynesians, who followed Keynes (1936) in promoting the *stop-and-go* policy. Their argument for this policy was, that it can effectively respond to business cycles as the central bank supports the economy with monetary expansion in times of crisis and confines the economy with a restriction in times of expansion. In reference to Keynesians, many central banks followed this paradigm, until Monetarists, ahead with Friedman (1968), opened

a discussion of a delay in the monetary policy transmission mechanism and criticized the ineffectiveness of discretion. Friedman suggested that the central bank, in order to stabilize the economy, should rather follow a rule of an annual increase in the monetary base.

Following the rational expectations theory of Muth (1961), the anticipated monetary policy shocks performed upon a policy rule, which the central bank strictly follows, can be included in the rational expectations of agents. Included in the expectations, the shock to the economy can never have such destabilizing effect as the unanticipated discretion.

Kydland and Prescott (1977), used the mentioned rational expectations theory to show that the central bank should rather follow a policy rule. Although using the discretionary policy the central bank can react better to the current problems in the economy, it can seriously destabilize the economy due to the delayed effect of the monetary policy. Therefore, the benefit of following a stated policy rule lies in the stabilization of the economy.

Calvo (1978) analysed the consistency of the monetary policy and found that in the case of the perfect foresight ability of the agents an inconsistent policy is in fact the optimal policy.[1] Thus, he suggests that if the agents are capable of perfect foresight then the optimal policy should be discretionary.

Barro and Gordon (1983b) show that in the short run, discretion can be optimal for the central bank as it can benefit from surprise inflation. On the other hand, in the long run equilibrium, people adjust their inflation expectations to these surprise shocks and the only result is higher inflation caused by the higher inflation expectations. Thus, as Barro and Gordon (1983b) show, the equilibrium rate of inflation and money growth can be decreased if the central bank stops acting with discretion and starts to follow a policy rule.

Following these arguments, the discretionary *stop and go* policy not only does not stabilize the economy but can even make it more volatile, as the central bank receives the macroeconomic aggregates with delay and also the transmission mechanism of the monetary policy is not immediate.[2]

However, the implementation of a policy rule itself might not be enough. The important part of the policy rule is that the central bank consistently follows it. Otherwise, it still acts with discretion and the agents lose the belief in the central bank's purposes to act in accordance with the rule (Mishkin, 2004). If the inconsistency of the central bank is unpredictable by the agents then they cannot include it in their rational expectations. Such inconsistency works as an unexpected shock to the economy which increases the business cycle fluctuations.

In the 1970s, in reaction to the mentioned critique of the *stop-and-go* policy, many central banks implemented a money-growth targeting policy rule as suggested by Friedman (1968).[3]

As the money growth targeting policy requires stability between inflation and the monetary base and is less transparent and legible to the people (Mishkin, 2004), money-growth targeting has been gradually succeeded by inflation target-

[1]The perfect foresight ability of agents assumes that agents face no uncertainty in their decision-making and, hence, always predict the future correctly.

[2]The delayed effect of the monetary policy is called the *monetary policy horizon* and usually takes 4-6 quarters, see Czech National Bank (2009b).

[3]For example the German Federal Bank, the Fed, the Bank of Japan and the Bank of England.

ing since the 1990s.[4] Also, some central banks prefer exchange rate targeting policy rule.[5]

In this subsection, I discussed the benefits and costs of discretion and of following a policy rule in general. Summarizing the literature, I concluded that the central bank should follow the announced monetary policy rule, otherwise, the agents are not able to incorporate the discretionary changes into their expectations and the central bank's policy may work as unexpected shock to the economy. In the next subsection, I examine the mentioned policy rules in more detail and discuss the advantages of each of the policy rule as well as the examples of legislation of these policy rules.

1.1.2 Types of monetary policy rules

In this subsection, I analyse in detail the monetary policy rules that a central bank can conduct when aiming at maintaining price stability.

Money-growth targeting

In this policy strategy, the central bank announces a certain target at which it will allow for the growth of the chosen monetary aggregate.[6]

In the 1970s, several central banks adopted this rule, including the German Federal Bank, the Fed, the Bank of Japan, the Swiss National Bank and the Bank of England. However, their performance of this policy was far from the one suggested by Friedman (1968), as these central banks in fact did not strictly follow the rule of constant monetary aggregates growth, but selected the annual growth rates of the aggregates arbitrarily (Mishkin, 2004).

The commitment to this monetary policy strategy in these central banks was legislated in the act on the given central bank. As an example, see the extract of the section 2A of the Federal Reserve Reform Act of 1977:[7]

"The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall ***maintain long run growth of the monetary and credit aggregates*** *commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates. The Board of Governors shall consult with Congress at semiannual hearings before the Committee on Banking, Housing, and Urban Affairs of the Senate and the Committee on Banking, Finance and Urban Affairs of the House of Representatives about the Board of Governors' and the Federal Open Market Committee's objectives and plans* ***with respect to the ranges of growth or diminution of monetary and credit aggregates for the upcoming twelve months****, taking account of past and prospective developments in production, employment, and prices."*

[4]The first central banks that implemented inflation targeting were The Reserve Bank of New Zealand in 1990, the Bank of Canada and the Bank of Israel in 1991.

[5]For example, the Danmarks Nationalbank, the Central Bank of Lybia and the Central Bank of Morocco.

[6]For example, the strategy can be announced as a target of 5 % annual M1 growth.

[7]Pub.L. 95–188, 91 Stat. 1387, enacted November 16, 1977.

According to this Section, the Fed adopted the money-growth targeting using the instrument of policy rates to achieve a given goal of monetary and credit aggregates growth determined for the upcoming twelve months. In practice, the achieved growth was not set as a constant, but was arbitrarily chosen for the given year according to the development of the economy.

Although the constant money growth rule was not followed in any of the money growth targeting countries, the German Federal Bank was quite successful in keeping the prices growth at a sustainable level. The German case proves that the money-growth targeting can be successful even when the central bank does not strictly follow the constant growth rule. The key determinant of the success of this policy lies in the clear statements of the central bank's strategy to the people (Mishkin, 2004). Freedman et al. (1996), King (1996), Clarida and Gertler (1997), Bernanke and Mihov (1997), Clarida, Galı, and Gertler (1998) or Mishkin (1998) discuss that the German Federal Bank's monetary policy was in fact very similar to what would the central bank do under the inflation targeting regime rather than what it should have done under the money-growth targeting.

The main advantages of money-growth targeting are given by the frequent reporting of monetary aggregates which allows to observe almost immediately whether the central bank follows the money-growth target or not. Thus, the public holds information about the stance of the monetary policy and central bank's intentions, which helps to anchor inflation expectations (Mishkin, 2004).

On the other hand, the big disadvantage is that when there is not a strong and reliable relationship between inflation (or other goal variables) and the monetary aggregate, this policy rule does not work, because the goal is not achieved even if the money-growth target is met (Mishkin, 2004). In such a situation, the quick informational advantage towards the public does not work, because it gives minimal information about the real stance of the monetary policy.

Inflation targeting

Inflation targeting has become popular in the 1990s and later became the most frequently used policy rule.[8]

The switch to this regime was formally adopted by amendments to the acts on the central banks stating that the primary goal of the central bank is to maintain price stability. As an example, see the very first legislation of inflation targeting in Section 8 of the Reserve Bank of New Zealand Act 1989:

"The primary function of the Bank is to formulate and implement monetary policy directed to the economic objective of ***maintaining stability in the general level of prices*** *while maintaining an exchange rate that is conducive to real export growth and job creation."*

Inflation targeting is based on several steps that the central bank performs. Firstly, the central bank announces an inflation target either as a constant or as an interval. Secondly, the bank declares a price stability to be its primary goal.

[8]The first central bank that implemented inflation targeting was the Reserve Bank of New Zealand in 1990, followed by the Bank of Canada and the Bank of Israel in 1991, the Bank of England in 1992, the Swiss National Bank and the Bank of Finland in 1993, the Reserve Bank of Australia and the Bank of Spain in 1994, followed by other central banks later.

Thirdly, the central bank acts transparently and makes public announcements which documents the central bank's predictions and stance on the monetary policy (Svensson, 2010).

Unlike in money-growth targeting regime, in inflation targeting, the stability between money aggregates and inflation is not necessary. Also, inflation targeting is more understandable and transparent for the public. Further, the transparency of the policy makes the central bank's actions more visible. Therefore, it puts pressure on the central bank to be more consistent and resistent to short-term political pressures (Mishkin, 2004). Furthermore, the transparency and documents on the plans of the central bank increase the central bank's credibility which positively affects the stability of inflation expectations.

On the other hand, if the central bank loses its credibility, it can disrupt inflation expectations and significantly harm the economy. The critiques of inflation targeting usually discuss these two problems. Firstly, in contrast with the exchange rate and the monetary aggregates, for the central bank, it is much harder to control inflation. Also, the information about inflation is more delayed, thus, the central bank has to be forward-looking and should decide upon future predictions of inflation. Secondly, inflation targeting is quite rigid and makes the central bank unable to react to immediate problems (Mishkin, 2004). Note that this is true only in the case that the central bank is constant in its reaction function's parameters which is not what we observe in the data, see the literature survey provided by Yüksel, Metin-Ozcan, and Hatipoglu (2013). Also, I find this argument invalid because it, implicitely, criticizes inflation targeting for not being enough discretionary. As I discuss in Section 1.1.1, this is not a negative feature of inflation targeting but, rather, a positive one.

Exchange rate targeting

An alternative to inflation targeting is the exchange rate targeting regime which is, nowadays, in the practice of some central banks.[9] This policy is enacted in the acts on the central banks such that the stability of the national currency is set as the primary goal, see Section 1 of The National Bank of Denmark Act as an example:

"Danmarks Nationalbank ... shall as the Central Bank of this country have the object in conformity with this Act and the regulations given under this Act to ***maintain a safe and secure currency system in this country****, and to facilitate and regulate the traffic in money and the extension of credit.*

In exchange rate targeting, the central bank fixes the exchange rate of the domestic currency to some foreign currency at some explicit level. Usually, it also announces the fluctuations range in which the deviations from the fixed level are tolerated. In contrast to inflation targeting and money-growth targeting, this policy rule is not possible for all central banks. To perform this policy, the central bank needs a strong and stable international currency to fix the exchange rate of the domestic currency with and as such is feasible only for small economies.

[9]For example, the Danmarks Nationalbank, the Central Bank of Lybia, the Central Bank of Morocco.

Furthermore, in this regime, the central bank needs to dispose of large deposit reserves to be able to react to shocks to the exchange rate.

In exchange rate targeting, the central bank intervenes in case the exchange rate moves out of the tolerated range. If it faces appreciation pressures, it can decrease monetary policy rates which causes a capital outflow of investments as the interest rates are relatively lower. To invest elsewhere, investors sell their domestic capital holdings and want to exchange the domestic currency for foreign currency. As a result of the central bank's intervention, the appreciation is suppressed. Oppositely, if the central bank faces depreciation pressures, it increases the monetary policy rates which results in capital inflow and increased demand for the domestic currency. Alternatively, the central bank can directly intervene using its deposit reserves to exchange them for the domestic currency to face the depreciation; and exchange the domestic currency for the foreign currency in order to suppress the appreciation (Obstfeld & Rogoff, 1995).

In case the targeted exchange rate is not sustainable, the central bank can move the fluctuation range or increase its bounds.

1.1.3 Monetary policy instruments

To achieve the policy targets, the central banks use monetary policy instruments. In all three discussed monetary policy rules, the main policy instrument is the interest rate setting. Nevertheless, the central bank can use also other instruments that aim at achieving the monetary policy targets as well as at achieving other than monetary policy targets. Note that some of the discussed instruments may be entrusted to other monetary policy authorities depending on the independence level of the central bank.

Revenda (2011) classifies the monetary policy instruments as direct and indirect instruments. Direct instruments directly regulate or affect financial institutions in their decision-making and are accepted involuntarily. In contrast, the indirect instruments only push the financial institutions to act in line with the intentions of the central bank but are not mandatory.[10]

Open market operations

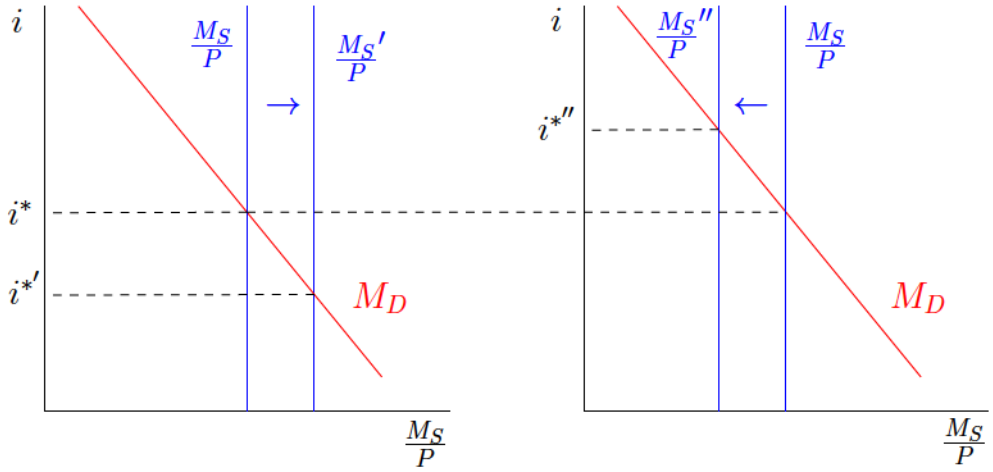
Using open market operations, the central bank buys or sells debt securities (usually government bonds) from or to domestic financial institutions in order to regulate the monetary base or affect the short-term interest rates. In response to the central bank's purchase of debt securities, the money that the central bank pays for the purchase is added to the monetary base and lead to an increase in the monetary base. In contrast, the sales of the debt securities decrease the monetary base (Edwards, 1997).

As shown in the following Figure 1.1, an increase in monetary base promotes the real money supply on the market ($\frac{M_S}{P}$). With a higher quantity of money

[10] According to Revenda (2011), the indirect instruments are open market operations, the central bank's policy rates and foreign exchange interventions. Direct instruments contain liquidity requirements, credit limits, limits on the commercial banks' interest rates and mandatory deposits. The instruments of minimum reserve requirements and moral suasions, persuasions and gentlemen's agreements cannot be unambigously classified and thus are considered to be partly direct and partly indirect.

available at the market, it is less expensive to borrow money. Therefore, the interest rate i^* drops to the new level of $i^{*'}$, reflecting the cheaper money (in Figure 1.1 depicted in the left graph). In contrast, a decrease in the monetary base caused by the central bank's sales of securities makes the money less available in the market. In response, the interest rate increases (in Figure 1.1 depicted in the right graph).

Figure 1.1: Changes in the monetary base and the interest rate



Note: The left graph shows an increase in the monetary base caused by the central bank's purchase of securities which increases the real money supply $\frac{M_S}{P}$. More money in the economy makes loans cheaper and the interest rate decreases $i^{*'}$. In contrast, the right graph shows the effect of the central bank's sales of securities which decrease the monetary base and increase the interest rate $i^{*''}$.

Following Revenda (2011), we may examine the following three types of open market operations, according to their effect on the monetary base. Direct operations contain sales and purchases of the government bonds and have a permanent effect on the monetary base. Other operations are the repurchase agreements in which the central bank sells the securities while being obliged to repurchase them later. In response, the monetary base firstly decreases but after the repurchase returns to the previous level. Oppositely, using reverse repurchase agreements, the central bank buys the securities to sell them later, which increases the monetary base temporarily. Furthermore, the repurchase agreements can be open or term - having a fixed date of the repurchase (Bowsher et al., 1979). Usually, the term repurchase agreements are preferred by the central banks (Revenda, 2011). The third type of open market operations are the switch operations which consist of an exchange of the securities for the same securities with a different maturity date. The effect of these operations on the monetary base is neutral because the balance sheet of the central bank does not change (Revenda, 2011).

For the Czech National Bank, this monetary policy instrument is amended by part six of Act No. 6/1993 Coll. of the Czech National Council of 17 December 1992 on the Czech National Bank (further "Act on the Czech National Bank") which allows the Bank to perform the open market operations in three ways.

Firstly, according to Section 32 paragraph 1 of the Act, to achieve its targets, the Czech National Bank is allowed to perform open market operations with financial institutions. These include mainly: account maintenance and deposit

acceptance, trading investment instruments and providing credits. As an *ultima ratio* remedy, the Czech National Bank can also provide short-term (3 month) credits to sustain the liquidity of the financial institutions. These operations fulfil the open market operations definition because, for the provided credits, the Czech National Bank must require debt security (see paragraph 2 of Section 32).[11]

Secondly, as amended in Section 33 paragraph 1 of the Act, the Czech National Bank can issue securities and trade them on the open market.

Thirdly, the Czech National Bank can secure the Financial Market Guarantee System with liquidity when it faces a critical shortage of money and is not able to fulfil its duties of maintaining financial stability through the deposit insurance given by Act No 374/2015 Coll. on Recovery and Resolution in the Financial Market. The liquidity is provided with the short-term (3 month) credit or the repurchase agreement. As the short-term credit must be backed with securities these operations also come under the definition of open market operations.

Interest rate setting and facilities

The setting of the monetary policy rates is the main tool of many central banks. The policy rates are usually determined by the governing body of the central bank - in the Czech National Bank the bank board. The policy rates of the central bank directly affect the market interest rates and through the transmission mechanism also the exchange rate, consumption, investments, savings, output of the economy and prices. Generally, it holds that at the policy horizon,[12] an increase in the policy rates decreases inflation and a decrease in the policy rates increases inflation. Usually, the central banks select their main policy rate which determines also the moves in the rest of the policy rates which are connected to it.

The most common practice is that the central bank controls three policy rates. Firstly, the interest rate on the repurchase agreements for which the liquidity is provided to the banking system. Secondly, the rate on the deposit facility, which allows banks to deposit overnight the liquidity surplus with the central bank. And thirdly, the rate on the lending facility for which the banks can borrow the liquidity from the central bank overnight.

The Czech National Bank follows this scheme of three policy rates. The authority over policy rates is amended by the Act on the Czech National Bank in Section 23. The Bank's main policy rate instrument is the repo rate which is, usually, 1 percentage point lower than the lombard rate and 1 percentage point higher than the discount rate. It is the rate which the Czech National Bank pays for the repurchase agreements with financial institutions. The financial institutions may dispose of the surplus liquidity, which they can deposit overnight with the Czech National Bank for the discount rate. In contrast, when being short of liquidity, the financial institutions can borrow money from the Czech National Bank for the lombard rate. Notice, that the deposit rate and the lombard rate determine the lower and the upper bounds for the short-term interest rates on the interbank market.

[11] Therefore, the Bank in fact buys the debt security in exchange for liquidity.

[12] The monetary policy horizon denotes a period after which the changes in the monetary policy fully affect the economy.

Foreign exchange interventions

An instrument of foreign exchange interventions (FX interventions) is a powerful tool when the central bank needs to artificially change the interest rate on the market.

This tool is important, especially, in the case when the central bank uses the exchange rate targeting policy. When the currency exchange rate evolves differently than the central bank desires it can intervene. To suppress the appreciation of the currency, the central bank sells the domestic currency in exchange for the foreign currency. Oppositely, facing depreciation, the central bank buys the domestic currency for its foreign currency reserves.

This instrument can be unconventional in the case when the central bank uses it to temporarily depreciate the currency in order to promote the economic activity in the country (monetary expansion).[13] Oppositely, foreign exchange interventions when the central bank artificially appreciates the currency can help to restrict the monetary policy conditions when necessary.[14]

This instrument is amended in the Czech legislation as follows. According to Section 35 of the Act on the Czech National Bank, after the hearing with the government, the Central Bank determines the exchange rate regime. Since 1998, the Czech National Bank has a directed floating regime. In this regime, the Central Bank is not committed to keeping some exchange rate level, however, can intervene in the exchange rate to use it as a policy instrument when needed. Moreover, the Czech National Bank announces the exchange rate of the Czech Koruna to foreign currencies. To do so, it disposes of the foreign exchange reserves.

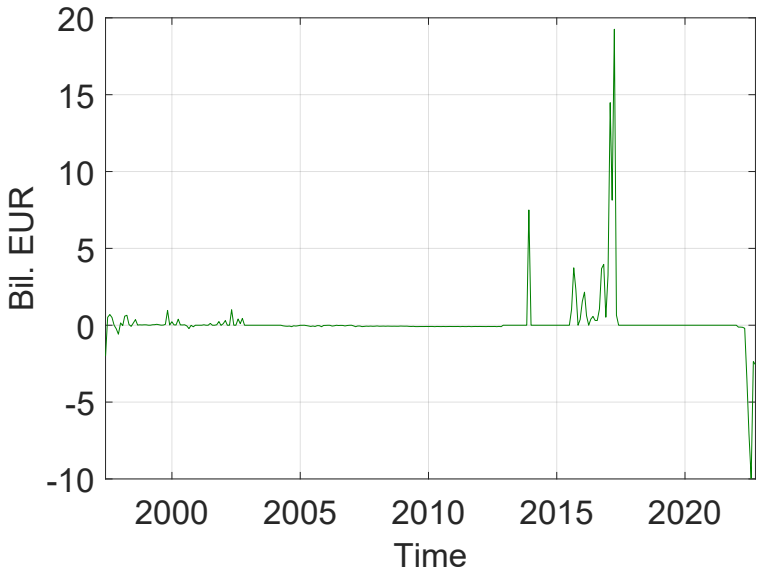
The problem with foreign exchange interventions is that they can be quite costly because the central bank intervenes against the market pressures.[15] In recent foreign exchange interventions, since January 2022, the Czech National Bank has spent about 26 bil. Euros. The highest intervention activity was, however, between 2013 and 2017 as shown in the following Figure 1.2.

[13] See the Czech National Bank's monetary policy in 2013-2017 discussed in Section 5.6.

[14] This is the current practice of the Czech National Bank, see the discussion of the Czech National Bank's monetary policy in the period of 2020-2022 discussed in Section 5.8 .

[15] This can be explained by the following example. Assume that the central bank intervenes to artificially depreciate CZK/EUR from the current market level of 26 CZK/EUR to 27 CZK/EUR. In that case, the central bank buys Euros for Korunas for the disadvantageous exchange rate. The value of its Euro assets drops quickly when the exchange rate returns to the market level of 26 CZK/EUR. A similar effect happens when the central bank intervenes for stronger currency with the difference that the Koruna holdings that are generated from Euros eventually lose their value.

Figure 1.2: Czech National Bank's FX interventions in bil. EUR (data source: CNB



Note: This figure shows the evolution of the Czech National Bank's foreign exchange interventions. The interventions are generated when the bank sells Korunas to buy Euros (positive numbers in the graph) and are shrinking when the bank sells Euros to buy Korunas (negative numbers in the graph).

Currently, in the Act on the Czech National Bank, none of the monetary policy instruments is assigned as the main policy instrument. On one hand, this allows the central bank to flexibly use any instruments that are needed. On the other hand, the central bank might act with discretion. As discussed in the discretion vs. policy rules debate, such discretion makes it harder for economic agents to correctly anticipate the monetary policy decisions of the bank board, which might lead to increased business cycle fluctuations. Therefore, *de lege ferenda* I would suggest to explicitly amend that the main monetary policy instrument is the interest rate setting and I would legally define the ground for foreign exchange interventions and quantitative easing as unconventional tools that may be used when the changes in the interest rates are of no use or to prevent the exchange rate from excessive volatility.

Minimum reserve requirements

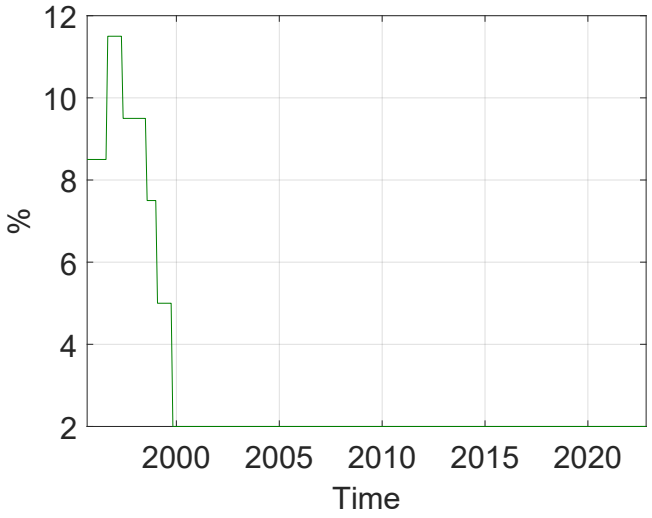
The minimum reserve requirements serve as a security of banks' liquidity in the case of bank runs. However, especially in the last decade, the minimum reserve requirements are of less importance because the banks dispose of large amounts of liquidity. This is demonstrated with a decrease in the minimum reserve ratio to low values, usually 1 or 2 %.[16] For some central banks this policy tool is

[16]Latest changes in the reserve ratio of the European central banks include these: in 2012 the European Central Bank decreased the ratio from 2 % to 1 %; the Hungarian National Bank decreased the ratio also from 2 % to 1 % in 2016; in response to the COVID-19 pandemic, the National Bank of Poland decreased the ratio from 3.5 % to 0.5 % in March 2020.

so unimportant that they cancelled it completely (or announced a 0 % ratio).[17] As Federico, Vegh, and Vuletin (2014) showed, generally, the central banks of developing countries have higher reserve ratios than those of developed countries due to a higher need for currency stability.

Also the Czech National Bank decreased the ratio of the minimum reserve requirements to a low value of 2 % as shown in Figure 1.3 below.

Figure 1.3: Reserve ratio in the Czech Republic in 1995 M8 - 2022 M10 (data source: macrovar)



Note: The Czech National Bank increased the minimum reserve requirements ratio in 1997 and later started to decrease it gradually. The reserve ratio dropped to 2 % value in 1999. Since 1999, the Czech National Bank has not changed the reserve ratio and has kept it at this constant level.

Using the minimum reserve requirements, the central bank announces mandatory reserves that the financial institution must deposit with the central bank.[18] The ratio of the mandatory reserves is computed from all the liabilities that a financial institution has with the non-banking subjects.

Following Gray (2011), the minimum reserve requirements have three main monetary policy functions: prudency, monetary control and liquidity.

Firstly, the requirements act prudentionary as they increase the reliability of the financial institutions to be able to fulfil their liabilities in times of crisis or to successfully face the bank runs.[19]

Secondly, the reserves allow the central bank to perform monetary control through a money multiplier. The higher the reserves ratio, the lower the multiplier effect because the central banks can lend further less money than with a lower ratio.[20] In reference to Bindseil (2004), nowadays, this function of the minimum

[17] In 2022 these include the Fed, the Bank of England, the Norges Bank, the Bank of Canada, the Riksbank or the Reserve Bank of New Zealand.

[18] Note that the reserves are in the liabilities side of the central bank's balance sheet and in the assets side of the financial institution's balance sheet.

[19] Nowadays, the liquidity and solvency of the financial institutions are secured, rather, with other instruments, mainly with mandatory deposit insurance, for details see Pokorny (2021b).

[20] Formally, the multiplier m is computed as the inverse function of the reserves requirement ratio RR: $m = \frac{1}{RR}$.

reserves is very limited, because it does not match the performance of modern monetary policy implementation as the main role play the interest rates which allow the central bank to effectively increase or decrease the liquidity of the financial institutions themselves. Despite this, the minimum reserve requirements can supplement the instrument of interest rates setting. As noted, an increase in policy rates leads to capital inflow when the investors want to utilize the relatively higher interest rates. To finance these investments, the investors demand the domestic currency causing its appreciation. Sometimes these consequences are not desirable and the central bank increases the minimum reserve requirements ratio to restrict the investment opportunities by decreasing the effect of the money multiplier, limiting the banks' earnings from higher capital savings (Gray, 2011).[21]

Thirdly, the minimum reserve requirements serve as a source of liquidity. They stabilize the volatile demand for reserves on the interbank market which can be seriously affected by many exogenous factors. Thus, the reserves implicitly decrease the volatility of interbank interest rates, which promotes economic activity on this market (Gray, 2011). In the literature this function of the minimum reserve requirements is considered to be the main reason for keeping this monetary policy tool in some of the developed countries (Weiner et al., 1992; Clinton, 1997; Gray, 2011).[22]

Mandatory minimum reserve requirements of the Czech financial institutions are constituted by Section 23 of the Act on the Czech National Bank. These reserves have to be kept in the Czech Koruna. The second paragraph of this amendment settles an upper bound for the minimum reserve requirements which cannot exceed 30 % of the difference between the liabilities and credits of the institution. The Czech National Bank announces the minimum reserve requirements with a decree and can announce different reserve ratios for different types of legal persons if the monetary policy situation requires such a dispersion. The Central Bank can sanction the breach of minimum reserve holdings by setting an interest rate on the amount of the missing reserves at the level of a lombard rate increased by five percentage points. This interest rate, however, cannot be lower than 5 %.

Liquidity rules, credit limits, limits on the commercial banks' interest rates and mandatory deposits

Another monetary policy instruments are the liquidity rules which regulate the structure of assets and liabilities of the financial institutions' balance sheets which are meant to secure their liquidity and solvency.[23] In the Czech Republic, the liquidity rules are given by Regulation No 575/2013 of the European Parliament and of the Council on prudential requirements (CRR I) and Regulation No 876/2019 of the European Parliament and of the Council on capital requirements (CRR II). The adequate capital holdings that satisfy the law must reach at least 8 % of

[21]The mentioned process is a common practice of the Latin central banks. The central banks of developed countries usually do not use this practice as it might lead to shadow banking due to its implicit taxation effect as discussed in Glocker and Towbin (2012).

[22]Notice, that the stability can alternatively be achieved by the introduction of a deposit rate and lombard rate which determine the lower and upper bound of the interbank interest rates.

[23]As discussed by Revenda (2011), the central bank can regulate, for example, the ratio of short-term and long-term credits and deposits.

risk-weighted assets.

With credit limits, the central bank can regulate the maximum amount of money that the financial institution can lend to a client. Such a maximum amount decreases the supply of loanable funds and increases the credit interest rates. Also, the non-realized credit amounts above the limit restrict the effect of the money multiplier and the monetary base (Revenda, 2011).

The credit limits are anticipated by Section 45a of the Act on the Czech National Bank. Nevertheless, their purpose is in protecting the consumer as a weaker contractual party rather than being a monetary policy tool. Due to their effects on the economy through the transmission mechanism, they can therefore be considered as a quasi-monetary policy instrument. Section 45a forbids creditors of consumer credits secured by immovables to breach the limits given by the credit indicators. These indicators are the LTV, DSTI, DTI and their concrete values are enacted by the Czech National Bank's administrative act - the measure of a general scope.[24]

According to the current Measure of a General Scope No I/2021 on the Upper Limits of Credit Indicators ("Measure of a General Scope on the Credit Indicators"), the consumers are divided into two groups. The first group of consumers ("protected consumers") contain those persons who have not reached or his spouse or registered partner who has not reached 36 years of age. The second group of consumers ("rest of the consumers") contains those who do not belong to the first group.

The LTV indicator depicts an upper bound for the ratio of consumers' total liabilities from consumer credits secured by the same real estate and the credit principal. For the *protected consumers*, this ratio cannot suppress 90 % and for the *rest of the consumers* 80 %.

The DSTI indicator is computed as a ratio of the consumer's expenditures given by the total value of his debts and his income. The Measure of a General Scope on the Credit Indicators allows this ratio to be 50 % for the *protected consumers* and 45 % for the *rest of the consumers*.

The DTI indicator measures the ratio of the total amount of the consumer's debts and his income. For the *protected consumers*, the maximum allowed value of this ratio is 9.5 and for the *rest of the consumers* it is 8.5.

Furthermore, the central bank can set the limits on the maximum (or minimum) amount of the interest rates of the financial institutions.[25] This instrument directly affects the short-term interest rates on the interbank market. Setting a lower maximum rate forces the financial institutions to decrease their interest rates, which can affect the foreign capital movements and the exchange rate (Revenda, 2011).

Finally, the monetary authority can regulate certain subjects (usually state departments, state funds, municipalities and others) by prescribing them mandatory deposits with the central bank in order to control the transactions in their accounts. In the Czech Republic, this duty is amended in Section 33 and the following of Act No. 218/2000 Coll., on Budgetary Rules. Section 3, letter h)

[24]Measures of a general scope ("opatření obecné povahy") are the administrative acts with a concrete object and generally selected types of addressees (subjects).

[25]The minimum limits were in effect in 1990-1992 in the Czech and Slovak Federative Republic in order to decrease the dominant position of the banks at that time.

then regulates the finances which have to be deposited with the Czech National Bank. They include mainly the state budget, bank accounts of the tax collectors, accounts of public healthcare companies and others. As these subjects cannot deposit with financial institutions, the monetary base is decreased. This happens because, with the central bank, the deposits are not subject to the money multiplier because they are not further used on the money market.

Moral suasions, persuasions and gentlemen's agreements

Following Revenda (2011), the monetary policy instruments also include moral suasions, persuasions and gentlemen's agreements made by the central bank to specify its monetary policy intentions.

With moral suasions, the central bank publicly formulates its desires of the financial institutions' behaviour for the given period. They might and might not be stated in a written form.

In contrast with moral suasions, the persuasions are more concrete and more strict.

Unlike the moral suasions and persuasions, the gentlemen's agreements usually are in written form and after the signature, they come into force and their breach can be sanctioned.

Although moral suasions and persuasions do not have binding power, financial institutions usually follow them to maintain a good relationship with the central bank.

In the Czech Republic, these instruments are amended in Section 3b of the Act on the Czech National Bank upon which the Bank can release recommendations, notifications or warnings addressed to the public or particular subjects to fulfil its targets.

Unconventional instruments

In the previous decade, many European countries faced deflationary pressures and economic recession. In response, the central banks used their main policy tool and decreased their policy rates to values close to zero. Nevertheless, this expansionary monetary policy was not successful in sufficiently anchoring economic activity and the central banks searched for an alternative solution. The problem was, that the nominal interest rates were believed to be bounded by the zero lower bound and the central banks were limited in decreasing the policy rates further.

In reference to Krugman, Dominquez, and Rogoff (1998), a situation when the central bank already has policy rates at low values and concurrently faces low inflation or deflation and when the central bank's decrease of a policy rate is ineffective is more or less a situation of a liquidity trap as discussed by Keynes (1936). Trapped by liquidity, the preference for liquidity is absolute in the sense that everyone prefers liquidity holdings over debt securities due to their minimal or zero yields. In such a situation, the central bank's expansion of the monetary base is ineffective because the economic agents consider the debt securities and the money holdings to be the perfect substitutes (Hicks, 1937). Similarly, Svensson (2000) describes the liquidity trap as a situation of ineffective monetary policy due to zero lower bound when the economy is saturated with liquidity and the

economic agents are indifferent between money holdings and lending the money for zero interest rate. According to Krugman et al. (1998) and Eggertsson and Woodford (2003), a way how to escape the liquidity trap is by promoting inflation expectations. The central bank can do so by committing itself to an inflation target. Notice that the key determinant of this strategy lies in the ability of the central bank to keep the target. If the central bank loses the credibility of securing the inflation target then the inflation expectations are lower and the central bank needs to try some other stimulants. These stimulants are usually called unconventional monetary policy tools.

The first unconventional tool is the policy of negative interest rates. In search of a way out of the liquidity trap, some central banks decreased temporarily the interest rates into negative values and broke the assumption of the zero lower bound.[26] Therefore, the central bank is not limited by the zero lower bound but, rather, by the effective lower bound which can be negative.

As discussed, the central bank's policy rates and the interbank market interest rates are essentially connected. If the central bank decreases the nominal interest rates to negative values, then also the interbank market interest rates might move into the negative. This means that financial institutions face a negative interest rate when they want to deposit their liquidity either with the central bank or with another financial institution. Being subject to a negative interest rate, the financial institution not only does not receive interest for lending the other subject its own liquidity but also pays interest for doing so. Thus, in such a situation, the financial institution rather keeps its liquidity or alternatively lends it to firms and households for any interest higher than the cost of possible solvency failure of the debtor and other market risks. The mentioned process is called the credit channel of the monetary policy transmission mechanism. The transmission mechanism of lowering the interest rate (even into a negative) is, however, much more complicated and I will discuss it in more detail later.[27]

In the period 2012-2017, the Czech National Bank had its main policy rate - the repo rate - at the historical minimum of 0.05 %. In this period, the bank board discussed the negative interest rates policy but its stance on this policy was rejective. The bank board expressed that the negative interest rates are not a proper instrument for expanding the monetary policy. Nevertheless, the board considers the negative interest rates to be a useful tool against appreciation pressures on the Czech Koruna caused by the interest rate differential between the Czech Republic and the European Union. The board discussed that the negative interest rates policy might be harmful to the financial stability, although it considered the Czech financial system to be quite resistant and the prospective decrease of policy rates into a negative should not affect it (Czech National Bank, 2016b).

Economists are not uniform in evaluating the negative interest rate policy. Some argue that its practice helped the central banks to improve economic performance and stabilize inflation, see Arteta et al. (2016); Viñals, Gray, and Eck-

[26]The central banks that moved its main policy rate into negative values contain the European Central Bank, the Danmarks Nationalbank, the Sveriges Riksbank or the Swiss National Bank. The Central Banks of Norway, Japan and Hungary lowered only the deposit rate to negative values, while keeping their main policy rate above zero.

[27]As discussed in Arteta, Kose, Stocker, and Taskin (2016), the negative interest rates policy affects the economy in a similar way as the conventional changes in the interest rate setting.

hold (2016). Others criticize the negative policy rates for decreasing profitability which incentives the creditors to lend to riskier borrowers (Brunnermeier & Koby, 2018; Heider, Saidi, & Schepens, 2019), and for increasing the amount of risky investments as the investors search for higher yields in a low yields environment (Rajan, 2013). These can seriously jeopardise financial stability.

The second unconventional tool is quantitative easing. Using this instrument, the central bank effectively changes its balance sheet by buying securities from financial institutions. In doing so, the central bank affects the level of reserves that the financial institutions hold. Notice that the policy is similar to open market operations. The difference, however, is in the intentions of the central bank. Contrary to open market operations, the change in financial institutions' reserves is not only a by-product of the policy but, rather, the main reason for the policy (Joyce, Miles, Scott, & Vayanos, 2012).

Quantitative easing was first used in Japan in the 1990s. Facing the zero lower bound, the Bank of Japan purchased government securities from financial institutions seeking to boost the level of their cash reserves. With this policy, the Bank of Japan aimed at increasing asset prices through the transmission mechanism and suppressing the deflationary pressures in the economy. Later on, many central banks followed the Bank of Japan in implementing this policy, although with some differences. The Bank of England bought UK government bonds from the private non-banking sector; similarly, the Fed selected the strategy of purchasing US treasury bills but also bought the agency debt and agency mortgage-backed securities; the European Central Bank performed quantitative easing mainly through the repurchase operations.[28]

Similarly as any other central bank of the Eurosystem, the Czech National Bank, is forbidden to directly finance the government debt as amended in Section 34a of the Act on the Czech National Bank. Nevertheless, the Bank can extend the reserves similarly as the European Central Bank did, i.e. by repurchase operations. In March 2021, the parliament repealed Section 28 of the Act on the Czech National Bank, which restricted the Central Bank to purchase only those government bonds that have no restrictions on maturity. Thus, the Czech National Bank can conduct quantitative easing by purchasing government bonds from financial institutions, however, direct purchase from the government is still prohibited. The stance of the bank board towards using quantitative easing has been, rather, neutral but the Central Bank does not exclude using it in the future (Czech National Bank, 2020a).

By buying securities from financial institutions, a central bank increases the reserves of these institutions. Inversely, by selling the securities, the financial institutions exchange the long-term assets for short-term assets (deposits). Reducing the stock of privately held relatively long-term assets, their price grows. As the overall duration of risk exposure decreases, subjects on the financial market will require lower risk premiums. The higher prices of assets and the lower risk premiums lead to cheaper credits, which enhance consumption and investments

[28]The reason for quantitative easing differed for these central banks. The European Central Bank had to solve the problem of the Target system, when it faced a massive outflow of banks' liquidity from some euro area countries (for example Ireland, Greek, Portugal, Spain) to other countries (for example Germany, Luxemburg, Netherlands), for details see Sinn and Wollmershäuser (2011). In contrast, the quantitative easing of the Fed and the Bank of England was adopted to affect the yields and prices of private sector assets, mainly bonds.

and the overall economic performance (Joyce et al., 2012).

1.1.4 Transmission mechanism of the policy rate setting

I already mentioned that the main policy instrument of the Czech National Bank is the interest rate setting. In this subsection, I provide a detailed discussion of how the changes in the central bank's interest rates affect the economy. We can sort the effects on economic behaviour into channels according to the variables that cause them. In what follows, I discuss an effect of an increase in the policy rates (i.e. the monetary restriction). The transmission mechanism of a decrease in the policy rates has the exact opposit effect.

Exchange rate channel

A *ceteris paribus* increase in the domestic policy rates increases the interest rates on the financial markets. As the domestic interest rates are relatively higher, the foreign investors demand the domestic currency to invest in the country and the domestic currency appreciates. If the increase of the policy rates is unanticipated, the exchange rate, usually, appreciates immediately. On the other hand, if it is anticipated, the currency appreciates even before the policy rate is changed. The appreciation of the currency has two effects on the consumers. Firstly, for the domestic consumers who hold the domestic currency the foreign goods are relatively cheaper (as the purchasing power of the domestic currency increased). In contrast, for the foreign consumers, the domestic goods are relatively more expansive and they decrease consumption of domestic goods. The firms that are selling the imported goods or produce from foreign intermediate goods will purchase these with less costs and are willing to decrease the price of their final products. Thus, the domestic consumer prices fall. Furthermore, the domestic goods dispose of relatively lower competitive power and the domestic producers can respond either with a price or a production decrease. Producing less, the firms do not need as much labour force as before and the unemployment grows as the employers are dismissed. A lower employment decreases the wage growth which also affects prices negatively.[29]

Interest rate channel

A *ceteris paribus* increase in the domestic policy rates increases the interest rates on the interbank market which directly affects the interest rates on deposits and credits. In the environment of high interest rates, borrowing the money is relatively more costly and the households prefer to delay consumption and save the money for this higher interest rate.[30] Furthermore, those firms that use credits for financing face higher interest rates and hence higher cost. Also, the firms face higher opportunity cost of not saving the money for relatively higher interest rates and their relative yield of investments drops. The overall effect is that the firms decrease their investment activity. Lower investment activity

[29] Notice the importance of this channel in the Czech economy which exports over 70 % of its GDP (Eurostat, 2021).

[30] Whereas in the case of relatively lower interest rates the credits are cheaper and the households increase consumption.

of firms and lower consumption of households lead to a decrease in economic performance, an increase in unemployment and a decrease in wages and inflation.

Credit channel

The credit channel is closely related to the interest rate channel. In response to an increase in interest rates, financial institutions demand higher instalments and both households and firms face a higher cost of repaying the debt. The problem is that some of these borrowers might become insolvent and their credit might fail. Due to the failed credits, the financial institutions will demand higher risk premium and hence higher interest for the credit. For similar reasons as discussed in the interest rate channel, consumption, investment, production, wages and prices drop.

Asset prices channel

An increase in interest rates also negatively affects asset prices and their yields. Higher interest rates again promote the opportunity cost of holding assets. A rational agent should prefer depositing his wealth with the bank if the interest rates on savings accounts are higher than the real yield from the possession of the asset. A decrease in demand for the assets leads to their lower prices. Therefore, the households face a decrease in their wealth and reduce consumption. Similarly, the firms decrease their investment activity and the economic performance weakens. Also, the prices drop for similar reasons as discussed in the former channels.

1.2 Czech National Bank legislation of the policy targets

Institutionally, the Czech National Bank is established by Article 98 of the Constitution which commits the Bank to maintain price stability and ensures its independence, which can be disrupted only based on law.

The role of the Czech National Bank is determined by the Act on the Czech National Bank. In Section 1, Paragraph 1 the Act states that the Czech National Bank shall supervise the financial markets and resolve the crises. The main purpose of maintaining price stability is, however, mentioned in Section 2, Paragraph 2. Therefore, the selected monetary policy rule of the Czech National Bank is inflation targeting.

Section 2, Paragraph 2 further declares the second primary target of the Bank - securing financial stability. The Bank performs this duty using macro-prudential policy which identifies the potential risks that possibly can jeopardise the financial stability. The secondary targets come to force only when their achieving cannot harm the primary targets and contain the stable economic growth of the Czech economy and the support of the monetary and fiscal policy of the European Union in order to help the Union to achieve its targets. Notice that, unlike some other central banks, the Czech National Bank does not have in its mandate the care for employment.[31]

[31]For example, the Fed's duty is to promote effectively the maximum employment, according

to the Federal Reserve Act.

2. Independence of the Czech National Bank

In establishing the authority over the monetary policy, a broad consensus that the monetary policy should be independent of policymakers has emerged (Bernanke, 2010). Independence is essential because the targets of the central banks are set from a long-term perspective, whereas the policymakers usually focus on the short-term development of the economy, as they seek re-election. Dependent central bankers might suffer from the policymakers' pressures which could lead to monetary policy decisions that are not favourable in the long-term perspective.

According to financial theory, we can decompose independence into four components: *institutional independence, functional independence, personal independence and financial independence* (Vostrá, 2018). However, it is more precise to distinguish also the budgetary independence, as discussed in the text below.

2.1 Institutional independence

The institutional independence refers to the independence of monetary authority to the legislative, executive and judiciary powers. The basis for institutional independence of the Czech National Bank is given in the Constitution where the Chapter which regulates the Czech National Bank is separated from the Chapters that constitute the legislative, executive and judiciary powers.

Explicitly, the institutional independence is enacted by Section 9 Paragraph 1 of the Act on the Czech National Bank which prohibits the Czech National Bank, and especially the bank board to seek or take instructions from the institutions mentioned when carrying out the primary objective. This provision was changed by the parliament as it did not in its previous version properly reflected Article 130 of the Treaty on the Functioning of the European Union. The main problem was that it covered only the relationship between the Government, other administrative departments and the Czech National Bank.

Following Section 10 Paragraph 1, the Czech National Bank reports its position on proposals presented to the Government for consideration in the fields of competence of the Bank. Since these reports have only the advisory purpose and are not legally binding, this provision does not disrupt the institutional independence of the Czech National Bank.

Further, the institutional independence is not harmed by Sections 2a, 3 and 3a of the Act on the Czech National Bank that obliges the Bank to periodically but also *ad hoc* inform the Chamber of Deputies of the Czech Parliament and European Systemic Risk Board about the stance of the monetary policy and the financial stability.

Furthermore, the institutional independence is not harmed by the right of the Minister of Finance or another nominated member of the Government to attend the meetings of the Bank Board and provide his recommendation to monetary policy, because this recommendation is only asvisory.[1] Similarly, the indepen-

[1]This right is enacted in Section 11 Paragraph 1 of the Act on the Czech National Bank.

dence is not jeopardised by the right of the Governor or his Deputy to attend the meetings of the Government in an advisory capacity.[2]

2.2 Functional independence

The functional independence is guaranteed by the autonomy of the Czech National Bank when deciding upon inflation target and monetary policy instruments that are used to secure it.

The grounds for the functional independence are given by Article 98 Paragraph 1 *in fine* of the Constitution. Following this provision, no one can intervene in the primary purpose (maintaining price stability) of the Bank, unless this intervention is based on a statute.

With respect to functional independence, the original version of Section 9 Paragraph 2 of the Act on the Czech National Bank was considered to be problematic, because it enacted that the Czech National Bank had the duty to consult the inflation target and the foreign exchange regime with the Government. After the critique that the consultations could lead to Government interference in the central bank's decision-making, this Section was reformulated such that the Czech National Bank and the Government have a mutual informational duty about things related to monetary and fiscal policy.

Similarly, Section 34 Letter a) of the Act which states that the Czech National Bank sets the foreign exchange regime after the consultation with the Government is not considered to be in conflict with the functional independence, because the consultation is allowed only when the primary target is not jeopardised. Moreover, the final decision over the foreign exchange regime is still fully in the hands of the Czech National Bank.

2.3 Financial independence

With financial independence, the Czech National Bank is forbidden to directly finance the public sector. As I already discussed in part 1.1.3 the former Section 28 of the Act on the Czech National Bank which allowed the Central Bank to purchase government bonds that have no restrictions on maturity was considered a violation of the financial independence. Therefore, this Section was repealed in March 2021. Nowadays, the prohibition of direct public debt financing is amended in Section 34a of the Act on the Czech National Bank. Nevertheless, indirect financing by purchasing government bonds from financial institutions is allowed. The main reason why indirect financing is not forbidden is that it serves as an unconventional monetary policy tool, which helped many central banks to leave the close-to-zero inflation environment.

2.4 Budgetary independence

The budgetary independence is given by the separated budget of the Czech National Bank which is legislated by Section 47 of the Act on the Czech National

[2]This right is enacted in Section 11 Paragraph 2 of the Act on the Czech National Bank.

Bank. This independence is magnified by Paragraph 2 of this Section according to which the only income to the budget are Bank's own profits.

The Czech National Bank's budget is approved by the bank board independently. Nevertheless, the financial management of the Bank is under the revision of the Chamber of Deputies as amended in Section 47 Paragraph 3 of the Act on the Czech National Bank. Under this provision, the Bank submits an annual financial report to the Chamber of Deputies within three months at the end of the calendar year.

In response, the Chamber of Deputies may approve the report, acknowledge it or reject it. In case that the report is rejected, the Czech National Bank submits a revised report within six weeks. This report shall comply with the reproaches of the Chamber of Deputies.

The current text of Section 47 was accepted with the amendment of the Act on the Czech National Bank No. 447/2000 Coll. in response to a very expensive reconstruction of the Bank's building. The original amendment was problematic as it separated the budget of the Czech National Bank into activities expenditures concerning maintaining the main target and to operations and investment expenditures. While the activities expenditures were approved by the bank board independently, the operations and investment expenditures were planned by the bank board, but approved by the Chamber of Deputies. This version of Section 47 was, however, subject to a repeal proposal of the President of the Czech Republic to the Constitutional Court. In response, the Court repealed this provision in Judgement of the Constitutional Court Pl. ÚS 59/2000, because there was not a clear line between the two parts of the budget. Moreover, even if the line would have been clear, the provision violated the budgetary independence of the Czech National Bank, as the considerable shortage of operations and investment expenditures could indirectly influence the decision-making of the bank board not only about the instruments affecting the price stability.

Furthermore, the financial management of the Bank is under audit by the Supreme Audit Office as enacted in Section 3 Paragraph 3 of the Supreme Audit Office Act No. 166/1993 Coll. The Supreme Audit Office controls not only the legality of the budget revenues and expenditures but also their efficiency. Nevertheless, it does not have any authority to enforce more effective financial management.

2.5 Personal independence

The personal independence refers to an ideal state, in which the appointed bank board member executes his mandate according to his best knowledge and belief only. *Personally independent* member of the bank board is not affected by the fact that he is appointed by a given political body and that he potentially could be recalled if his actions are not in favour of this political body. Moreover, *personally independent* bank board member does not execute his mandate seeking reappointment from the political body again. Furthermore, personal independence refers also to the resistance of the bank board member's mandate to the corruption and prioritization of own interests.

This independence is probably the most challenging to deliver and yet it is not a bit less important than the rest of the central bank independencies.

The appointment process is quite problematic from its very first step - the selection of the bank board members. In an ideal world, the bank board should consist of the very best economic experts in the field of monetary policy and concurrently from the highly moral persons. However, the Czech legislation is rather lenient in this manner.

Although there are a few limitations to who can become a bank board member, these limitations are insufficient in comparison with the legislation of other important mandates.[3] According to Section 6 Paragraph 6 of the Act on the Czech National Bank the bank board member may become any Czech citizen, who is fully competent to perform legal acts, has completed a university education, is of integrity and is a person recognised standing and professional experience in monetary matters.

De lege ferenda thoughts lead me to a suggestion that the bank board member should also be at least 30 years old and should reach **economic** education at least at the master's level. In advance, similarly, as with any other mandate of similar importance, the bank board member should take the oath of office before being appointed to the mandate.[4]

On the other hand, the problem of corruption and prioritization of own interests seems to be well restrained in the Czech legislation. To prevent corruption, the bank board member receives relatively high remuneration.[5] To secure that the bank board member does not prioritize his own interest, his mandate is incompatible with any activity which might cause any conflict of interest as well as incompatible with the position of the legislative body member, member of the Government and membership of the governing, supervisory or inspection bodies of other banks or commercial undertakings and performance of any independent gainful occupation, as stated in Section 6 Paragraph 5 of the Act on the Czech National Bank. Allowed exceptions are scientific, literary, journalistic, artistic and pedagogical activities and pedagogical activities and management of own assets.

The current legislation of requirements on the person of the bank board member would not have been so insufficient in case the appointment was not decided based on the will of a single person - the will of the Czech President. This President's authority is enacted in Article 62 letter k) of the Constitution and it is the President's only appointment authority to the constitutional mandate where the president is not further restricted by consent of another body except for the appointment of Chairpersons and Vice-Chairpersons of courts who are appointed

[3]For example, the limitations on the person that shall become a judge are much more strict. Such a person must have Czech citizenship, must be at least 30 years old, must be fully competent to perform legal acts, must be of integrity and must have experience and moral character that guarantees he will execute the mandate properly. Moreover, the person must have obtained a law education at the master's level at a Czech university and must pass the judicial exam. For details see Section 60 of Act No. 6/2002 Coll. on Courts and Judges.

[4]Note that the practice of oath of the central bank board members is quite common in Europe, see Article 13 Paragraph 4 of the Act on the Narodowy Bank Polski as an example.

[5]According to the 2021 yearly financial report, the Governor of the Czech National Bank received approx. 5.9 mil. CZK of gross wage, his Deputies approx. 4.7 mil. CZK and the rest of the bank board members approx. 4 mil. CZK (Czech National Bank, 2021a). Note that the Czech National Bank must publish the wages of the bank board members according to Section 47 Paragraph 3 of the Act on the Czech National Bank.

among judges.[6]

Making the president the only body that decides on the members of the bank board is a clear attempt to minimalize the possible ties of the bank board members to the legislative or executive bodies. The question is whether this goal is legitimate when the sake of the monetary policy of the whole country, and thus the welfare of the people, lies in the appointment decision of a single person.

De lege ferenda thoughts lead me to a suggestion of a solution to this problem. There are many ways where the legislation might head to. Firstly, the appointment of the bank board could be conditional on the consent of the Senate, similar to the appointment of the Justices of the Constitutional Court. Secondly, the appointment could be shared with the Chamber of Deputies in a way that the Chamber suggests the members of the bank board and from these candidates, the President selects his preferred candidate.[7] Thirdly, the appointment could be shared with the Chamber of Deputies and Senate and each of the bodies would appoint a given fraction of the seats independently.[8] There are many other schemes available in foreign legislation, and the practice - of a single body that appoints the bank board - is rather scarce.

As noted, another essential characteristic of the personal independence is that the bank board member is not influenced in his decision because of the fear of being relieved from the office. In Czech legislation, this problem is solved by the impossibility of relief unless the bank board member no longer fulfils the legal conditions for the mandate or because he is guilty of serious misconduct (Section 6 Paragraph 10 of the Act on the Czech National Bank).[9] The second reason for relief is quite inconcrete and possibly may weaken the personal independence. However, Article 14 of the Protocol No. 4 on the Statute of the European System of Central Banks and of the European Central Bank provides protection to the Governor such that he or the Governing Council (of Eurosystem) may refer the decision to the Court of Justice for review.

The question is whether the current legislation of a relief of the bank board member could be more efficient. Firstly, I think that the protection against the relief given by the Court of Justice's review should be available to any bank board member, not only the Governor and his Deputies. Moreover, the provision of *serious misconduct* could be more specified at least using a demonstrative listing. Furthermore, I think that the bank board members should be revocable for any intended breach of the legal duties of the Czech National Bank that arise directly from the bank board decisions.

[6]When the President appoints the Prime Minister and other members of the government in accordance with Article 62 letter a) of the Constitution, they must obtain a vote of confidence from the Chamber of Deputies (see Article 68 of the Constitution). The appointment of the Justices of the Constitutional Court, according to Article 62 letter e), is conditional on the consent of the Senate as depicted in Article 24 Paragraph 2 of the Constitution. Similarly, I could continue with the rest of the appointments in Article 62. President also has other appointment authorities given in Article 63 of the Constitution. The actions in this Article must be, however, validated by the countersignature of the Prime Minister or a member of the Government designated by him (Article 63, Paragraph 3 of the Czech Constitution).

[7]Similar practice is enacted for the appointment of the Bundesbank Board members (see Article 7 Paragraph 3 of the Act on Bundesbank).

[8]Similar practice is enacted in Article 13 letter b) of the Act on Narodowy Bank Polski.

[9]Note that this provision has its origins in Article 14 of the Protocol No. 4 on the Statute of the European System of Central Banks and of the European Central Bank.

Another problem with the appointment process is the possibility of reappointment of the bank board member. Section 6 Paragraph 4 of the Act on the Czech National Bank states that the bank board members are appointed for a 6 years mandate, and according to Paragraph 3, no one can hold the position more than twice.[10]

At the end of his term, the bank board member might be motivated to decide on a monetary policy such that it favours the Czech President, seeking reappointment.

Moreover, the "ordinary" bank board member can be influenced similarly in a situation, when he runs his first mandate as a bank board member and at the same time the President appoints the Governor or his Deputy. In this case, the bank board member can also seek an even more prestige position and simultaneous extension of his current bank board membership and can decide on monetary policy in a way which favours the President's view. This can easily become a very serious problem as the President is not anyhow restricted to having any economic education, nor he does not have to be recognised standing and professional experience in monetary matters or in the area of the financial market. In advance, the President is not anyhow responsible for the appointment decision he performs, see Article 54 Paragraph 3 of the Constitution.

In my opinion, following the arguments above, the reappointment should be restricted. There are two possible solutions. Firstly, the possibility of reappointment would be cancelled and the Governor and his Deputies would be promoted from the current "ordinary" bank board members while their mandate as a Board member shall continue; or appointed without being the bank board members before. The latter option could be quite problematic, because in practice it can be useful when that the Governor and his Deputies have previous experience from the bank board meetings so they can efficiently lead them. Secondly, the reappointment[11] would be restricted such that noone can be reappointed consequtively twice. This would effectively eliminate the possibility that the bank board member will try to decide in favour of the President seeking reappointment. Personally, I find the second option to be more efficient.

In advance, the problem of appointing the bank board members such that the monetary policy preferences of the new bank board are completely changed is allowed due to the current setup of terms of the mandates. For example, current President Miloš Zeman is in the second term of his presidency since March 8, 2018, and his mandate ends on March 8, 2023. During his second term, he appointed Tomáš Holub and Aleš Michl as bank board members in December 2018. Moreover, in July 2022, he appointed current member of the bank board

[10]Note that in line with the Decision Pl.ÚS 14/01 of the Constitutional Court, the Governor belongs by definition in Section 6 Paragraph 1 of the Act on the Czech National Bank to the group of bank board members. And as such, under Section 6 Paragraph 3 of the Act, the appointment of the "ordinary" bank board member as a Governor automatically ends his first term as an "ordinary" bank board member and starts his second term as a bank board member with a position of Governor. This is exactly what happened with the current Governor Aleš Michl, who started his mandate as an "ordinary" bank board member in 2018 and was appointed as the Governor in 2022.

[11]In reference to Decision Pl.ÚS 14/01 of the Constitutional Court, this reappointment shall include also the promotion of the Governor and his Deputies from the "ordinary" bank board members.

Aleš Michl to the Governor's office, Eva Zamrazilová to the Governor's Deputy office and Jan Frajt and Karina Kubelková to the bank board member office. Furthermore, in February 2023, Miloš Zeman will appoint another bank board member for ending Oldřich Dědek and Governor's Deputy Marek Mora. Summing up, in his second term, Miloš Zeman will perform eight appointments at the minimum. There is even an opportunity for the ninth appointment in case Miloš Zeman appoints one of the current bank board members to the empty Governor's Deputy office. Now compare this number of appointments with the number of appointments that will remain for the next President who will be in the office from March 2023 to March 2027. The next President will appoint only the new bank board member for the ending mandate of Tomáš Holub in December 2024.

In an ideal world, the number of appointments should be uniformly distributed between the mandates of the Presidents which promotes the personal independence. Nevertheless, I do not come up with some systematic solution that would secure this uniformity without any further amendment. However, if the bank board member, Governor or his Deputy would not be able to appointed to the office in the two consecutive terms, there will not be any reason why to have the mandate of the bank board member, Governor or his Deputy one year longer than the President's.[12] Then the personnel changes could be uniformly distributed in time by *ad hoc* arbitrary extension of the mandate of some of the bank board members.

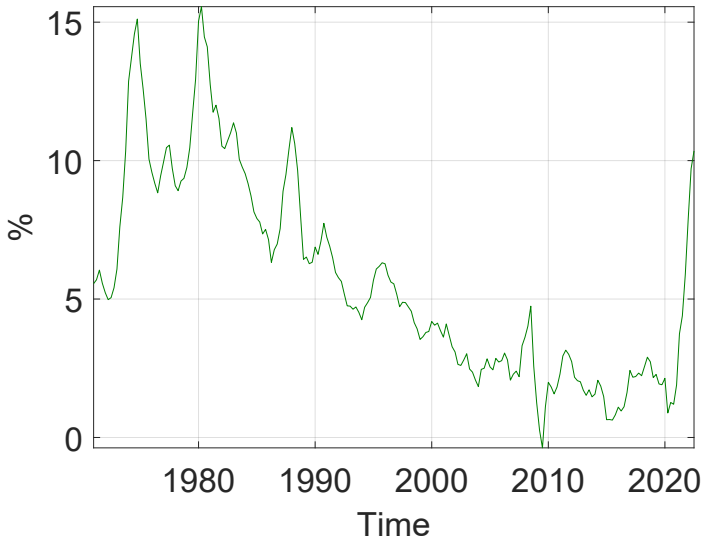
[12]Currently, President's mandate lasts 5 years.

3. Inflation

"The most important thing to remember is that inflation is not an act of God, that inflation is not a catastrophe of the elements or a disease that comes like the plague. Inflation is a policy." - Ludwig von Mises (2006, [1959]), p. 72

Inflation is one of the most important economic phenomena and can be defined as an overall increase in prices which is connected with a decrease in purchasing power of money. Inflation is, usually, denoted by the inflation rate which is defined as the percentage change in the overall prices level. The inflation rate has considerably varied across economies and throughout history. For example, the inflation in the Czech Republic was quite volatile in the 1990s and fluctuated around the 10 % level. In the 2000s inflation decreased to lower and more stable values of approx. 2 %. In response to the recent events, inflation quickly increased to 18 % (for a more detailed discussion see Chapter 5). Even the relatively high current inflation values in the Czech Republic are small compared to hyperinflations in some countries. For example, Venezuela faced inflation of 65,371.08 % in 2018.[1] The situation has been improved only slightly as in 2020 the inflation rate was still 2355.15 %.[2] Similarly, Zimbabwe was challenged by inflation of 557.21 % in 2020.[3] The overall trend of inflation rate in the OECD countries is shown in Figure 3.1 below.

Figure 3.1: Inflation rate in the OECD countries in 1971Q1-2022Q3 (data source: OECD)



Note: The graph shows the evolution of the inflation rate in the OECD countries in the period of 1971Q1-2022Q3. The introduction of inflation targeting in the 1990s has helped decrease inflation to values of approximately 2.5 %. Since Covid 19 pandemic, inflation is sharply growing again.

As shown in Figure 3.1 inflation in the 1970s was quite high and volatile. The

[1]Data source: Statista.
[2]Data source: Statista.
[3]Data source: Statista.

causes of such a pattern in the prices level changes are several. Firstly, at that time the mainstream economic belief was that there is a tradeoff between inflation and unemployment as presented by Samuelson and Solow (1960) in their modification of Phillip's curve. However, when the central banks artificially decreased unemployment in the economy, in the long run, the unemployment returned to its natural level and the only result was a price increase. Such effects of this employment policy were predicted by Friedman (1968), who showed that the inflation-unemployment tradeoff holds only in the short run. Secondly, in 1973 and 1979 in response to the Arab-Israeli conflict, the oil crises arose and led to shortages in the supply of oil, which increased the prices of oil and the costs of firms, see the discussion of negative supply shock below Figure 3.3. Thirdly, the monetary policy of the central banks was not much oriented towards decreasing inflation as shown in the empirical literature on the time-varying Taylor rule, see Clarida et al. (2000) who show that the weight on inflation was relatively low in the 1970s. In the 1980s, Friedman's view on the Phillips curve became mainstream and the central banks oriented more to low inflation rather than low unemployment. This shift in the monetary policy was documented by Judd et al. (1998) who estimated that the weight on inflation increased in the 1980s. The emphasis on low inflation even increased in the 1990s with the implementation of inflation targeting in many countries. Although the central banks of OECD countries managed to decrease inflation to a low value of about 2.5 %, after the Covid 19 pandemic it has been growing at an increased pace again. This is caused by many inflationary factors appearing at the same time. Firstly, the fiscal policy was in a significant expansion to help firms and households to overcome production shutdowns during the Covid-19 pandemic. Secondly, the prices level responded to a long increase in monetary aggregates after the 2007 Great Recession. Thirdly, the OECD countries currently suffer from the consequences of the Russian invasion of Ukraine. The conflict has created an energy crisis that has been connected with unprecedented growth in energy prices.

3.1 Sources of inflation

There are many sources of prices growth. Generally, we can separate them according to whether they affect aggregate demand or aggregate supply. According to the demand or supply sources of inflation, we can define a *demand-pull* inflation and *cost-push* inflation.

Demand-pull inflation

In the case of *demand-pull* inflation, the prices growth is driven by an increase in the aggregate quantity demanded. The aggregate quantity demanded (AD) is explained differently by Monetarists and Keynesians. Monetarists derive the aggregate supply from Fisher's (2006 [1911]) equation of exchange which explains the relationship between money and goods in the market:

$$M \times V = P \times Q, \tag{3.1}$$

where M denotes the average amount of money in the economy during a period, V represents the average rate of turnover of money (i.e. the velocity of circulation of

money). P is the aggregate prices level in the economy and Q is the real product that utilizes the aggregate demand (and thus $Q = AD$). The equation 3.1 can be, therefore, rewritten as follows:

$$AD = \frac{M \times V}{P}. \tag{3.2}$$

According to Monetarists, the velocity of money V does not change in time. Also, the aggregate demand has a causal effect towards prices, not *vice versa*. Hence, the only variable that can affect the aggregate demand according to Monetarists' theory is the average amount of money M which is determined by the central bank. The source of inflation then lies in the money supply of the central bank (Friedman & Schwartz, 1963).

In contrast, Keynesians (see Keynes (1936)) derive the aggregate demand from the households' consumption C, planned investments of firms I, government expenditures G and net export Nx, such that:

$$AD = C + I + G + Nx. \tag{3.3}$$

The growth in any of these variables increases the aggregate demand. The Keynesian consumption is composed of the autonomous consumption C_A (independent of the level of households' income) and the income-dependent consumption $C_{NA} = mpc \times Y_D$, where the mpc denotes the marginal propensity to consume (i.e. the fraction of income that the households spend on consumption) and Y_D is the disposable income of the households:

$$C = C_A + mpc \times Y_D. \tag{3.4}$$

An increase in any of these variables leads to an increase in consumption C which increases the aggregate demand AD. It is worth mentioning that the disposable income Y_D is derived from the gross income Y_G reduced by income taxes T_Y, formally $Y_D = Y_G - T_Y$. Thus, an increase in taxes decreases the disposable income Y_D, which negatively affects the consumption C and, hence, reduces the aggregate demand AD.

The planned investments are negatively affected by this market interest rate and positively affected by the autonomous investments I_A that are independent of the interest rate, formally:

$$I = I_A - \alpha \times r, \tag{3.5}$$

where the α denotes the sensitivity of the investment activity on the market interest rate r. An increase in the autonomous investments I_A increases the aggregate demand AD through an increase in investments I. In contrast, the higher the sensitivity α and the market interest rate r, the lower the investments I and the lower the aggregate demand AD.

The net exports Nx are given by the difference between exports X and imports M:

$$Nx = X + M \tag{3.6}$$

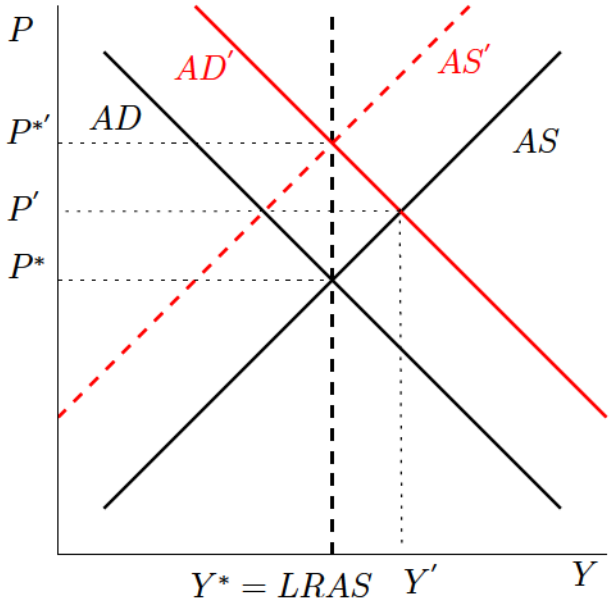
The stronger the exchange rate, the higher the imports M and the lower the exports X. Thus, the appreciation of the national currency decreases the net

exports Nx and the aggregate demand AD. In contrast, the depreciation of the currency increases aggregate demand AD.

Finally, the government expenditures affect the aggregate demand AD positively, although, the effect of an increase is not proportional due to the crowding-out effect of investments.[4]

The following Figure 3.2 shows the effect of an increase in the aggregate demand (AD') on the prices level P and output produced in the economy Y. In the short-run, the firms can react to increased demand by extending production from the former equilibrium state Y^* to Y' (quantity clearing) or by increasing prices from P^* to P' (prices clearing) causing inflation (in %) of $\pi = \frac{P'-P^*}{P^*} \times 100$. To increase production, the firms hire more labour on the labour market and unemployment falls. Notice, however, that the increase in production is unsustainable, unless, the productivity caused by technological progress increases as well. The difference between the temporarily increased production Y' and the potential product of the economy Y^* is called the output gap. Facing a positive output gap, the economy is overheated and is in an expansion. In the long run, the exceeding demand of firms on the labour market causes real wage growth. Higher wages are more costly for the producers, which shifts the aggregate supply to the left (AS'). To compensate for the higher cost, the producers increase the prices of their product to $P^{*'}$ and produce less Y^*. Notice, that the aggregate supply returns to its long-run equilibrium $LRAS$. As a result of the mentioned processes, the inflation (in %) will be $\pi = \frac{P^{*'}-P^*}{P^*} \times 100$.

Figure 3.2: *Demand-pull* inflation in AD-AS model



Note: An increase in the aggregate demand AD' moves the economy into expansion, where the product exceeds its potential $Y' > Y^*$. In the long-term, the economy returns to its potential but the prices increase to $P^{*'}$, which results in inflation (in %) of $\pi = \frac{P^{*'}-P^*}{P^*} \times 100$.

[4]For details, see the discussion of the crowding-out effect in IS-LM model provided in Mankiw (2010).

Cost-push inflation

As noted, the second source of inflation lies in negative aggregate supply shocks which increase the cost of production. The firms can have larger costs mainly due to these three reasons.

Firstly, an increase in the wages negotiated by the trade unions, or caused by the minimum wage growth determined by the government increases the expenditures on labour input. Due to a higher production cost, the firms can afford to produce less output and hire fewer workers than before. With the lower product on the market but the same demand, the firms will increase prices which leads to a *wage-push* inflation. If the produced good is only intermediate and serves as an input for the production of another product, the effect is even stronger (Machlup, 1960).

A similar effect on the prices level have other production shocks. Depreciation of the domestic currency increases the cost of the firms which sell an imported good or which import intermediate goods to use them as inputs. An important determinant of production cost is the supply of energy. In response to the current Russian-Ukrainian war, European firms face an unprecedented increase in production costs caused by a shutdown of the imports of Russian energy resources. The cost could arise also from a natural disaster or from other sources that destroy the firms' capital endowment. Further, the costs are increased when some important intermediate good is not effectively supplied in the market and the firm faces higher prices for purchasing this good. Furthermore, the impossibility to sell all of the product due to external shocks means that the firm has lower revenue to cover for loss connected with the fixed cost that arises in the short run. Thus, the firm can be forced to increase the price of its product to survive on the market. Notice, that the last two mentioned problems were common in many countries when the governments shut down production to fight the Covid-19 pandemic. In Europe, the disruption of the global value chains has been even magnified due to the Russian-Ukrainian conflict. The mentioned processes are one of the main reasons why, nowadays, Europe faces relatively high inflation.[5]

I show the effect of an increase in production cost and the resultant decrease in aggregate supply (AS') in Figure 3.3. In response to the higher production cost, the producers decrease the supply of the product to Y' (quantity clearing) and increase prices to P' (prices clearing). Thus, the aggregate supply decreases from AS to AS' causing a negative output gap $Y' < Y^*$ (i.e. recession). To produce the lower output of Y', the firms will employ fewer workers and on the labour market, the supply of labour will exceed the demand for it. Following this shock to the economy, two possible scenarios can happen.

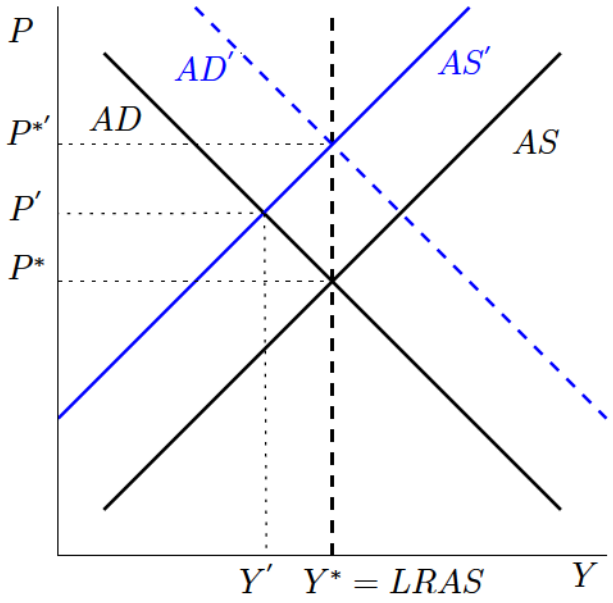
Usually, when the economy faces a recession, the government or the central bank stimulates the aggregate demand. If this happens, then we have the first scenario and the aggregate demand is shifted upwards to AD' and the recession is successfully overcomed, however, the backside effect is the overall prices increase of (in %) $\pi = \frac{P^{*\prime} - P^*}{P^*} \times 100$. In a regime of inflation targeting with a positive inflation target, the central bank would prefer this first scenario over the second scenario and would increase the money supply. The reason for this preference is

[5]The average inflation rate in the European countries that are OECD members was 16.7 % in October 2022 (data source: OECD).

that in the second scenario it must allow for deflation.

In the second scenario, the government and the central bank do not intervene. In the long run, the excess of supply over demand on the labour market caused by a decrease in production leads to a drop in real wages. Hiring for lower wages, the producers can afford to produce more and increase the aggregate supply back to the original level of AS, where the economy produces at its potential Y^* and in the long run equilibrium $LRAS$ for the prices level of P^*. Notice that in this second scenario, the prices in the short run increased to P' but as the production returned back to its potential, the prices decreased back to P^*. Thus, firstly the economy faces an inflation (in %) of $\pi = \frac{P'-P^*}{P^*} \times 100$, and later faces a deflation (in %) of $\pi = \frac{P^*-P'}{P'} \times 100$.

Figure 3.3: *Cost-push* inflation in AD-AS model



Note: An increase in the aggregate supply AS' moves the economy into the recession, where the product is lower than the economy's potential $Y' < Y^*$. In the long-term, the economy returns to its potential and if the government or the central bank promotes the aggregate demand then the prices increase to $P^{*'}$, which results in inflation (in %) of $\pi = \frac{P^{*'}-P^*}{P^*} \times 100$.

Other sources of inflation

An alternative *cost-push* inflation theory describes inflation as a reciprocal process in which inflation spills over from sectors with high demand and high prices. As the firms seek to follow market trends, they increase prices when they see that the prices in related sectors increased (Schultze, 1959; Balassa, 1964; Samuelson, 1964).

Samuelson and Solow (1960) discuss that inflation is also driven by the cooperative actions of oligopoly or monopoly markets, where the firms are not restricted by other competitors and increase the prices to gain more profit. Such inflation we call a *seller's* inflation.

Lastly, inflation can be caused by the central bank's inflation targeting policy in case the inflation target is announced as a positive value. If the central bank is reliable in keeping the inflation at its target then the economic agents include this target in their inflation expectations. Doing so, the key economic decisions, including planned prices increases of firms, count with the targeted level of inflation and the inflation expectations, in fact, create inflation. This process is confirmed by the findings of empirical literature where the inflation expectations have indeed large explanatory power when predicting inflation, see R. M. Solow (1969) or Coibion, Gorodnichenko, and Kamdar (2018). Also, the inconsistency in the monetary policy parameters can cause serious harm to inflation expectations when the changes in the decisions of the central bank are unanticipated by the agents. In a situation, when the agents expected a higher inflation level but the response of the central bank to the inflation gap decreased and the inflation remained low, the firms increased prices more than they should have which causes inflation. [6]

3.2 Consequences of inflation

Inflation has many consequences on economic agents. To some agents, these consequences are harmful, for others they are beneficial. To identify the consequences properly, we have to differentiate expected inflation which is based on the expectations about an increase in prices level from unexpected inflation. Unexpected inflation denotes those increases in the prices level that are not anticipated by the agents and, thus, their consequences are more severe. The inflation expectations can be anchored by the monetary authority. If the central bank predicts inflation correctly then its predictions are credible for the people and they expect inflation in the way the central bank prognoses it.

The main problem with inflation is that it unjustly redistributes the wealth of people. The redistribution affects the subjects on many levels. Firstly, inflation increases the relative contribution of progressive taxpayers compared to those who are not subject to the higher tax rate. Secondly, if the wages are not indexed to inflation or, more generally, do not increase with inflation then inflation redistributes the wealth from employees to employers. Because employers will pay lower real wages compared to before. Thirdly, if the debts are not indexed to inflation, then the value of repayments is depreciated by inflation and the wealth is redistributed from creditors to debtors. Lastly, the redistribution will affect those who expected inflation poorly, whereas those who expected it properly will be better off. This includes also the correct expectations of inflation volatility.

Further, inflation has other negative effects on economic agents. As the wealth of the agents is diminished by its decreasing purchasing power, they are better off increasing consumption and reducing savings.[7] Also, the informational function of prices can be significantly deformed which can harm the optimal decisions about price setting of the producers. Furthermore, unanticipated inflation increases the prediction error of determining the real return of financial assets which can

[6] For a more detailed discussion of inflation caused by inflation expectations and inconsistency in monetary policy parameters, see Pokorny (2021a).

[7] Low savings can be quite problematic and decrease the steady-state of the output of the economy in the very long run, see Solow (1956) model.

lead to improper investment decisions. Also, in such an environment, financial institutions demand a higher risk premium for lending money.

These unjust effects on legal obligations between the economic subjects can be mitigated by *clausula rebus sic stantibus* which is, usually, legislated in the Civil Code of the given country. In the Czech legislation, this *clausula* is amended in Section 1765 Paragraph 1 of Act No. 89/2012 Coll. (Civil Code). According to this provision, the substantial change in circumstances that creates a gross disproportion in the rights and duties of the parties establishes the right of the harmed party to renegotiate the contract. However, this right is in force only in case the change in circumstances occurs after the conclusion of the contract and when neither of the parties has expected it nor affected the change. In the judgement of the Czech Supreme Court No. 26 Cdo 1670/2018 from May 22, 2019, it is specified that the *clausula* is applied in the case that the increase in the prices is not caused by standard evolution in the economy that is anticipatable. Following this judgement, we may conclude that unexpectedly high inflation (or deflation) that was not anticipatable is a reason for the application of the mentioned provision.

Finally, if inflation is uncontrollably high then the basic function of money of being a medium of exchange can fail and people may start using other mediums of exchange instead.

Deflation has very similar effects as inflation but affects the economy in an opposite way than what was discussed.

Taking into account what was noted, the question remains, why do most of the central banks target a 2 % inflation rate rather than 0 %. One of the reasons is the zero lower bound and the liquidity trap. If the central bank targets 0 % inflation and the real economic growth is decreasing, the central bank cannot effectively lower the interest rates if they are already close to zero.

Another reason is that the central banks consider deflation to be a more serious problem than inflation. Many economists discuss the serious harm of high or long-term deflation, see e.g. Svensson (2000). They are not, however, unanimous in evaluating a short-term deflation. DeLong and Sims (1999) discuss that the effects of inflation and deflation are not symmetrical and that deflation at the same level as inflation is more harmful due to the mentioned problem of a zero lower bound. On the other hand, Hayek (1932) and Potužák (2018) consider deflation that is caused by technological growth during economic expansion to be natural.[8]

A third reason for the positive inflation target can be given by the imperfect information value of the price indexes that tend to overvalue the real inflation because they do not adjust for an increase in the product's quality which could be the real reason for its price increase (Revenda, 2011).[9]

[8]Notice that the output gap caused by economic growth can exceed the inflation gap caused by deflation and in such a situation the central bank may not increase the interest rates in order to promote inflation back to its target. The optimal reaction depends on the weights in the reaction function of the central bank, see Chapter 4.

[9]In such a situation the product is not more expensive due to inflation but, rather, due to its higher quality.

3.3 Why is price stability so essential?

As discussed in the mainstream literature, price stability is considered to be one of the main determinants of stable economic growth, financial stability and low unemployment at the natural level, see Svensson (2010) or Woodford (2012).

Generally, price stability suppresses all the negative effects of unexpected inflation or deflation (see Section 3.2).

When households and firms face stable prices, it is much easier for them to act optimally when making key economic decisions. Firstly, under price stability, the prices provide complete, credible and unbiased information about the situation in the market. Hence, the consumption, investment and asset purchasing decisions are errorless of improper prices information and the firms can informatively make proper investments. In contrast, in a situation when households and firms are uncertain about the prices level, they hardly detect whether the increased or decreased individual prices are caused by an overall change in prices or by the changes in the quantity demanded or supplied. Thus, with the lower uncertainty about the evolution of the prices, stable economic growth is enhanced (Poole, Wheelock, et al., 2008).

Another important effect of price stability is that it anchors inflation expectations as shown in many economic papers, see Batini and Laxton (2007), Gürkaynak, Levin, and Swanson (2010) and Davis, Presno, et al. (2014). Stable inflation expectations then stabilize the economy's output.

Further, stable prices avoid the unjust redistribution of wealth. When the inflation is stable, the contractual parties can easily incorporate inflation into the contract. When the prices remain stable and as expected then none of the parties is harmed.

Moreover, price stability permits tax laws and accounting rules to be expressed in the terms of a concrete currency without being subject to distortions arising from fluctuations in the value of money (Feldstein et al., 1999).

4. Empirical analysis of inflation targeting of the Czech National Bank

In this chapter, I empirically analyse whether the Czech National Bank fulfils its constitutional duty of having price stability as its main target and determine how the inflation targeting policy of the Bank changed over time. Firstly, I present the related literature that examines the central bank's reaction function in an inflation targeting regime then I discuss the declared reaction function of the Czech National Bank, and finally, I present the empirical model and discuss the obtained results.

4.1 Related literature

In the literature, two main approaches of modelling the central bank's interest rate reaction function in an inflation targeting regime are used. The first approach, see Barro and Gordon (1983a, 1983b), theoretically derives the reaction function from the optimization of the central bank's loss function. The second approach is based on empirical estimates. As shown by Taylor (1993), the behaviour of the central bank can be approximated as a simple interest rate rule:

$$r_t^* = \overline{rr} + \pi_t + 0.5(\pi_t - \pi^*) + 0.5x_t, \tag{4.1}$$

where the target rate for the nominal policy rate r_t^* is set according to the deviation of inflation π_t from its target π^* and the output gap x_t and the equilibrium real rate $\overline{rr}$ in the economy.

Replacing the concrete numbers for the parameters, one can generally rewrite equation 4.1 as follows:

$$r_t^* = \overline{r} + \xi_\pi(\pi_t - \pi^*) + \xi_x x_t, \tag{4.2}$$

where $\overline{r}$ denotes the *policy-neutral rate*,[1] ξ_π and ξ_x denote the weight parameter of the central bank on the inflation gap and on the output gap respectively.

Usually, the central banks reflect the delay of their monetary policy, see Czech National Bank (undated). Thus, their interest rate function is explained with more precise by the forward-looking version of equation 4.2:

$$r_t^* = \overline{r} + \xi_\pi(E\left\{\pi_{t+n}|\Omega_t\right\} - \pi^*) + \xi_x E\left\{x_{t+n}|\Omega_t\right\}, \tag{4.3}$$

where Ω_t denotes the information set available at time t when the central bank decides upon the interest rate setting. n index denotes the policy horizon.[2] The mathematics symbol E denotes expectation about the future value of a given variable. Thus the expression $E\left\{\pi_{t+n}|\Omega_t\right\} - \pi^*$ is the central bank's expectation about the inflation gap in the period $t+n$ given the disposable information Ω_t.

[1] The *policy-neutral rate* approximately reflects inflation π_t and the equilibrium real rate $\overline{rr}$, see Fisher and Barber (1907).

[2] As discussed by the Czech National Bank (undated), the policy horizon is 4-6 quarters.

If the central bank's inflation target has changed during the observed period then also the inflation target shall be indexed by t:

$$r_t^* = \overline{r} + \xi_\pi(E\{\pi_{t+n}|\Omega_t\} - \pi_{t+n}^*) + \xi_x E\{x_{t+n}|\Omega_t\}. \tag{4.4}$$

Also, the central bank might prefer smooth evolution of the interest rate rather than a vigorous one. In such a case, the central bank weights the lagged interest rate. We can acknowledge this preference by introducing a simple partial adjustment mechanism as in Clarida et al. (2000):

$$r_t = \rho r_{t-1} + (1-\rho) r_t^* \tag{4.5}$$

where r_t is the actual policy rate and $\rho \in [0,1]$ denotes the smoothing parameter.

We can plug 4.5 into 4.4 in order to get:

$$r_t = (1-\rho)\left[\overline{r} + \xi_\pi(E\{\pi_{t+n}|\Omega_t\} - \pi_{t+n}^*) + \xi_x E\{x_{t+n}|\Omega_t\}\right] + \rho r_{t-1}. \tag{4.6}$$

Although this is the most common specification that is used in the empirical literature on the Taylor rule, many papers (see the discussion below) show that the parameters are not constant as in equation 4.6 but, rather, time-varying:

$$r_t = (1-\rho_t)\left[\overline{r}_t + \xi_{\pi,t} E\{\tilde{\pi}_{t+n}|\Omega_t\} + \xi_{x,t} E\{x_{t+n}|\Omega_t\}\right] + \rho_t r_{t-1}, \tag{4.7}$$

where $E\{\tilde{\pi}_{t+n}|\Omega_t\} \equiv E\{\pi_{t+n}|\Omega_t\} - \pi_{t+n}^*$ is the expected inflation gap in $t+n$.

Following Baxa, Horváth, and Vašíček (2013), other variables that are in concern of the central bank can be added to the equation. As the Czech National Bank has been occasionally using foreign exchange interventions (see part 1.1.3), I will test also the significance of the weight parameter on the exchange rate gap:[3]

$$r_t = (1-\rho_t)\left[\overline{r}_t + \xi_{\pi,t} E\{\tilde{\pi}_{t+n}|\Omega_t\} + \xi_{x,t} E\{x_{t+n}|\Omega_t\} + \xi_{\mathcal{E},t} E\{\mathcal{E}_{t+n}|\Omega_t\}\right] + \rho_t r_{t-1}, \tag{4.8}$$

where $\mathcal{E}_{t+n}$ is the expected exchange rate gap and $\xi_{\mathcal{E},t}$ the weight parameter on the exchange rate gap.

4.1.1 Czech National Bank's reaction function

According to Article 98 of the Constitution, the Czech National Bank's main purpose is to maintain price stability. Another legal mandate of maintaining financial stability and safe functioning of the Czech financial system is added by Section 2 Paragraph 1 of the Act on the Czech National Bank. Additional policy targets of long-term economic growth and achieving European Union goals cannot by any means affect the policy decision that aims to achieve the primary target.

In line with the constitutional mandate, in the officially declared reaction function of the Czech National Bank, the Central Bank reacts with its interest

[3]The exchange rate gap is given as a difference between the exchange rate and the natural level of the exchange rate (a long run trend) in the economy, see Feldkircher, Huber, Moder, et al. (2016).

rates only in response to the deviation of inflation from its target (Czech National Bank, 2009a):

$$r_t = (1-\rho)\left[\overline{r} + \xi_\pi(E\left\{\pi_{t+4}|\Omega_t\right\} - \pi^*_{t+n})\right] + \rho r_{t-1} \tag{4.9}$$

In my empirical analysis, I am to test whether the Central Bank is truly focused on inflation targeting by adding to the reaction function also the output and exchange rate gaps. In case the response parameters to these variables are estimated insignificant, then this empirical analysis suggests that the Czech National Bank truly follows its constitutional mandate of maintaining price stability. On the other hand, if these variables are statistically significant then the Czech National Bank focuses also on the secondary monetary policy targets, although it might harm achieving price stability.

To evaluate inflation targeting and fulfilling the constitutional duty of price stability over the given monetary policy periods, I will map the evolution of the reaction function of the Czech National Bank over the years. This analysis is especially interesting with respect to the findings that unexpected shocks to the monetary policy parameters increase business cycle fluctuations (Pokorny, 2021a).

4.1.2 Review of results in the related empirical literature

There are several ways how to map the changes in the monetary policy parameters in the reaction function of the central banks.

Firstly, one can estimate the Taylor rule on sample splits and test whether the estimated parameters in each sample varied significantly. This procedure was performed in several papers. Judd et al. (1998) estimated the Taylor rule of the Fed using OLS and split the samples according to the chairmen of the Fed. Their results suggest that when Alan Greenspan held office, the Fed weighted both inflation and the output gap. They found the Fed's response to the output gap twice as large compared to Taylor (1993).[4] With Volker's appointment, the weight on both inflation and the output gap increased significantly in response to high inflation in the 1970s. In contrast, for Burn's period, the authors do not find a significant response of the Fed to inflation. On the other hand, in this period, the weight on the output gap increased.

Clarida et al. (2000) used the GMM estimator on sample splits of the pre-Volcker and post-Volcker eras. Similarly, as Judd et al. (1998), they found that in Volcker's period the weight on inflation was considerably higher. Orphanides (2004) also analyzed these subperiods and found that the main difference was in weight on the output gap as the pre-Volcker period is connected with a significantly higher weight on the output gap.

Martin and Milas (2013) used the GMM estimator on sample splits for the UK data and found that in the pre-2007 crisis years, the weight on the inflation gap was higher than after the crisis.

Alternative approaches to the estimation of the changes in monetary policy parameters are based on the estimation of the state-space model. In the literature, some papers use the Kalman (1960) filter approach, see Cogley and Sargent

[4] In Taylor (1993) the weight on the output gap was 0.5.

(2001); Plantier and Scrimgeour (2002); Jalil (2004); Boivin (2005); Trecroci and Vassalli (2006); Mésonnier and Renne (2007); Trehan and Wu (2007); Yüksel et al. (2013). Others use the GMM method, see Partouche (2007); Baxa et al. (2014); Korhonen and Nuutilainen (2016). Markov chain Monte Carlo is used in Wesche (2003); Kuzin (2006); Feldkircher et al. (2016). Other procedures are used in Kim and Nelson (2006); Kuzin (2006); Mandler (2007); McCulloch (2007); Liu, Xu, Zhao, and Song (2018).[5]

The main findings of the mentioned time-varying Taylor rule literature show that the monetary policy parameters that capture the preferences of the central banks' are dynamically evolving.

An important question is, whether this inconsistency in the monetary policy parameters can be considered a quasi-discretion. On one hand, nowadays, the central banks follow some policy rule (usually the Taylor rule); on the other hand, they are not consistent in reacting to macroeconomic variables.

If the changes in the central bank's reaction are anticipated by agents, they are incorporated into their inflation expectations and such changes cannot harm the stability of the economy. In contrast, unanticipated changes in the monetary policy parameters can seriously increase the business cycle fluctuations as I show in a theoretical DSGE model in Pokorny (2021a). Important findings to this debate are provided by Mandler (2007), who suggests that one of the sources of the uncertainty of agents is caused by unpredictable changes in the monetary policy parameters.

In the literature, three main sources of the monetary policy parameters' inconsistency are discussed. Firstly, the members of the governing body of the central bank have a time-limited tenure and their successors can view the monetary policy differently (Judd et al., 1998; Clarida et al., 2000; Favero & Rovelli, 2003; Valente, 2003; Orphanides, 2004; Martin & Milas, 2013). Also, the preferences of the members of the governing body can change during their term, e.g. due to public pressure and due to changing academic and social trends. If the central bank is not independent enough, the members can be also affected by political pressures. Such pressures might have occurred during the Covid-19 pandemic when the economies faced a massive drop in output due to production shutdowns (see Section 5.8). The central banks might have been influenced by the public and political pressures to keep the expansionary policy, although, they should have restricted the economy to achieve the main policy target of price stability at the monetary policy horizon. As a result to this factor and other recent events, the current inflation level is far above the inflation target (see Section 5.8).

Secondly, the central banks regularly update their prediction models, which can provide a different prognosis than the older models.[6]

Thirdly, the source of the changes in the monetary policy parameters can be caused by a change in the transmission mechanism of the monetary policy. The need for the severity of a central bank's reaction to the inflation and output gap critically depends on the inflation expectations of the agents. If the central bank successfully anchors inflation expectations to the level of its inflation target

[5]A detailed literature survey of the mentioned papers is provided in Pokorny (2021a).

[6]The Czech National Bank updated its prediction model to the Quarterly Prediction Model (QPM) model in 2002. In 2008 it switched it for a modern DSGE model g3. In 2019 the model was updated to the g3+ version.

then it does not have to react to the inflation gap so severely because inflation expectations self-enforce the desired inflation level (Benati, 2008; Zhang, Osborn, & Kim, 2008; Baxa et al., 2014).

4.1.3 Review of results in literature analysing the Czech data

In this subsection, I provide a review of the literature that examines the changes in the monetary policy parameters of the Czech National Bank. Frömmel and Schobert (2006) analyzed the sample splits by the GMM estimator to capture the changes in the monetary policy parameters in the six CEE countries, including the Czech Republic. Their estimates confirm that the Czech National Bank truly switched its policy from exchange rate targeting to inflation targeting in 1998. Horváth (2006, 2009) used the GMM and the Kalman filter and estimated a variety of Taylor rule specifications with a time-varying neutral policy rate on the Czech data. His results show a gradual decrease of the policy-neutral rate to levels similar to the euro area. Yilmazkuday (2008) added dummies for structural breaks to Taylor rule specification for the Czech Republic, Hungary and Poland and also found a policy shift to inflation targeting as did Frömmel and Schobert (2006), except for the Hungarian National Bank which did not truly shift the policy regime in the observed data range of 1994 M1 - 2007 M6.[7] Frömmel, Garabedian, and Schobert (2011) and Petreski (2011) used the Markov-switching to estimate the changes in the monetary policy parameters of the CEE countries. Their findings are in line with Frömmel and Schobert (2006) as they showed that the Czech National Bank shifted the monetary policy from exchange rate to inflation targeting as officially declared. Feldkircher et al. (2016) used the Markov chain Monte Carlo method and found a gradual decrease of the weight on the inflation gap in the Czech Republic for the data range of 2004 M7 - 2015 M5.

4.2 Methodology and model

4.2.1 Methodology

In this section, I discuss the methodology behind my estimates provided in Section 4.4. I follow the empirical approach of Clarida et al. (2000); Frömmel and Schobert (2006); Martin and Milas (2013) and use the Generalized method of moments (GMM) estimator on sample splits which enables to observe the changes in the monetary policy parameters within the subsample periods.

The most general characterization of the GMM approach was provided by Hansen (1982). The GMM estimator aims to find the true value of the estimated vector of parameters θ, or a reasonably close estimate.

Let w_t be a $(h \times 1)$ vector of variables that are observed at time t. Let θ denote an unobserved and unknown $(a \times 1)$ vector of coefficients, and let $h(\theta, w_t)$ be a $(r \times 1)$ vector-valued function. Let θ_0 define a true (population) value of θ. The GMM estimates a model where the expected value of the function of the

[7] The Hungarian National Bank officially implemented inflation targeting in June 2001.

true parameter vector θ_0 satisfies

$$E\left\{h(\theta_0, w_t)\right\} = 0 \tag{4.10}$$

Further, let $y_T = (w_T', w_{T-1}', ..., w_1')'$ be a $(Th \times 1)$ vector which includes all observations of the sample of the size T. Then we can receive a sample average of the vector-valued function in period t:

$$g(\theta, y_T) \equiv \frac{1}{T}\sum_{i=1}^{T} h(\theta, w_t) \tag{4.11}$$

As mentioned, the GMM chooses θ such that the sample moment $g(\theta, y_T)$ is as close as possible to the population moment of zero. Formally, the selection procedure is performed upon the following minimization problem of a scalar:

$$Q(\theta, y_t) = \arg\min_{\theta} \left[g(\theta, y_T)\right]' W_T \left[g(\theta, y_T),\right] \tag{4.12}$$

where $Q(\theta, y_t)$ denotes the vector-valued function of the optimal θ which solves the mentioned minimization problem and W_T is the sequence of positive definite weighting matrix.

Let S denote the asymptotic variance of the sample mean of $h(\theta_0, w_t)$ which is given as follows:

$$S = \lim_{T\to\infty} T \times E\left\{\left[g(\theta, y_T)\right]\left[g(\theta, y_T)\right]'\right\}. \tag{4.13}$$

The optimal value of the weighting matrix W_T is given by the inverse of the asymptotic variance matrix S^{-1} and the optimization problem in expression 4.12 can be rewritten as follows:

$$Q(\theta, y_t) = \arg\min_{\theta} \left[g(\theta, y_T)\right]' S^{-1} \left[g(\theta, y_T),\right] \tag{4.14}$$

Under the satisfied conditions, the GMM is consistent, asymptotically normal and with the right choice of the weighting matrix W_T also asymptotically efficient.

Due to possible the endogeneity of the regressors, I apply the GMM estimator to the Instrumental Variables approach, where the $t-1$ and $t-2$ lagged regressors are used as instruments. Having a linear model, one can rewrite it into a vector form:

$$y_t = z_t'\beta + u_t, \tag{4.15}$$

where z_t is a $(k \times 1)$ vector of explanatory variables, y_t is the dependent variable, β is a $(k \times 1)$ vector of unknown parameters and u_t is the error term. The endogenous explanatory variables might cause biased estimation as $E\left\{z_t u_t\right\} \neq 0$. Let x_t denote instrumental variables that are correlated with z_t but not with u_t.

Notice that the instrumental variables are a special case appliable to the GMM estimator where the vector of unknown parameters $\theta = \beta$ and the vector of observed variables $w_t = (y_t, z_t', x_t')'$. The vector-valued function is then given as:

$$h(\theta, w_t) = x_t(y_t - z_t'\beta) \tag{4.16}$$

For the derivations and more detailed discussion of the GMM and the instrumental variables equations, see Hamilton (1994).

4.2.2 Model

Following the discussion provided in Section 4.1, I transform the theoretical model in equation 4.8 into the econometric model by eliminating the unobserved forecast variables:

$$r_t = (1-\rho_t)\left[\overline{r}_t + \xi_{\pi,t}\tilde{\pi}_{t+n} + \xi_{x,t}x_{t+n} + \xi_{\mathcal{E},t}\mathcal{E}_{t+n}\right] + \rho_t r_{t-1} + \epsilon_t, \tag{4.17}$$

where ϵ_t is the error term.

The time-variability of the parameters is tested by using two separate subsamples. In each, the parameters are considered to be time-invariable. Therefore, the estimation equation does not include time-varying parameters:

$$r_t = (1-\rho)\left[\overline{r} + \xi_{\pi}\tilde{\pi}_{t+n} + \xi_{x}x_{t+n} + \xi_{\mathcal{E}}\mathcal{E}_{t+n}\right] + \rho r_{t-1} + \epsilon_t, \tag{4.18}$$

Proper parameter transformation, given by $\psi_{\overline{r}} \equiv (1-\rho)\overline{r}$, $\psi_{\pi} \equiv (1-\rho)\xi_{\pi}$, $\psi_x \equiv (1-\rho)\xi_x$, $\psi_x \equiv (1-\rho)\xi_x$ and $\psi_{\mathcal{E}} \equiv (1-\rho)\xi_{\mathcal{E}}$ ensures linearity of the model:

$$r_t = \psi_{\overline{r}} + \psi_{\pi}\tilde{\pi}_{t+n} + \psi_x x_{t+n} + \psi_{\mathcal{E}}\mathcal{E}_{t+n} + \rho r_{t-1} + \epsilon_t, \tag{4.19}$$

The policy horizon n is set to two ($n = 2$) in reference to Baxa et al. (2014).[8]

To get the original parameters in equation 4.17 after the estimation, I use a backwards transformation.[9]

4.3 Data

In this section, I present the data that are used for the estimation of the Taylor rule mapping the changes of the inflation targeting policy of the Czech National Bank in the data range of 1996 Q3 - 2021 Q2. The data is summarized in Table 4.1 below. To monitor the changes, the sample is split into two subsamples of 1996 Q3 - 2008 Q4 and 2009 Q1 - 2021 Q2 summarized in Table 4.2.

Table 4.1: Descriptive statistics of the whole data sample.

Statistic	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Interest rate	3.116	2.795	−0.3871	1.471	3.634	13.251
Inflation gap	−0.050	2.096	−4.387	−1.442	0.892	7.251
Output gap	0.0034	0.801	−6.383	−0.176	0.190	2.860
Ex. rate gap	− 0.017	1.443	−4.879	−0.647	0.424	5.901

Note: This table shows the descriptive statistics of the interest rate, inflation gap, output gap and exchange rate gap for 1996 Q3-2021 Q2.

[8]The policy horizon is usually given by 4-6 quarters, however, estimating such a distant horizon disproportionally increases the prediction error compared to the lower policy horizon. Thus, as suggested by Baxa et al. (2014), the policy horizon is set to 2.

[9]The backward transformation is computed as follows: $\overline{r} = \frac{\psi_{\overline{r}}}{(1-\rho)}$, $\xi_{\pi} = \frac{\psi_{\pi}}{(1-\rho)}$, $\xi_x = \frac{\psi_x}{(1-\rho)}$.

Table 4.2: Descriptive statistics of the subsampled data

1996Q1-2008Q4						
Statistic	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Interest rate	4.392	3.312	−0.3871	2.254	6.807	13.251
Inflation gap	−0.014	2.639	−4.387	−1.512	1.425	7.251
Output gap	0.003	0.381	−1.496	−0.147	0.125	1.402
Ex. rate gap	− 0.010	1.854	−4.879	−0.701	1.081	5.901
2009Q1-2021Q2						
Statistic	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Interest rate	1.790	1.074	0.100	0.657	2.620	3.645
Inflation gap	−0.116	1.341	−2.891	−1.343	0.794	4.129
Output gap	0.004	1.082	−6.383	−0.234	0.345	2.860
Ex. rate gap	− 0.044	0.845	−2.011	−0.526	0.330	2.678

Note: This table shows the difference between the descriptive statistics of the two subsamples of 1996 Q3 - 2008 Q4 and 2009 Q1 - 2021 Q2. Notice that except for the output gap, all variables are less volatile in the second period.

4.3.1 Short-term interest rate

To map the evolution of the changes in the policy rates of the Czech National Bank, I use time series from the OECD database on the short-term interest rate at which short-term (3-month) borrowings are effected between financial institutions or for which the short-term (3-month) government bonds are traded in the market. The values are computed as the averages of daily rates, measured in percentages. This variable is directly connected with the policy rates of the Central Bank, and as such, serves as a sufficient proxy for the censored policy rates of the Central Bank.[10] As empirically shown in Podpiera (2008), the censored pattern of the policy rates can bias the estimates as it does not always properly reflect the evolution in the economy.

Table 4.1 shows the descriptive statistics of this variable. Out of the used variables, it is the most volatile one (compare the standard deviations). Although the maximum value was measured as 13.25 %, the mean value was 3.116 %. The detailed evolution of this variable is shown and discussed in Chapter 5.

From Table 4.2 we see the comparison of the descriptive statistics of the two subperiods. Notice, that the mean value of the short-term interest rate decreased from 4.392 in the sample of 1996 Q3 - 2008 Q4 to 1.790 in the sample of 2009 Q1 - 2021 Q2. Also, the volatility of the short-term interest rate decreased as shown by the standard deviation. This means that the Czech National Bank managed to stabilize the interest rates at a lower level.

[10]The censored characteristic of the data is given by the limited meetings of the bank board over the year. The Czech National Bank board decides on the interest rates on the basis of eight regular meetings per year.

4.3.2 Inflation gap

The inflation gap is computed as the difference between inflation and the Czech National Bank's inflation target. I obtained the time series of inflation from the OECD database. The time series measures the changes in the consumer price index (CPI) on a period-to-period basis.

The inflation targets of the Czech National Bank are summarized in Table 4.3 below.

Table 4.3: Inflation targeting of the CNB

Year	CNB
1998	5.5 - 6.5 %
1999	4 - 5 %
2000	3.5 - 5.5 %
2001-2004	3 - 5 %
2005	2 - 4 %
2006-2009	3 %
2010-?	2 %

Note: The Czech National Bank implemented inflation targeting in 1998. Firstly, it used the announced interval as a targeted inflation level, since 2006 the inflation target is set as a constant.

I deduct the inflation target from the inflation level to get the inflation gap variable. Notice that before 1998, the Czech National Bank did not perform inflation targeting and had no inflation target. I treat the period of 1996 Q3 - 1997 Q4 as if the Central Bank had announced the inflation target as it did for 1998. This procedure should help to decrease the prediction error in the first periods where the 0 inflation target does not reflect the actual desires of the Czech National Bank over the inflation level. Also, for the periods of 1998 Q1 - 2005 Q4, the inflation target was set as an interval. For the purposes of the inflation gap computation, I proceed as if the Central Bank had set the inflation target as the mean value of these intervals.

As shown in Table 4.1, the inflation gap is the second most volatile variable (compare the standard errors). In contrast to the short-term interest rate, the inflation gap has not changed across the subsamples, however, its volatility decreased from 2.639 in the subsample 1996 Q3 - 2008 Q4 to 1.341 in the subsample 2009 Q1 - 2021 Q2, see the comparison of standard errors in Table 4.2. This suggests that the introduction of inflation targeting helped to stabilize the prices. The evolution of inflation and the inflation gap is discussed in detail in Chapter 5.

4.3.3 Output gap

The output gap is defined as the difference between the actual output and the potential (long-term) output of the economy. The output of the economy is given by the time series of the real gross domestic product. I use the time series

of seasonally adjusted real GDP from the ARAD database, computed by the expenditure approach and indexed to the reference period of 2015.

The time series on the output gap is computed applying Hodrick and Prescott (1997) filter on the real GDP time series.[11] To obtain the output gap as a percentage difference, I take a logarithm of the HP trend and deduct it from the logarithm of the real GDP.

Notice, that in the first subsample 1996 Q3 - 2008 Q4 the output gap was less volatile than in the second subsample 2009 Q1 - 2021 Q2 as shown in Table 4.2. This is caused mainly due to the financial crisis of 2007 that affected the Czech economy mainly between 2008 and 2013 and due to the Covid-19 production shutdowns, for details see the discussion in Chapter 5.

4.3.4 Exchange rate gap

In my specification of the Taylor rule, I aim to test whether the Czech National Bank takes into account the exchange rate when deciding about policy rate setting. An important question is how one should define the exchange rate gap. If the central bank has a fixed currency and sets an explicit exchange rate target then the problem is simple. In such a situation the target is deducted from the actual exchange rate and the resultant value is the exchange rate gap. Even in its period of exchange rate targeting in 1993-1997, the Czech National Bank did not state an explicit exchange rate target, but rather, a fluctuation range (see the analysis in Chapter 5).

In contrast, during the unconventional policy of foreign exchange intervention, the Czech National Bank targeted the CZK/EUR exchange rate to 27 CZK. Nevertheless, this policy did not mean that the interest rates will be affected by the exchange rate gap because the Czech National Bank aimed to keep low interest rates to promote inflation back to the targeted 2 % level. Therefore, it is not appropriate to choose some explicit target that would constitute the exchange rate gap.

I consider the best strategy to define the nominal exchange rate gap as the deviation of the exchange rate from the long-run trend as performed by Feldkircher et al. (2016).

The time series on the nominal CZK/EUR exchange rate is available at EUROSTAT.[12] Similarly as in the output gap derivations, one can use the Hodrick and Prescott (1997) filter to map the long-run trend of the exchange rate gap. Note that I deduct the logarithm of the estimated exchange rate trend from the logarithm of the actual exchange rate to get the exchange rate gap as the % deviation.

In contrast with the volatility of the output gap in the two analysed subsamples, the volatility of the exchange rate was considerably higher in the first subsample period of 1996 Q3 - 2008 Q4 as depicted in Table 4.2. The higher volatility was caused by many factors one of them being the exchange rate speculations on the Czech Koruna in 1997.

[11] See the Appendix, equation A.1.

[12] In the years before the implementation of EURO, the exchange rate is weighted by the ECU unit.

4.4 Results and discussion

Table 4.4 below shows the GMM estimations results of a model derived in equation 4.18. The estimations are performed on four samples. The validity of the t-tests is secured by using the heteroskedasticity autocorrelation consistent (HAC) covariance matrix of Newey and West (1987).

As shown in Table 4.4, at the 95 % significance level, for all four samples, the weight on the exchange rate gap and the output gap are insignificant which implies that the Czech National Bank follows its constitutional duty of maintaining price stability and the secondary targets are of interest only when the primary target is achieved. This is in line with Horváth (2006, 2009) who finds the weight on the output gap to be insignificant in most of his specifications. Also, Mackiewicz-Łyziak (2016) estimates the weight on the output gap and the weight on the exchange rate insignificant in most of her specifications. Similarly, Frömmel and Schobert (2006); Frömmel et al. (2011) who analyzed structural breaks in the Taylor rule did not find the weight on the exchange rate and on the output gap to be significant. In contrast, Petreski (2011) finds that before the monetary policy switches the weight on the exchange rate was significant, although the weight on the output gap was estimated also insignificant. Finally, Feldkircher et al. (2016) also finds insignificant results for the weights on the exchange rate and output gap.

J-statistic shows that the selection of the $t-1$ and $t-2$ lagged variables of inflation gap, output gap and the exchange rate gap and the $t-2$ and $t-3$ lagged variables of the interest rate is exogenous, and thus, these variables serve as valid instruments.

The first estimation (1) is performed on the whole data range of 1996 Q3 - 2021 Q2. The model predicts the data generating process of the interest rate quite well, see Figure A.1 in Appendix. The second estimation (2) is taken only on the first subsample of 1996 Q3 - 2008 Q4 and the model is also quite sufficient, see Figure A.2 in Appendix. In contrast, the unsystematic shock to key variables caused by the production shutdowns directed by the government to fight the Covid-19 pandemic seriously harms the predictions of the model (3), which is estimated on the subsample of 2009 Q1 - 2021 Q2. Notice how poorly the model predicts the data generating process in Figure A.3 in Appendix. This problem would not be that serious if I would have more data after the 2020 crisis. A possible solution to getting valid estimates is to omit the 2020 Q1 - 2021 Q2 period which is performed in the model (4) where only the subsample of 2009 Q1 - 2019 Q4 is subject to estimation.

The estimated smoothing parameter ρ is quite large which suggests that the Czech National Bank conducts the changes in the policy rates rather smoothly. Similar values are estimated in Horváth (2006); Petreski (2011); Feldkircher et al. (2016); Mackiewicz-Łyziak (2016). As shown in Horváth (2009), when the policy-neutral rate is estimated time-variably then the coefficient of the smoothing parameter drops to much lower values of approx 0.4.[13] For the first subsample, the parameter is considerably higher (model (2)) which shows that the Czech

[13]The high values of the smoothing parameter are discussed in detail in Rudebusch (2005) who analyzes why the estimators estimate the parameter to be quite high when in fact the policy inertia is not that high.

National Bank decreased the smoothing behaviour in the period of 2009 Q1 - 2019 Q4 (model (4)).

The policy-neutral rate $\overline{r}$ - denoting the long-run equilibrium of nominal interest rate - significantly decreased between the two subperiods from 5.947 % in the subsample 1996 Q3 - 2008 Q4 to 1.241 % in the subsample 2009 Q1 - 2019 Q4. This decrease is partly caused by the decrease in inflation and partly due to an overall increase in the money supply in the EU. A gradual decrease in the policy-neutral rate was also estimated by Horváth (2006, 2009). His estimates of the policy-neutral rate are close to those for the first subsample. In Petreski (2011), the policy-neutral rate for his first subsample 1994 M4 - 1999 M2 is close to ours; in contrast, in his second subsample, his estimate of the policy-neutral rate is insignificant.[14] Mackiewicz-Łyziak (2016) estimates of the policy-neutral rate are very low in all of her specifications close to zero for the sample of 1998 Q1 to 2014 Q2. Such estimates are much lower than ours and of Horváth (2006, 2009).

The Czech National Bank's weight on inflation gap ξ_π decreased from the value of 2.638 in the first subsample of 1996 Q3 to 0.468 in the second subsample of 2009 Q1 - 2019 Q4. Hence, the Czech National bank reacted to the observed inflation gap by changing the interest rate less firmly than in the first subsample. Without further analysis, it would seem as if the Central Bank started to be less precise in maintaining price stability but it is not the case as the prices remained stable in spite of lower weight on the inflation gap, see the discussion in Chapter 5. The main reason for the decrease in this parameter is caused by successfully anchored inflation expectations in the Czech economy.[15] This finding is in line with the empirical literature on the evolution of inflation expectations in the Czech Republic, see Horvath et al. (2008); Sousa and Yetman (2016). In comparison with Horváth (2006, 2009); Petreski (2011); Feldkircher et al. (2016); Mackiewicz-Łyziak (2016), I estimated relatively higher values of this parameter.

[14] This result is quite strange as it suggests that the central bank did not set the interest rates according to the natural interest rate at all.

[15] Similar explanation of a decrease in this parameter is provided in Benati (2008); Zhang et al. (2008); Baxa et al. (2014).

Table 4.4: GMM estimation results (HAC robust)

	Dependent variable:			
	Interest rate			
	(1)	(2)	(3)	(4)
ρ	0.831^{***}	0.877^{***}	0.756^{***}	0.609^{***}
	(0.073)	(0.036)	(0.121)	(0.133)
$\overline{r}$	5.414^{***}	5.947^{***}	0.717^{*}	1.241^{***}
	(1.609)	(1.306)	(0.394)	(0.151)
ξ_π	1.974^{***}	2.638^{***}	0.209	0.468^{***}
	(0.422)	(0.635)	(0.156)	(0.148)
ξ_x	-2.348	-1.620	-1.689	-0.057
	(2.415)	(4.421)	(1.221)	(0.176)
$\xi_\mathcal{E}$	0.247	0.437	0.451	-0.193
	(0.514)	(1.310)	(0.620)	(0.322)
Observations	100	50	50	44
R^2	0.925	0.925	0.392	0.873
Adjusted R^2	0.922	0.920	0.338	0.860
Residual Std. Error	1.176	1.364	0.574	0.264
J-statistic	2.364	2.781	1.251	2.201
Prob(J-statistic)	0.500	0.427	0.741	0.532

*p<0.1; **p<0.05; ***p<0.01

Note: (1) Estimation results for the whole data range 1996 Q3 - 2021 Q2; (2) Estimation results of subsample 1996 Q3 - 2008 Q4; (3) Estimation results of subsample Q1 2009 - Q2 2021, inconsistent due to Covid-19 unsystematic crisis; (4) Estimation results of subsample 2009 Q1 - 2019 Q4.

5. Analysis and discussion of the Czech National Bank's monetary policy

In this chapter, I provide an analysis of the Czech National Bank's monetary policy decisions. I divide the periods according to important changes which could affect the Czech National Bank's implementation of monetary policy. These changes include: the switch from exchange rate targeting to inflation targeting in December 1997; the implementation of the QPM model as the main prediction model in 2002; the replacement of the QPM model by the modern DSGE model g3 in 2008; the introduction of the foreign exchange interventions in 2013; the end of the foreign exchange interventions in 2017; and the update of the prediction model to g3+ version in 2019. In addition, I provide a short history of the Czech National Bank's predecessors.

5.1 Predecessors of the Czech National Bank

The Czechoslovak Republic gained its independence from Austria-Hungary in 28$^{\text{th}}$ October 1918. Having independence, many problems of the newly constituted state remained unsolved, including the establishment of the institution holding the authority over the monetary policy. The Czechoslovak Republic kept the institutions of the Austria-Hungary empire and the main monetary authority remained the Austrian-Hungarian Bank.

The Austrian-Hungarian Bank had its headquarters in Wien and Budapest. After 1918, the Czechoslovak Republic demanded representation in the general banking board of the Austrian-Hungarian Bank and the establishment of headquarter in its territory which was proceeded on December 2, 1918. Nevertheless, the independent monetary authority was not created until the government enacted Directive No. 119/1919 Coll. that establishes the Banking Office of the Ministery of Finance. Meanwhile by Act No. 84/1919 Coll., the currency reform came into force.

The Banking Office of the Ministry of Finance served as the state's bank. In 1920, it took over the administration of the foreign exchange policy.

The establishment of independent monetary authority had been prepared since 1920 when Act No. 347/1920 Coll. was enacted which prepared the ground for the National Bank of Czechoslovakia. However, the constituent sitting was performed later in 1926 when the first banking board was appointed which officially declared the creation of the Bank since 21$^{\text{st}}$ March 1926.

The National Bank of Czechoslovakia had a legal form of a joint-stock company and two-thirds of its capital of 12 million gold dollars was held by private investors and one-third by the state. Its main purpose was to secure currency and perform free market operations. Similarly to today, the Central Bank's credits to the government were forbidden.

In September 1938, after the Munich Agreement, the Central Bank's name was changed to the Czech-Slovak National Bank by the government's Directive

No. 16/1939 Coll. in response to secure more rights for the nationalities of Slovaks and Rusyns.

With the occupation of Nazi Germany on March 15, 1939, the Central Bank authorities were deposed by the German Reichsbank's representatives who transferred the gold monetary reserves to the Reichsbank. In response to the announcement of the Protectorate of the Bohemia and Moravia, the Central Bank changed its name to the National Bank for Bohemia and Moravia. Although the Central Bank was controlled by Nazi Germany, the Czech representatives played an important role when they resisted the idea of the customs union of the Protectorate with the German Reich. Meanwhile, the government in exile entrusted the monetary and financial policy to the Czechoslovak Monetary Office by the president's Decree No. 16/1944 Official Journal which was subordinate to the ministry of finance in exile. The Office's mandate ended in May 1945 with the end of WW2.

After the reunion of Czechoslovakia in May 1945, in the country, two separated monetary territories remained - Czech and Slovak. Both of them had their own monetary authority. Factically, Czechoslovakia had two Central Banks which were joined into the Czechoslovak National Bank by the president's Decree No. 139/1945 Coll. In 1948 the parliament enacted Act No. 38/1948 Coll. which changed the Central Bank's legal form into a public state office and which restored the banking board. Although the Governor and Vice-Governors were still appointed by the President, the rest of the board was chosen by the Government based on the Ministry of Finance's proposal. Thus, the independence requirements for the modern central bank were seriously violated.

The socialistic ideology in Czechoslovakia changed the banking industry completely when the Central Bank became a *monobank* covering the monetary policy and replacing all commercial banks. This change was amended in Act No. 31/1950 Coll. on the Czechoslovak State Bank. Also, the Central Bank completely lost its independence and became subordinated to the Ministry of Finance, which held the option of appointing and appealing the General Director of the Central Bank.[1]

The Czechoslovak State Bank was given the authority over the money supply, ensuring the payment settlements, providing credits, administrating the foreign exchange reserves and control over the subjects in the economy. The exemption to the *monobank* system was the establishment of the Czechoslovak Commercial Bank in 1964.

In 1989, the *monobanking* system was repealed by Act No. 130/1989 Coll. and Act No. 158/1989 Coll. The Czechoslovak State Bank lost the mandate for commercial banking which was given back to private subjects. Also, the Central Bank regained its independence as the Bank's chairman was appointed by the President based on the recommendation of the Government.[2] Furthermore, the position of the advisory team of the Central Bank's chairman was changed into the reappointed banking board based on the Constitutional Act No. 556/1990 Coll.

[1] A gain in independence was achieved in 1965 when the General Director gained the similar power as a minister and was present in the government's dealings.

[2] Notice, however, that the independence was not codified until 1992 when Act No. 22/1992 Coll. came into force.

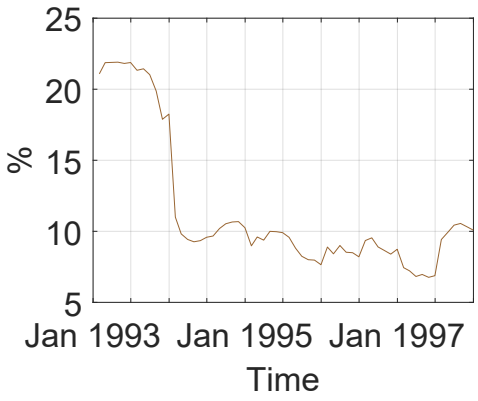
In 1992, the Czech and Slovak politicians agreed upon the dissolution of the joint federate state and the Czechoslovak State Bank prepared for the separation. The Constitutional Act No. 439/1992 Coll. allowed the future separated states to create their own central banks. Based on this Act, the Czech National Bank was created on December 17, 1992 by the Act. No. 6/1993 Coll. Although in 1993 the newly created Central Banks began their activities, the countries still had the same currency which was separated in February 1993 when the Czech Koruna was introduced.

Nowadays, the existence and independence of the Czech National Bank are amended by Article 98 of the Constitution. The role of the Central Bank is then further codified by Act No. 6/1993 Coll. on the Czech National Bank.

5.2 1993-1997

At the beginning of this period, the Czech National Bank faced relatively high inflation of approximately 20 %, which was caused by the transformation process from a centrally planned to a free-market economy. The main source of the prices increase was the liberalization of the prices that were directively determined by the government before 1990. Compared to the inflation level in the 2000s and 2010s discussed later, inflation remained relatively high around the 8 % level after 1994, see Figure 5.1 below.

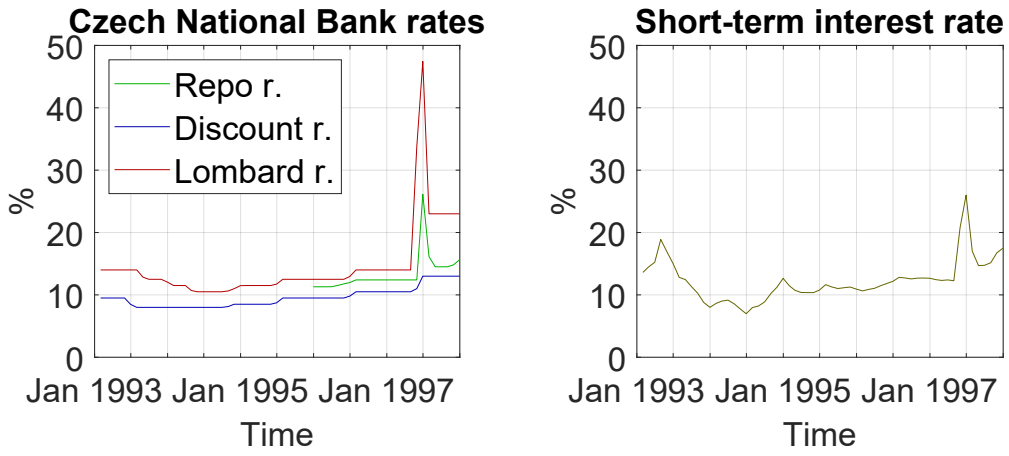
Figure 5.1: Inflation in January 1993 - December 1997 (data source: OECD)



Note: This Figure shows the evolution of inflation in the Czech Republic from January 1993 to December 1997. Except for 1993 and 1994, inflation fluctuated around 8 % level.

The nominal short-term interest rates and the policy rates of the Czech National Bank reflected this high inflation and with the exemption of 1997, the repo rate and the short-term interest rates fluctuated around approximately 12 % level, see Figure 5.2. Notice that the central bank started to use its main policy rate - the repo rate - in December 1995. The reason for the unprecedented increase in policy rates in 1997 was caused by speculations on the Czech Koruna discussed later.

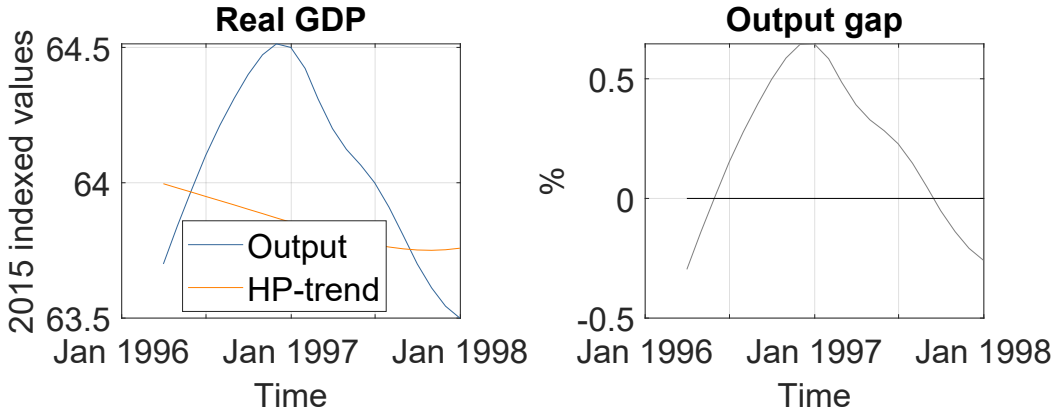
Figure 5.2: Interest rates in January 1993 - December 1997 (data source: ARAD, OECD)



Note: This Figure shows the evolution of the Czech National Bank's policy rates (left graph) and the evolution of the monthly average of short-term interest rates (right graph) from January 1993 to December 1997. Except for 1997, the repo rate and the short-term interest rates fluctuated around 12 % level.

As shown in Figure 5.3, the real GDP grew until the Czech National Bank introduced the minimum reserve requirements in July 1996 (see Figure 1.3), which decreased the money supply growth and restricted the amount of credits. The fall in domestic production was magnified when the Czech National Bank started to increase the main policy rates to fight the speculations on the Czech Koruna in 1997. An increase in the interest rates restricted the economic activity of agents through the exchange rate transmission channel.

Figure 5.3: Output and output gap in March 1996 - December 1997 (quarterly data source: ARAD, monthly data source: own processes)

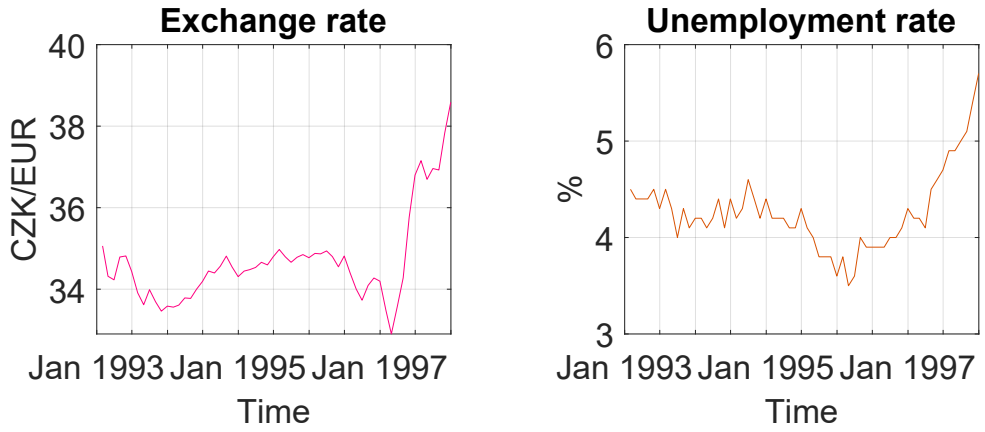


Note: This Figure shows the evolution of the output and potential output (left graph) and the evolution of the output gap (right graph) from March 1996 to December 1997. The data are in real terms with respect to the 2015 reference year. In 1996 the economy grew but then the output dropped due to the restrictive policy of the Czech National Bank. The quarterly data obtained from the ARAD database is interpolated into monthly data using cubic splines.[3]

[3]The interpolation method is described in the Appendix, Section A.3.

The restrictive monetary policy and the resultant decrease in production led to higher unemployment as depicted in 5.4. Before the exchange rate speculations on the Czech Koruna and the resultant crisis in 1997, the unemployment rate fluctuated around approximately 4.3 % level.

Figure 5.4: Exchange rate and unemployment in January 1993 - December 1997 (data source: EUROSTAT, OECD)



Note: This Figure shows the evolution of the CZK/EUR exchange rate (left graph) and the evolution of unemployment (right graph) from January 1993 to December 1997. The exchange rate fluctuated around approx. 35 CZK/EUR level. When the Czech Koruna became freely convertible, the Czech currency appreciated. Later it faced a massive capital outflow connected with a depreciation of the currency.

From 1993 to 1997, the main target of the Czech National Bank was to maintain internal and external currency stability. The monetary policy was performed mainly through the exchange rate transmission mechanism. The most important instruments that the Czech National Bank used were the money aggregate M2 and the foreign exchange interventions as the Central Bank committed itself to maintain the changes of the exchange rate in the bounds of $\pm 0.5\%$ from the central parity.

Since October 1995, the Czech Koruna became a freely convertible currency on the international markets. Due to an interest rate differential, the Czech Koruna was demanded by many investors and appreciated from approx. 35 CZK/EUR to approx. 33 CZK/EUR as shown in Figure 5.4. In response to appreciation pressures in 1996, the Czech National Bank increased the tolerated fluctuation bounds to $\pm 7.5\%$.

The bad state of the Czech economy at the beginning of 1997 led to a decrease in the trust of the investors in its performance which resulted in a massive capital outflow. As the investors sought to transfer their Koruna assets into foreign assets, the currency depreciated up to the level of approx. 38 CZK/EUR. The crisis was magnified by the speculative motives of some investors. The response of the Czech National Bank were foreign exchange interventions and an unprecedented increase in the policy rates by which the Central Bank wanted to create an interest rate differential which should bait the investors to keep their assets in the Czech Koruna. The effort of the Czech National Bank was, however, unsuccessful and the fixed exchange rate regime was replaced by the floating.

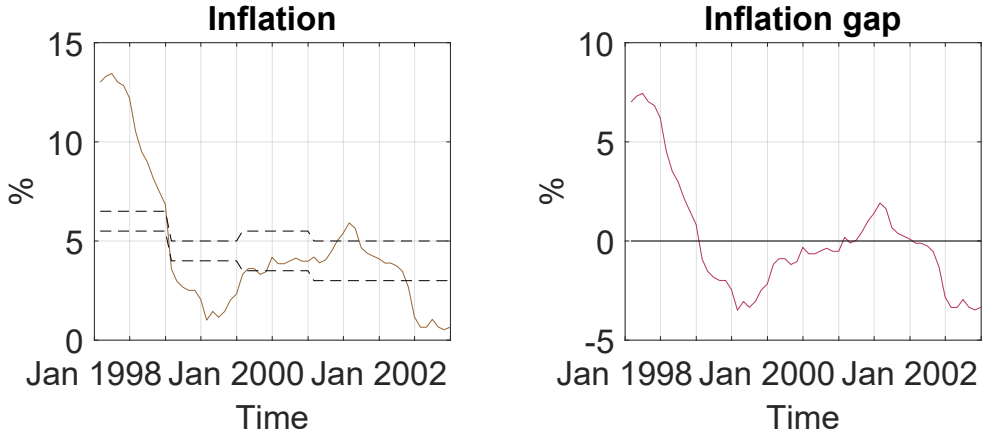
By switching the exchange rate regime, the Czech National Bank lost its main leverage on inflation which was earlier given by the fixed exchange rate. Abandoning the exchange rate targeting policy rule, the Czech National Bank had to choose between money growth targeting and inflation targeting if it did not want to act discretionary. Following the modern monetary policy trends, the bank board switched its main policy rule to inflation targeting in December 1997.

While losing the exchange rate targeting policy the Czech National Bank's governor, Mr Tošovský who became the prime minister of the Czech Republic left his office to Mr Kysilka to perform the governorship in his absence.

5.3 1998-2002

The depreciation of the exchange rate connected with the currency crisis and the changes in the legislation of prices regulation and the indirect taxes led to a *cost-push* inflation. Due to a higher cost, the firms increased the prices of their product and inflation increased from a 10 % level in December 1997 to approx. 13 % at the beginning of 1998, see Figure 5.5.

Figure 5.5: Inflation and inflation gap in January 1998 - December 2002 (data source: OECD, ARAD)



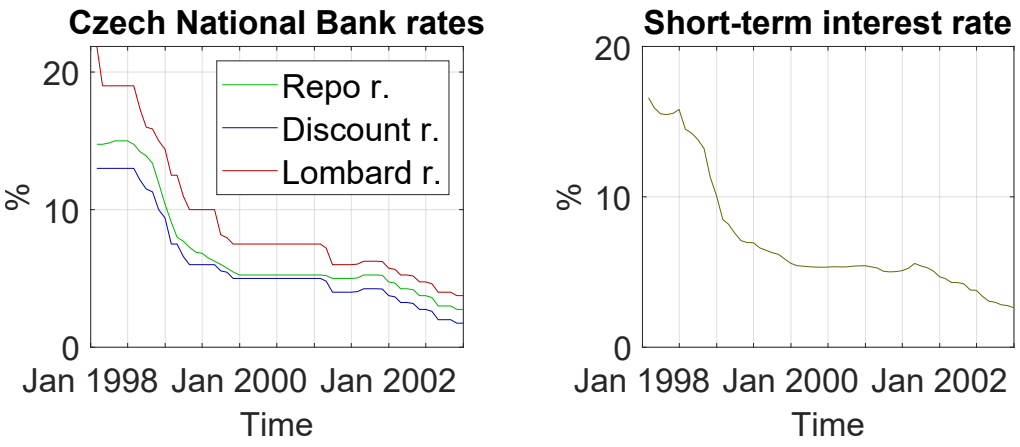
Note: This Figure shows the evolution of inflation (left graph) and the inflation gap computed as the difference between inflation and inflation target of the Czech National Bank (right graph) in the Czech Republic from January 1998 to December 2002. In the left graph on inflation, the dashed lines show the target intervals of the Czech National Bank. Notice that in this period, inflation was relatively volatile. Only in 2000 and 2001, the Czech National Bank was successful in maintaining inflation in the targeted interval.

The Czech National Bank managed to decrease inflation to the target of 5.5 - 6.5 % in December 1998. The Central Bank's policy over inflation was unsuccessful as the inflation fell far below the inflation target of 4 - 5 % in 1999. In July 1998 the bank board decided to start decreasing the interest rate as it faced a negative inflation gap at the $t+12$ (July 1999) monetary policy horizon. The decrease in interest rates, however, should have been much more severe and should have been performed earlier as inflation decreased to low values of approx. 2 % in the summer of 1999. As estimated in Chapter 4, the Czech National Bank had

quite a large preference for interest rate smoothing which explains the graduality of changes in the policy rates. This drop in inflation was caused by many factors, one of them being lower risk premium and lower inflation expectations (Czech National Bank, 1998).

Furthermore, in 2000 and 2001, the Czech National Bank was quite successful in keeping inflation within the targeted interval. Later, in the second half of 2002, inflation fell to low values below 1 %. It is relevant to analyse the Czech National Bank's predictions of inflation in the summer of 2001. The bank board expected the breakdown point in the summer of 2002 but expected that the inflation will return to the targeted interval (Czech National Bank, 2001), which did not happen. Thus, the Central Bank's predictions were inaccurate and it should decrease interest rates rather than increase them to promote inflation back to the target. Notice, however, that the Central Bank started decreasing the interest rates at the beginning of 2002 realizing disinflationary pressures, see Figure 5.6.

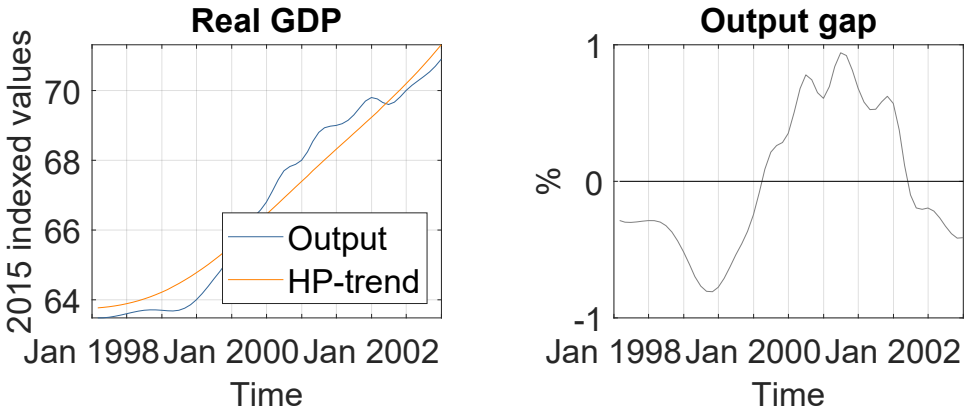
Figure 5.6: Interest rates in January 1998 - December 2002 (data source: ARAD, OECD)



Note: This Figure shows the evolution of the Czech National Bank's policy rates (left graph) and the evolution of the monthly average of short-term interest rates (right graph) from January 1998 to December 2002. This period is connected with the gradual decrease of the policy rates. For example, the repo rate decreased from approx. 15 % in 1998 to approx. 3 % in 2002.

After the 1997 currency crisis, the Czech economy enjoyed quite stable economic growth, see Figure 5.7 below.

Figure 5.7: Output and output gap in January 1998 - December 2002 (quarterly data source: ARAD, monthly data source: own processes)



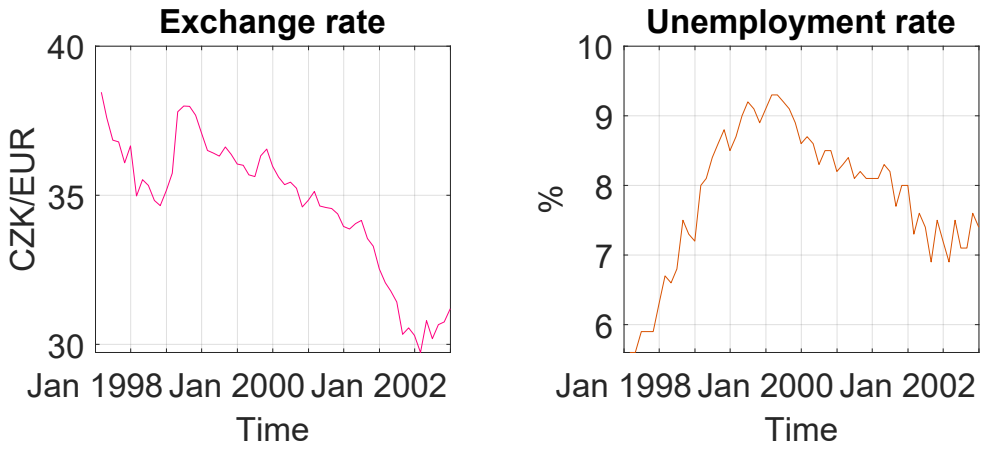
Note: This Figure shows the evolution of the output and potential output (left graph) and the evolution of the output gap (right graph) from January 1998 to December 2002. The data are in real terms with respect to the 2015 reference year. In this period, the Czech economy grew in its potential and real production. The quarterly data obtained from the ARAD database is interpolated into monthly data using cubic splines.[4]

After the depreciation of the Czech Koruna caused by the capital outflow and exchange rate speculations, the exchange rate remained quite volatile, see Figure 5.8. The fast appreciation of the Czech Koruna was noticed by the bank board which decided to intervene as it did not find a relevant cause for such a fast increase and expected that this appreciation overrates the true market value of the Czech Koruna. It decided to intervene to depreciate the currency (Czech National Bank, 1999).

The gradual appreciation of the Czech Koruna from the second half of 1999 was caused mainly due to another wave of privatization in the Czech Republic where the majority of financial institutions were bought by foreign investors. Also, observing the steady growth of the Czech economy from the second half of 1999, many investors regained their belief in the Czech economy and increased investments in Czech assets for which they demanded Czech Koruna. As a result, the Czech Koruna fastly appreciated, especially in 2002. The high volatility of the exchange rate was of concern to the bank board which decided to perform foreign exchange interventions to decrease the pace of the appreciation in January 2002. This intervention, however, had only a small effect as depicted in Figure 5.8. Furthermore, the bank board decided to repeat this strategy again from July 2002 to September 2002 which finally helped to stop the appreciation. As a result of these events, Czech Koruna appreciated from approx. 37.5 CZK/EUR in the second half of 1999 to approx. 32 CZK/EUR in December 2002.

[4]The interpolation method is described in the Appendix, Section A.3.

Figure 5.8: Exchange rate and unemployment in January 1998 - December 2002 (data source: EUROSTAT, OECD)



Note: This Figure shows the evolution of the CZK/EUR exchange rate (left graph) and the evolution of unemployment (right graph) from January 1998 to December 2002. In this period, the exchange rate appreciated to approx. 32 CZK/EUR. Unemployment firstly rapidly increased to 9 % and then decreased to lower values of approx. 7.5 %.

One of the problems of the Czech economy after the currency crisis was the disproportionality between the real wages, which grew and the output of the economy which stagnated in 1998 and 1999. For the higher real wages, firms hired fewer workers and unemployment increased from approx. 6 % in January 1998 to approx. 9 % in January 2000. To satisfy an increased demand caused by the lower interest rates, firms started to hire more workers and unemployment decreased to approx. 7.5 % in 2001.

During the 1998-2002 period, Mr Kysilka held the governor's office in Mr Tošovský's stead until 23.7.1998. Mr Tošovský then continued in his term until 31.11.2000 when Mr Tůma succeeded him. In contrast to Judd et al. (1998), Clarida et al. (2000), Orphanides (2004) who studied Fed's chairmen, we do not observe clear changes in the performance of the monetary policy by the Czech National Bank caused by the personal changes of the governors.

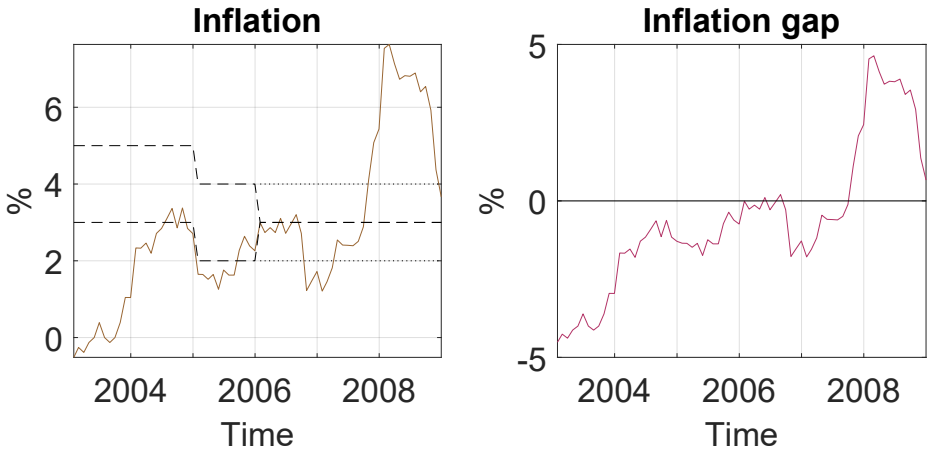
Finally, the Czech National Bank started to use the semi-structural quarterly prediction QPM model in 2002. I will discuss its possible effects on the behaviour of the Czech National Bank in the period 2003-2008.

5.4 2003-2008

At the beginning of this period, the Czech National Bank faced very low inflation (in some periods even deflation) far below the inflation target for 2001-2004 of 3-5 %, see the graph on the inflation gap in Figure 5.9. According to the bank board, this decrease in inflation was caused by many factors, mainly by low foreign demand for domestic goods (caused by the appreciation of the Czech Koruna), technological progress and other external disinflationary pressures (Czech National Bank, 2002). To increase inflation in 2003, the Czech National Bank repeatedly decreased the policy rates in 2002 (see Figure 5.6) and performed foreign exchange interventions to promote foreign demand for domestic goods. The

question is whether the Czech National Bank should have decreased the policy rates more than it did to promote inflation more fastly. As noted, the preference of the Czech National Bank over the smooth changes in the interest rate was estimated quite large for the period 1996-2008, see Section 4.4. This smoothing preference can be one of the reasons why the bank board did not react more severely.

Figure 5.9: Inflation and inflation gap in January 2003 - December 2008 (data source: OECD, ARAD)



Note: This Figure shows the evolution of inflation (left graph) and the inflation gap computed as the difference between inflation and the inflation target of the Czech National Bank (right graph) in the Czech Republic from January 2003 to December 2008. In the left graph on inflation, the dashed lines show the target intervals of the Czech National Bank. Since 2006 the target was announced as a constant of 3 % with the tolerated range of inflation gap $\pm$ 1 % (in graph depicted by dotted line). In this period, the Czech National Bank faced low inflation below the target in 2003. From 2004 to the autumn of 2007 the Czech National Bank relatively successfully kept inflation around the target or close to the tolerated range. Nevertheless, in 2008 inflation increased far above the target.

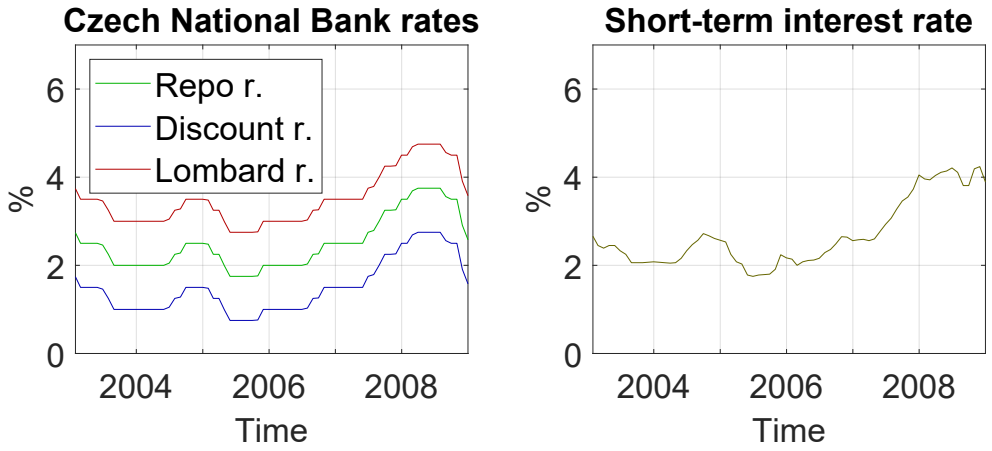
The continuing gradual decrease in the interest rates (see Figure 5.10) in the first half of 2003 and stabilized exchange rate (see Figure 5.12) brought an increase in inflation since autumn 2003. The Czech National Bank quite correctly anticipated that the inflation will return to the inflation target and from July 2003 stopped decreasing the policy rates.

In the period 2004 - autumn 2007, the inflation targeting policy of the Czech National Bank was quite successful in maintaining inflation on its target or in the tolerated range (in Figure 5.9 denoted by the dotted line).

In contrast, in 2008, inflation got far above the inflation target. The fast increase in inflation was caused by many factors. The most important factor was a worldwide overheating of economies where the output was above its potential, see 5.11. The bank board marked the increasing prices of food, energy and indirect taxes to be the main source of an increase in inflation. All members of the bank board, however, agreed that the increase in inflation in 2008 will be only temporary and that it should not be reflected by vigorous changes in the policy rates (Czech National Bank, 2007). Instead, the Central Bank decided to gradually increase the policy rates to decrease inflation back to the target. At the beginning of 2008, in response to the monetary policy of the Czech National

Bank, inflation started to decrease. The unexpected fast decrease in inflation came after the bankruptcy of Lehman Brothers in September 2008. The bank board anticipated that the fast global disinflation will spill over to the Czech economy and started decreasing the policy rates to prevent a negative inflation gap at the policy horizon (Czech National Bank, 2008b).

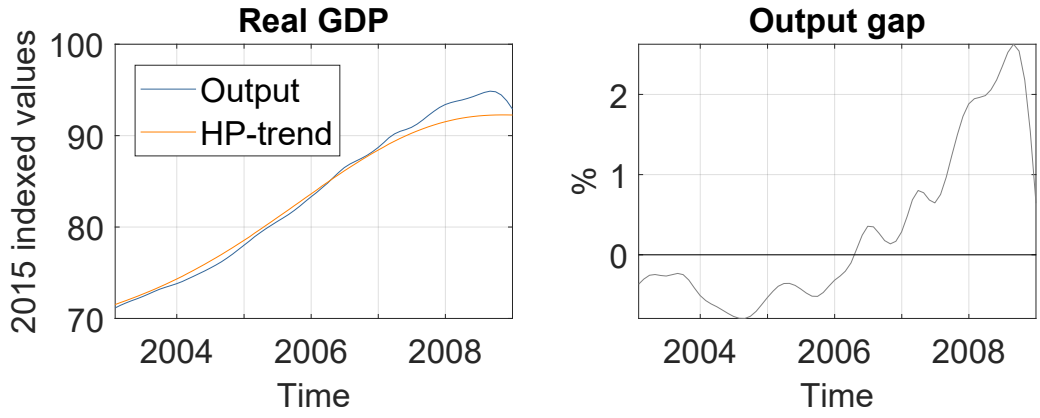
Figure 5.10: Interest rates in January 2003 - December 2008 (data source: ARAD, OECD)



Note: This Figure shows the evolution of the Czech National Bank's policy rates (left graph) and the evolution of the monthly average of short-term interest rates (right graph) from January 2003 to December 2008. In this period the policy rates did not change much. In the second half of 2007, the Czech National Bank increased the policy rates to limit increasing inflation. After the bankruptcy of Lehman Brothers, it started decreasing the policy rates to promote low inflation at the policy horizon.

In the period 2003-2008, the economy followed the growth observed in 1998-2002 (see Figure 5.7). The economy performed close to its potential until 2007 when the economy started to overheat and the output gap increased, see Figure 5.11. Production started to decrease after the bankruptcy of the Lehman Brothers in 2008 when the Great Recession emerged and when the foreign decrease in economic performance spilt over to the Czech economy.

Figure 5.11: Output and output gap in January 2003 - December 2008 (quarterly data source: ARAD, monthly data source: own processes)

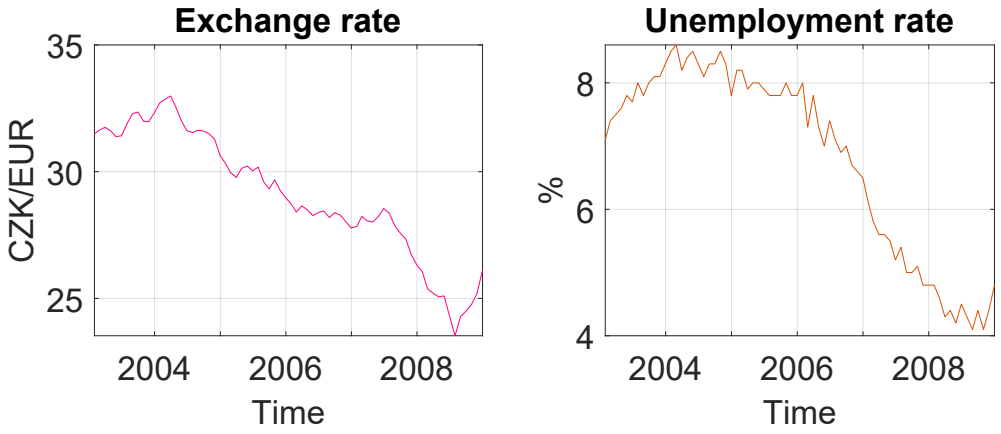


Note: This Figure shows the evolution of the output and potential output (left graph) and the evolution of the output gap (right graph) from January 2003 to December 2008. The data are in real terms with respect to the 2015 reference year. In this period, the Czech economy's production potential and actual production grew. The quarterly data obtained from the ARAD database is interpolated into monthly data using cubic splines.[5]

The foreign exchange interventions performed in 2002 helped to stabilize the exchange rate at approx. 32 CZK/EUR in 2003 and 2004. In the rest of the period, the exchange rate strongly appreciated to the historically minimum level of 23.05 CZK/EUR, see Figure 5.12. The appreciation was caused by stable economic growth which enticed foreign investments to Czech assets and by the growing foreign demand for domestic goods as well as by the convergence of the Czech economy to the Eurozone level. The first two of these factors worked in the opposite way and depreciated currency when the economic crisis emerged after the bankruptcy of Lehman Brothers in September 2008. The depreciation helped Czech firms to be internationally more competitive because with the depreciation the domestic goods became relatively cheaper the foreign consumers.

[5]The interpolation method is described in the Appendix, Section A.3.

Figure 5.12: Exchange rate and unemployment in January 2003 - December 2008 (data source: EUROSTAT, OECD)



Note: This Figure shows the evolution of the CZK/EUR exchange rate (left graph) and the evolution of unemployment (right graph) from January 2003 to December 2008. In this period, the exchange rate appreciated to approx. 25 CZK/EUR. Unemployment firstly remained around 8 % level in 2003-2005 and then decreased to approx. 4.3 %.

Although the GDP grew in the period of 2003-2008, unemployment remained at approx. 8 % level in 2003-2005, see Figure 5.12. The decrease in unemployment was caused by many factors, one of them being the growth in real wages in 2006 and 2007.

It is hard to evaluate the effect of the QPM model introduced in 2002 on the validity of predictions of the Czech National Bank. Nevertheless, in comparison with the previous period of 1998-2002, the predictions of the Czech National Bank were more accurate except for the 2008 crisis which could have been hardly mapped by any model. Therefore, the QPM could have improved the Central Bank's predictions. In 2008 the QPM was replaced by the modern DSGE model g3 which is derived from the microeconomic basis and as such is resistant to Lucas (1976) critique. I will evaluate the predictions of the model in the next period.

Notice, that in this period, the Governor's mandate was held by Mr Tůma who remained the Governor until June 2010. Hence we can not discuss possible changes in the monetary policy due to the personal changes in the governor's chair.

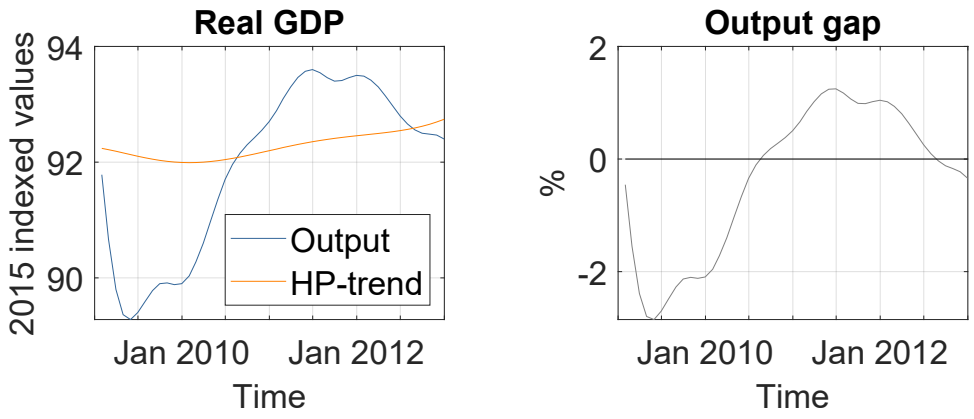
5.5 2009-2012

During this period, the Czech economy faced the majority of the consequences of the crisis which emerged in 2008. The predictions of the bank board from the meeting in November 2007 were correct as the high inflation in 2008 was only temporary. In fact, due to the decrease in energy prices, the decrease in foreign demand for domestic goods and because the foreign investors pulled their investments in Czech assets back, the inflation decreased even below the tolerance bounds depicted in Figure 5.13 by the dotted line.

The bank board expected that the inflation will decrease in 2009 and continued decreasing the interest rates to promote inflation back to the targeted level (Czech

National Bank, 2008a). Once again the question is whether the evolution of prices needed a more severe decrease in interest rates. As noted, for the data range of 2009 - 2019, I estimated that the smoothing preference of the Czech National Bank was significant yet lower than in 1996 - 2008, see Section 4.4. This is in line with the fact that the bank board did not want to change the interest rate unsmoothly.

Figure 5.13: Inflation and inflation gap in January 2009 - December 2012 (data source: OECD, ARAD)



Note: This Figure shows the evolution of inflation (left graph) and the inflation gap computed as the difference between inflation and the inflation target of the Czech National Bank (right graph) in the Czech Republic from January 2009 to December 2011. In the left graph on inflation, the dashed line shows the inflation target of the Czech National Bank and the dotted lines the tolerance bounds. In this period, inflation was relatively stable in comparison with the previous periods and for most of this period, it remained in the tolerated range.

The evolution of inflation in the second half of 2009 and 2010 was well predicted by the bank board as it expected that inflation will decrease to close-to-zero value in 2009 and in 2010 will converge to the targeted level of 2 %, if the bank board continues in decreasing the policy rates, see Czech National Bank (2009c) and Figure 5.14. An increase in inflation was pulled mainly by increases in the prices of food and energies. The bank board stopped changing the policy rates in the summer of 2010 as it had inflation at the targeted level of 2 % at the policy horizon.

After the third prognosis of the analytic team of the Czech National Bank, in August 2011, the bank board faced a decision on whether to increase interest rates or not. In favour of this increase was the expected increase in inflation in the monetary policy horizon slightly above the 3 % level. Although the bank board decided to remain the policy rates unchanged, some members of the bank board suggested that the Central Bank should reflect the inflationary pressures and increase the policy rates. Also, the bank board discussed that low interest rates in the long term can jeopardise financial stability in the future. However, the majority of the bank board decided not to change the policy rates (Czech National Bank, 2011).

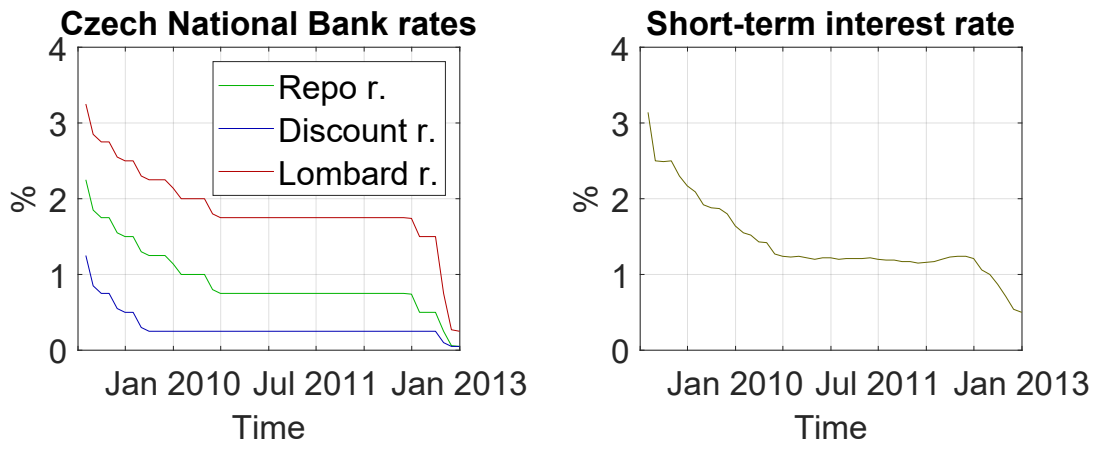
In this decision, the bank board could react differently than when it previously faced a positive inflation gap at the policy horizon. The decision of the majority

of the bank board could have been affected by the public and political pressures as it seems that the bank board members reflected the evolution of the exchange rate which fastly appreciated (see Figure 5.16) or low GDP compared to the pre-crisis period (see Figure 5.15 and compare it with Figure 5.11).[6]

The evolution of inflation at the end of 2012 and the expected inflation in 2013 forced the bank board to decrease the policy rates to historically lowest values (called *technically zero values*). The prediction of the bank board that inflation in 2013 will decrease to the lower bound of the tolerated range was accurate. Also, the prediction that it will decrease below the lower bound in 2014 was accurate (see the discussion in Section 5.6). At the November 2012 meeting, the bank board also committed itself to keep the policy rates at these low levels until the inflationary pressures rise again (Czech National Bank, 2012). The main cause of a decrease in inflation was the drop in aggregate demand due to the bad state of the economy after the crisis.[7]

Notice that this drop in the policy rates was not completely transmitted to the short-term interest rates in the financial market as depicted in Figure 5.14 below.

Figure 5.14: Interest rates in January 2009 - December 2012 (data source: ARAD, OECD)



Note: This Figure shows the evolution of the Czech National Bank's policy rates (left graph) and the evolution of the monthly average of short-term interest rates (right graph) from January 2009 to December 2012. During this period, the Czech National Bank gradually decreased the policy rates; for example, the repo rate decreased from approx. 2 % in January 2009 to 0.05 % in December 2013.

The production in the Czech economy decreased after the 2008 crisis due to the lower aggregate demand. The economy was growing back in 2010 and 2011. In 2012 the production started decreasing again which was caused by many factors mainly by a decrease in foreign demand for domestic goods caused by the European debt crisis but also due to a low domestic aggregate demand

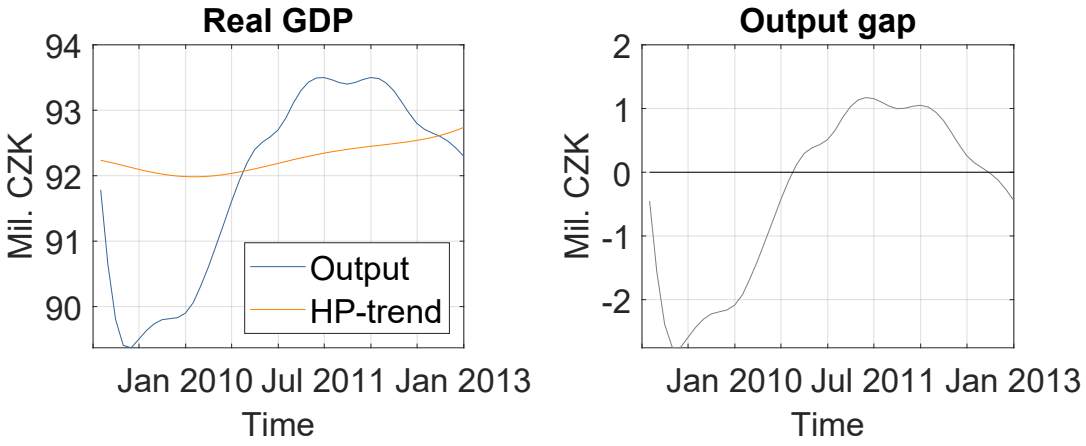
[6]The concern of the evolution of the exchange rate was explicitly discussed at the board meeting, see Czech National Bank (2011).

[7]See Figure 3.2, where the positive shock to aggregate demand is discussed. A decrease in inflation is caused by the negative shock to aggregate demand.

as shown in Figure 5.15 below. Lower production increased unemployment (see 5.16).

Due to the budget deficit caused by the crisis, the Government performed fiscal restrictions which in combination with lower employment and lower real wages seriously harmed the economy and caused a decrease in households' consumption and firms' investments. These events led to another decrease in aggregate production in 2012 (see Figure 5.15) and in 2013 (see Section 5.6).

Figure 5.15: Output and output gap in January 2009 - December 2012 (quarterly data source: ARAD, monthly data source: own processes)

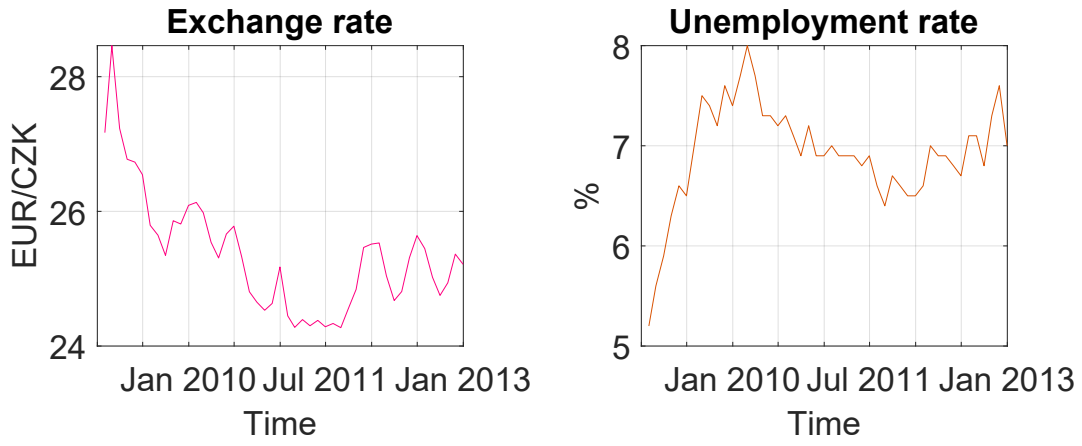


Note: This Figure shows the evolution of the output and potential output (left graph) and the evolution of the output gap (right graph) from January 2009 to December 2012. The data are in real terms with respect to the 2015 reference year. During this period, the Czech economy faced most of the harm caused by the 2008 crisis. The quarterly data obtained from the ARAD database is interpolated into monthly data using cubic splines.[8]

In this period, the exchange rate continued appreciating as it did in the pre-crisis period analysed in Section 5.4, except for the increase in February 2009, see Figure 5.16. The appreciation was driven mainly by the continuing growth in demand for investments in Czech assets by foreign investors. After the appreciation in 2009, the exchange rate fluctuated around 25 CZK/EUR level.

[8]The interpolation method is described in the Appendix, Section A.3.

Figure 5.16: Exchange rate and unemployment in January 2009 - December 2012 (data source: EUROSTAT, OECD)



Note: This Figure shows the evolution of the CZK/EUR exchange rate (left graph) and the evolution of unemployment (right graph) from January 2009 to December 2012. In this period, the exchange rate firstly appreciated from approx. 28 CZK/EUR and then fluctuated around 25 CZK/EUR. The unemployment firstly increased to 8 % in 2009 and then decreased and fluctuated around 7 %.

As noted, a decrease in aggregate demand affected production. Lower production increased unemployment in the economy. Figure 5.16 shows that in 2009 the unemployment increased from approx 5.2 % to approx. 7.5 %. In 2010 and 2011, the production started to increase (see Figure 5.15) which promoted employment (i.e. decreased unemployment). Since 2012, the Czech economy faced a second wave of recession and production decreased again due to lower aggregate demand (see Figure 5.15). To produce less, fewer workers were needed and unemployment increased again.

In 2008, the Czech National Bank switched its main prediction model to a modern DSGE model called g3. The model provided the bank board with very accurate predictions of inflation even in times of crisis when the predictions usually suffer from relatively large prediction errors. As analysed above, the prognosis of the bank board quite precisely met the true dynamics of inflation. In comparison with the previous period when the Czech National Bank used the QPM model, the reasons why the inflation moved out of the tolerated range were caused by the decisions of the bank board, rather than due to errors in prediction. I discussed that one of the problems, why the Central Bank did not react adequately, was the smoothing preference over the policy rates.

During this period, Mr Singer succeeded Mr Tůma in the governor's office in July 2010. From Figure 5.14 we see that after Mr Singer took the office, the Czech National Bank stopped decreasing the interest rate. The reason why it did can, however, be hardly connected with the changes in governors. Although we can speculate that Mr Tůma could have voted differently in August 2011 and might have influenced other members of the bank board when the bank board perhaps should have increased the interest rates.

5.6 2013-2017

During this period, the Czech National Bank faced low inflation below its inflation target but already had the policy rates at very low values and was limited in using its conventional monetary policy tools.

A decrease in inflation in 2013 was expected by the bank board which reacted in November 2012 by decreasing the policy rates to historically lowest values, see the discussion in Section 5.5. At its November meeting, the bank board stated that it will keep the policy rates at *technically zero values* until inflation rises again (Czech National Bank, 2012). The prediction of the bank board that inflation will decrease to the lower bound of the tolerated range in 2013 was accurate as inflation decreased to 1 % value, see Figure 5.17.

In December 2012, the bank board anticipated that inflation could decrease below the lower tolerance bound in 2014 and stated that it is ready to use unconventional instruments to promote inflation. It had only two choices as quantitative easing has been forbidden according to the Act on the Czech National Bank.[9] Firstly, it could decrease policy rates even into the negative values as many other central banks did.[10] Secondly, it could perform foreign exchange interventions to artificially depreciate the Czech Koruna. At the meeting in December 2012, the bank board stated that it is ready to start the foreign exchange interventions if they are needed in the following periods. Notice, that this statement itself depreciated Czech Koruna at the beginning of 2013 as shown in Figure 5.20.

The bank board firstly voted on the usage of foreign exchange interventions at the board meeting in August 2013 when the decrease of inflation to close- to-zero values in 2014 seemed to be inevitable. At the meeting, this unconventional tool was discussed as some members of the board feared that the interventions could destabilize the Czech economy, see (Czech National Bank, 2013a). Similarly, in the September meeting, the bank board voted on interventions but decided not to use them (Czech National Bank, 2013b).

The breaking point when the bank board finally decided to start the interventions was at the November 2013 meeting, see Czech National Bank (2013c). At that meeting, the bank board analysed two possible scenarios. The first scenario was to continue in a monetary passivity despite that the situation needed monetary expansion. Such passivity would probably seriously harm domestic economic activity because some other European countries decreased the interest rates to negative values and the interest rate differential would cause a capital inflow. The net capital inflow would abruptly appreciate the Czech Koruna which would further decrease the economic activity through the exchange rate transmission mechanism.[11]

The bank board preferred the second scenario of performing foreign exchange interventions to keep the exchange rate at the 27 CZK/EUR level which should have suppressed the negative effects of the exchange rate appreciation caused by the interest rate differential.

An important question is whether the negative interest rate policy was not a more appropriate tool, as it does not require using foreign exchange reserves.

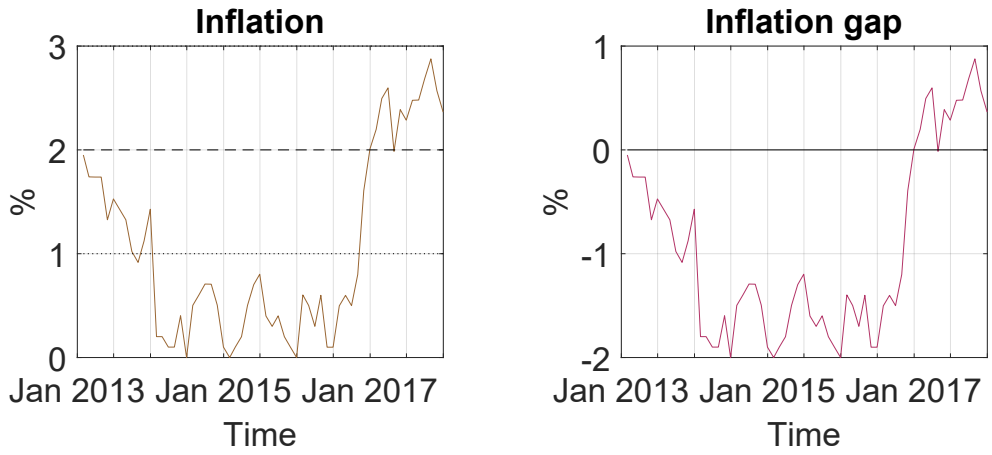
[9] See the discussion in Subsubsection 1.1.3.

[10] See the discussion in part 1.1.3.

[11] See the process in the exchange rate transmission channel discussed in Subsubsection 1.1.4.

Although it causes more indebtedness of households and firms.

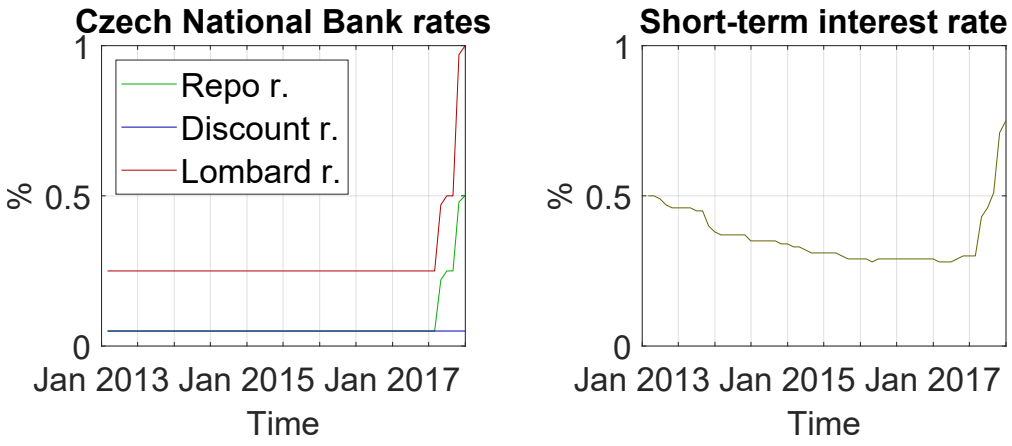
Figure 5.17: Inflation and inflation gap in January 2013 - December 2017 (data source: OECD, ARAD)



Note: This Figure shows the evolution of inflation (left graph) and the inflation gap computed as the difference between inflation and the inflation target of the Czech National Bank (right graph) in the Czech Republic from January 2013 to December 2017. In the left graph on inflation, the dashed line shows the inflation target of the Czech National Bank and the dotted lines the tolerance bounds. In this period, inflation was relatively stable, however, was mostly below the tolerated range.

As inflation remained low, in the period of 2014, 2015 and most of 2016, the Czech National Bank kept the interest rates at *technically zero values* (see Figure 5.17 below) and performed foreign exchange interventions to keep the exchange rate at 27 CZK/EUR level. Due to the unchanging forecast of low inflation, the bank board discussed also the possibility of introducing the negative interest rate policy (see Czech National Bank (2015)), however, it decided not to use this policy. The policy of foreign exchange interventions was successful in both keeping inflation in positive values and in maintaining economic growth (see Figure 5.19).

Figure 5.18: Interest rates in January 2013 - December 2017 (data source: ARAD, OECD)



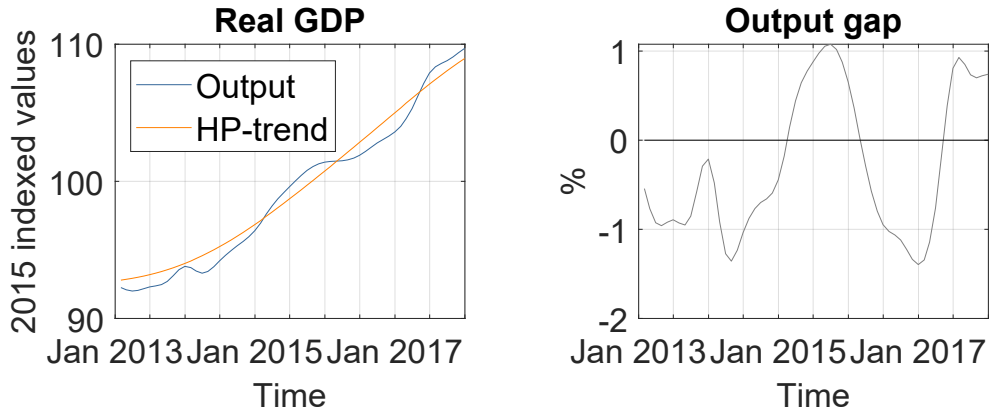
Note: This Figure shows the evolution of the Czech National Bank's policy rates (left graph) and the evolution of the monthly average of short-term interest rates (right graph) from January 2013 to December 2017. During this period, the Czech National Bank was limited in its main monetary policy instrument of setting the policy rates as they were close to zero and the Central Bank refused to decrease the policy rates below the zero lower bound. Notice, that the policy rates were not transmitted to short-term interest rates which remained higher. At the end of the period, the bank board decided to increase the policy rates to reflect the strong inflationary pressures.

An increase in inflation to the targeted level at the end of 2016 and slightly above the target in 2017 was correctly predicted by the Czech National Bank analysts team in February 2016 prognosis, see Czech National Bank (2016a). Following this prognosis, the bank board stated that it expects that it will stop the unconventional foreign exchange interventions and that it will return to using the conventional monetary policy tool and will increase the policy rates in 2017.

This expectation was fulfilled. The Central Bank returned to the interest rate setting in August 2017 when the bank board decided to increase the interest rates as inflation was predicted to remain at the upper bound of the tolerance range at the policy horizon (Czech National Bank, 2017b). Also, the bank board decided to end the foreign exchange interventions in April 2017 (Czech National Bank, 2017c).

We can evaluate the period of foreign exchange interventions positively as it helped the Czech National Bank to prevent the economy from deflation and secured stable real economic growth as shown in Figure 5.19 below.

Figure 5.19: Output and output gap in January 2013 - December 2017 (quarterly data source: ARAD, monthly data source: own processes)



Note: This Figure shows the evolution of the output and potential output (left graph) and the evolution of the output gap (right graph) from January 2013 to December 2017. The data are in real terms with respect to the 2015 reference year. In this period, the Czech economy enjoyed quite stable economic growth. The quarterly data obtained from the ARAD database is interpolated into monthly data using cubic splines.[12]

The evolution of the exchange rate was affected by the directed floating regime when the Czech National Bank intervened to artificially depreciate it to 27 CZK/EUR.

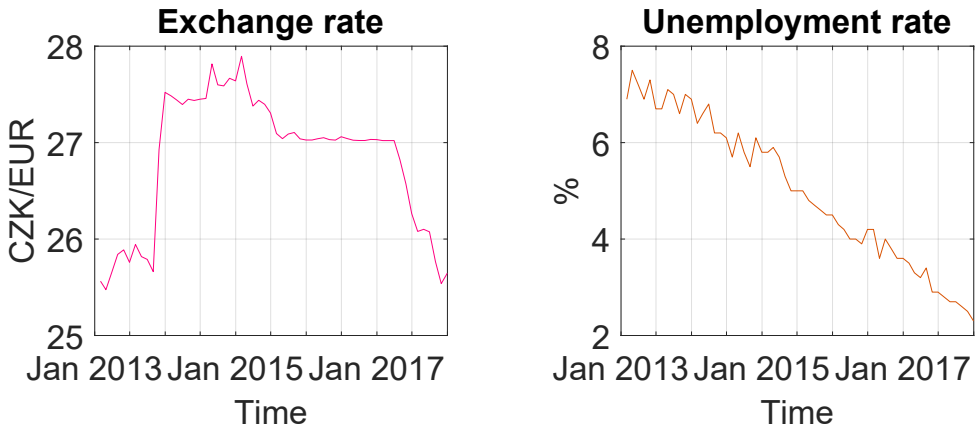
The announcement of the bank board that it is ready to use unconventional tools from December 2012 slightly depreciated Czech Koruna in the first half of 2013. Nevertheless, the key depreciation of the Czech Koruna appeared after the bank board decided to begin interventions in November 2013 to keep the exchange rate close to 27 CZK/EUR.[13]

The artificially depreciated the exchange rate remained around 27 CZK/EUR until April 2017 when the bank board decided to stop the interventions. Notice that after the central bank stopped intervening, the exchange rate returned to the values of approx. 25.5 CZK/EUR which was exactly the value before the introduction of the interventions.

[12]The interpolation method is described in the Appendix, Section A.3.

[13]An important question for further research is how much the central bank needs to actually intervene and what part of depreciation is caused by the market which knows that the central bank will intervene if the exchange rate behaves differently.

Figure 5.20: Exchange rate and unemployment in January 2013 - December 2017 (data source: EUROSTAT, OECD)



Note: This Figure shows the evolution of the CZK/EUR exchange rate (left graph) and the evolution of unemployment (right graph) from January 2013 to December 2017. During this period, the exchange rate depreciated to approx. 27 CZK/EUR due to foreign exchange interventions of the Czech National Bank and then appreciated back to the original level when this unconventional tool was stopped in April 2017. Unemployment gradually decreased to the level of approx. 2.5 %.

The unemployment rate gradually decreased to a historically minimum level of approx. 2.5 % due to stable growth in the production, see Figure 5.19.

Finally, we can discuss that the appointment of the current governor - Jiří Rusnok - in July 2016 has not had any clear impact on the changes in the performance of the monetary policy of the Czech National Bank.

5.7 2018-2019

From the monetary policy perspective, in this period the Czech National Bank faced inflationary pressures at the monetary policy horizon and had been increasing the policy rates gradually. Thanks to an increase in the policy rates in 2017 it delivered inflation within the tolerance bounds for most of the period.

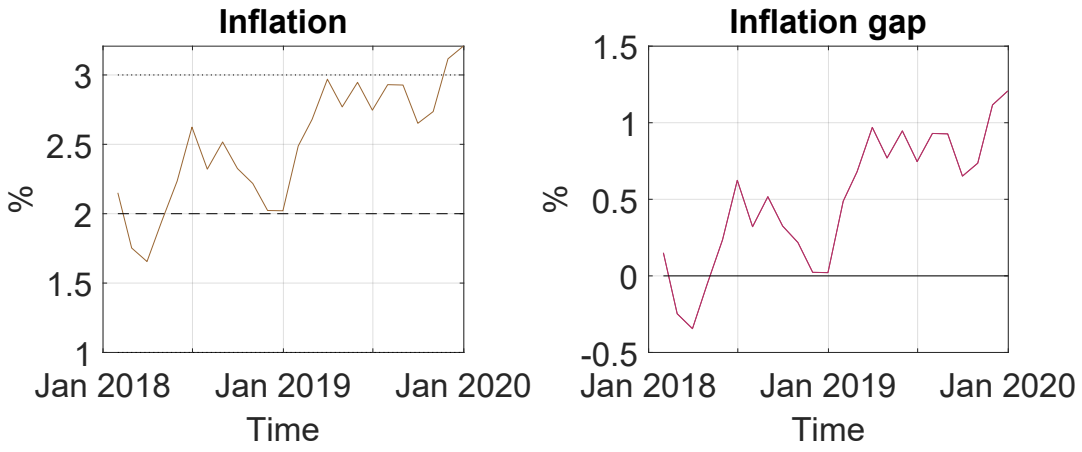
Figure 5.21 shows a decrease in inflation to the 2 % targeted level which was correctly anticipated by the bank board at the February 2017 meeting, see Czech National Bank (2017a). Similarly, the prediction of the evolution of 2018 inflation was correct, however, for 2019 the bank board predicted that at the policy horizon, the inflation will be slightly below the target of 2 % which was not a correct prediction. The central bank stated that according to the prognosis it expects to increase the policy rates in Q1 2018 and for the rest of 2018 the policy rates shall remain unchanged (Czech National Bank, 2018a).

As shown in Figure 5.22, the bank board decided to act differently than it stated earlier as it increased the policy rates in the second half of 2018. The reason for this change in the monetary policy was an unpredicted increase in energies and in aggregate demand. Although the bank board discussed that the economy needs a vigorous increase in the interest rates by at least 50 base points, the bank board preferred smooth changes in the policy rates and increased them only by

25 base points (Czech National Bank, 2018c). Notice that this complies with the results obtained in Section 4.4 as I estimated quite strong policy inertia of the Czech National Bank in the period of 2009 Q1 - 2019 Q4. The main argument for why the bank board did not increase the interest rates more was the risk of instability in the exchange rate which depreciated. The bank board feared that it might lose its credibility as the markets could wrongly interpret the conduct of the Bank as if it targeted exchange rate rather than inflation (Czech National Bank, 2018c).[14] More severe increases in the policy rates would probably suppress the summer 2018 CZK/EUR depreciation, see Figure 5.24. This policy was one of the reasons why, at the monetary policy horizon, inflation exceeded the tolerated range and remained above it in the first half of 2020, see Figure 5.21 below and Figure 5.25.

For the rest of 2018, the bank board continued with smooth increases in the policy rates to reflect the inflationary pressures at the monetary policy horizon.

Figure 5.21: Inflation and inflation gap in January 2018 - December 2019 (data source: OECD, ARAD)

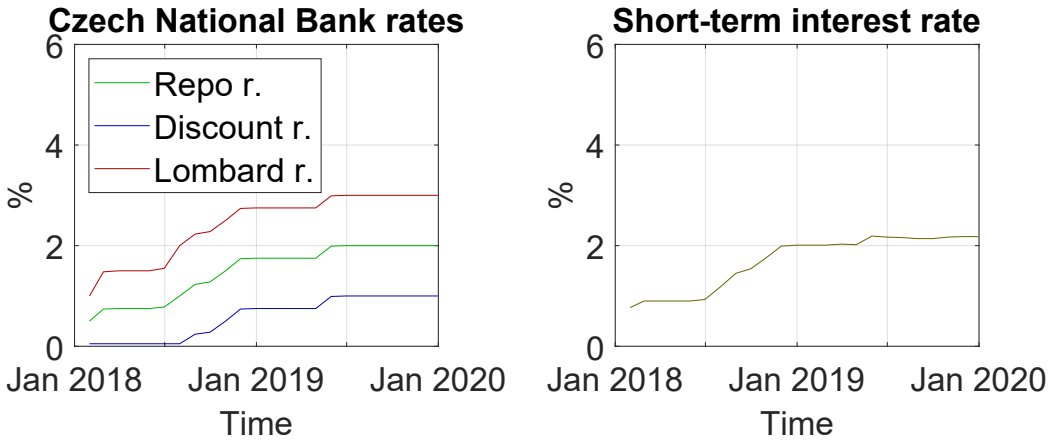


Note: This Figure shows the evolution of inflation (left graph) and the inflation gap computed as the difference between inflation and the inflation target of the Czech National Bank (right graph) in the Czech Republic from January 2018 to December 2019. In the left graph on inflation, the dashed line shows the inflation target of the Czech National Bank and the dotted lines the tolerance bounds. During this period, the Czech National Bank was successful in maintaining inflation within the tolerance bounds.

In 2019, the policy rates remained unchanged except for the increase in May 2019. At the May meeting, the bank board expected that if it increases the policy rates, inflation will return to the 2 % target at the horizon in summer 2020 (Czech National Bank, 2019b), which was an incorrect prediction, as the inflation decreased to the 2 % level later in 2021, see Figure 5.25.

[14] One could ask whether such conduct was not in fact breach of inflation targeting rule (and of the constitutional duty of maintaining price stability) in favour of securing the credibility as the Czech National Bank, in fact, did not increase the interest rates more as suggested by inflation targeting policy rule.

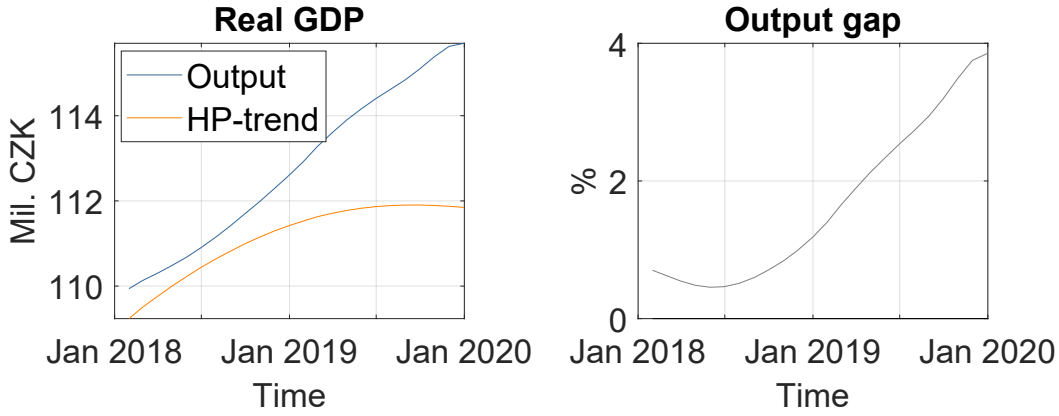
Figure 5.22: Interest rates in January 2018 - December 2019 (data source: ARAD, OECD)



Note: This Figure shows the evolution of the Czech National Bank's policy rates (left graph) and the evolution of the monthly average of short-term interest rates (right graph) from January 2018 to December 2019. During this period, the Czech National Bank gradually increased the interest rates; for example, the repo rate increased to 2 %.

Also, the smooth increase in the policy rates did not sufficiently reflect the overheating of the Czech economy which steadily grew but remained above its potential as shown in Figure 5.23.

Figure 5.23: Output and output gap in January 2018 - December 2019 (quarterly data source: ARAD, monthly data source: own processes)



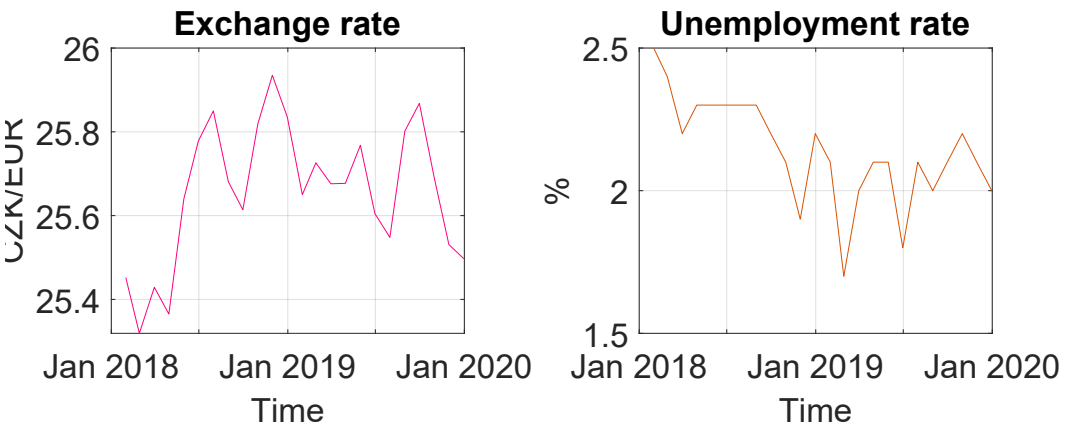
Note: This Figure shows the evolution of the output and potential output (left graph) and the evolution of the output gap (right graph) from January 2018 to December 2019.The data are in real terms with respect to the 2015 reference year. During this period, the Czech economy was steadily growing above its potential which resulted in a positive output gap. The quarterly data obtained from the ARAD database is interpolated into monthly data using cubic splines.[15]

In 2018 and 2019, the exchange rate was quite stable in comparison with the previous periods as it fluctuated around 25.7 CZK/EUR level. The 2018 depreciation, depicted in Figure 5.24 below, was caused by the capital outflow

[15]The interpolation method is described in the Appendix, Section A.3.

due to increased global risks (Czech National Bank, 2018b). Nevertheless, the interest rate differential and the real convergence of the Czech economy to the Eurozone prevented the currency from more severe depreciation.

Figure 5.24: Exchange rate and unemployment in January 2018 - December 2019 (data source: EUROSTAT, OECD)



Note: This Figure shows the evolution of the CZK/EUR exchange rate (left graph) and the evolution of unemployment (right graph) from January 2018 to December 2019. During this period, the exchange rate was quite stable as it deviated between 25.3-25.9 CZK/EUR. Unemployment followed the decreasing trend from the previous period and decreased to 2 % where it fluctuated.

The unemployment rate decreased in 2018 to a 2 % level where it fluctuated in 2019. This continuing trend of very low unemployment reflected the real growth of the economy depicted in Figure 5.23.

At the end of this period, the Czech National Bank started to use the updated prediction model g3+, which is more accurate in predictions compared to the g3 as it more sufficiently models the development in foreign economy (Brázdik et al., 2020).

5.8 2020-2022

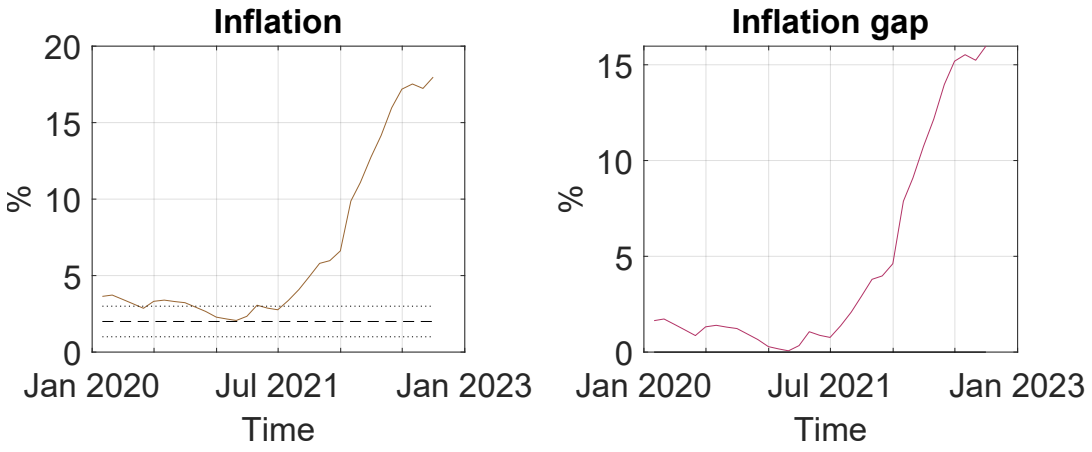
This period has been very unstable as the Czech economy faced unexpected exogenous shock given by the Covid-19 pandemic. Moreover, the autumn 2021 energy crisis in Europe also negatively affected the economy and was even deepened when Russia invaded Ukraine in February 2022.[16]

The Covid-19 pandemic, which spread to Europe in February 2020 was unexpected and the monetary policy of the Czech National Bank did not reflect it in its previous foresight. There is no surprise that the bank board's prediction of the evolution of the Czech economy was inaccurate as it did not account for this pandemic and its severity. At the August 2019 meeting, the bank board expected that, due to planned restrictive monetary policy, inflation will decrease and return to the target at the monetary policy horizon (i.e. in the second half of 2020), see Czech National Bank (2019a). Due to many factors, especially the

[16]In summer 2022, Russia stopped the exports of gas to most of the European countries.

depreciation of the Czech Koruna (see Figure 5.28), inflation in the second half of 2020 remained slightly above the target (see Figure 5.25 below).

Figure 5.25: Inflation and inflation gap in January 2020 - September 2022 (data source: ARAD, OECD)



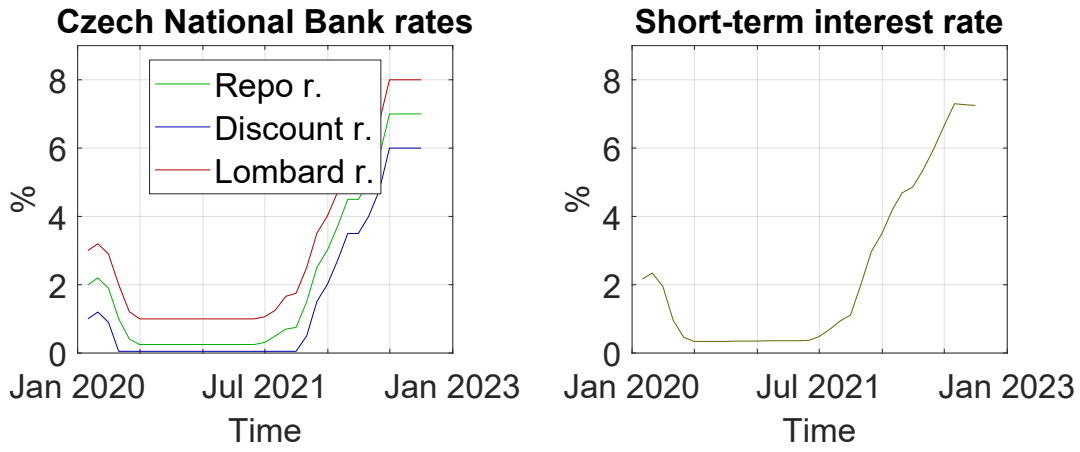
Note: This Figure shows the evolution of inflation (left graph) and the inflation gap computed as the difference between inflation and the inflation target of the Czech National Bank (right graph) in the Czech Republic from January 2020 to September 2022. In the left graph on inflation, the dashed line shows the inflation target of the Czech National Bank and the dotted lines the tolerance bounds. In this period, inflation was relatively volatile compared to previous periods especially due to a rapid prices increase in 2022.

At the February 2020 meeting, the majority of the bank board did not evaluate the risks connected with the Covid-19 in China as being a serious threat to the overall economic activity and the board increased the interest rates to secure the stability of inflation expectations around 2 % level (Czech National Bank, 2020c).

A fast depreciation of the exchange rate caused by the net capital outflow and the expected decrease in economic activity induced the bank board to decrease the policy rates at the extraordinary meeting in March 2020. The predictions of the bank board over the inflation dynamics showed that only the lower interest rates could suppress strong disinflationary pressures connected with a decrease in production that would possibly decrease inflation below the target (Czech National Bank, 2020b). The situation required another decrease in the policy rates at the ordinary March 2020 meeting and at May 2020 meeting, see Figure 5.26 below.

Note, that at the monetary policy horizon of the mentioned meetings, inflation remained at the tolerance bounds and was close to the inflation target. Hence, the decrease in the policy rates successfully maintained inflation within the tolerance bounds.

Figure 5.26: Interest rates in January 2020 - September 2022 (data source: ARAD, OECD)



Note: This Figure shows the evolution of the Czech National Bank's policy rates (left graph) and the evolution of the monthly average of short-term interest rates (right graph) from January 2020 to September 2022. During this period, the Czech National Bank responded to the Covid-19 pandemic with monetary expansion when it decreased the policy rates. It had been increasing them again in the period starting in autumn 2021 in response to increasing inflation at the monetary policy horizon.

In the second half of 2021, inflation had been increasing far above the inflation target and above the tolerance bounds. At the policy meetings in August and November 2020 and in February 2021, the bank board did not expect this evolution of inflation and kept the policy rates at their level. *Ex post* we may evaluate this policy as a mistake. The bank board underestimated the effect of abrogation of the super gross wage,[17] which in 2021 increased the aggregate demand as the income of employees increased significantly.

At June 2021 meeting, the bank board realized this mistake and noticed that the inflationary pressures are increasing, although it expected a much lower increase in inflation. The major source of inflation was expected to be driven by increasing demand that cannot be quantitatively satisfied due to interrupted global value chains which were significantly harmed due to production shutdowns in many economies during the first wave of the pandemic. In response, the bank board decided to gradually increase the policy rates since this meeting (Czech National Bank, 2021b).

More vigorous change in the interest rates was necessary in presence of the inflationary pressures given by increasing problems in global value chains and by increasing prices in the energy sector.[18] Due to these problems, the bank board expected inflation to reach a 7 % level at the end of 2021, see (Czech

[17]Super gross wage was a concept that the taxable income base was increased by employer's social security contributions and the employee's health insurance. Act No. 609/2020 Coll. on the changes to some taxation acts and some other acts, changed the taxable income base only to gross wage.

[18]The problems with prices of energies were caused by many factors, one of them being low effectiveness of renewable power plants and the legislation of the European Union towards aiming at lower carbon and nuclear energy production. In the Czech Republic, this crisis significantly increased prices of energies which led to the bankruptcy of one of the biggest gas suppliers - Bohemia Energy.

National Bank, 2021c), and decided to increase the interest rates more vigorously to decrease inflation at the policy horizon back to 2 % targeted level. As shown in Figure 5.26, this trend of increases in the policy rates has followed ever since until the personnel changes in the bank board in July 2022.

The evolution of prices growth in 2022 was partly unexpected due to the Russian invasion of Ukraine in February 2022. In response to this event, the ongoing energy crisis was even deepened as Russia decreased exports of oil and gas to Europe. Moreover, the ongoing global value chain disruptions caused an imbalance between supply and demand which led to even higher prices increase. The bank board reacted to these inflationary pressures with another interest rates hikes in all monetary policy meetings in the first half of 2022. In addition, since the Russian-Ukrainian war, the bank board has decided to use foreign exchange interventions to prevent the Czech Koruna from excessive depreciation. Moreover, as noted by the bank board, the stronger currency was also used as an instrument that can reduce the effect of the unprecedented foreign temporary increase in energy prices (Czech National Bank, 2022b).

In July 2022, the mandates of Governor Jiří Rusnok, his Deputy Tomáš Nidetzský and the bank board member Vojtěch Benda ended. President Miloš Zeman appointed current bank board member Aleš Michl to the governorship and appointed his Deputy Eva Zamrazilová to the office and appointed Karina Kubelková and Jan Frajt to the office of bank board members. These personnel changes in the bank board completely changed the monetary policy strategy of the previous bank board, where the majority was in favour of using interest rates as the main policy tool and in favour of increasing the interest rates in an environment of prevailing strong inflationary pressures at the monetary policy horizon.

At its first monetary policy meeting in August, the new bank board decided to take a different stance on monetary policy. It considered the inflationary pressures at the monetary policy horizon to be driven mainly by the exogenous shock that cannot be suppressed by means of the domestic interest rates. Also, as the domestic economic activity was predicted to be falling into a small recession in the following months, the bank board did not consider a further increase in interest rates to be a solution (Czech National Bank, 2022c). Following these arguments, the bank board decided to excempt the foreign inflationary pressures by distanting the current monetary policy horizon two months ahead.[19] Therefore, the bank board decided not to use the main monetary policy instrument - the policy rates. Moreover, the central bank decided to continue in foreign exchange interventions to ensure a strong exchange rate of the Czech Koruna to reduce the effect of the unprecedented foreign temporary increase in energy and core prices. The bank board have continued with the strategy of stable policy rates and foreign exchange interventions towards stronger currency using the very same arguments in September and November monetary policy meetings.

A few important remarks should be noted with regard to this new bank board's

[19]The monetary policy horizon in the main prediction model g3+ was previously set at the horizon t+4, reflecting the impulse responses functions that capture the transmission mechanism delay in 4-6 quarters ahead (Czech National Bank, 2009a). In the summer monetary policy report, however, the Central Bank decided to look at a more distant horizon of 6-8 quarters (in the main prediction model $t + 6$), see Czech National Bank (2022a).

monetary policy strategy and argumentation. Firstly, the distancing of the monetary policy horizon in the reaction function is just a different way how one can express the changes in the bank board preferences. If it would be possible to look into the future, we might be able to analyse the change in the bank board preferences in its Taylor rule using future data. This behaviour would probably reflect higher smoothing parameter ρ as well as lower weight on the inflation gap ξ_π and higher weight on the output gap ξ_x.[20] Secondly, the argumentation that an additional increase in the policy rates is not necessary, because the domestic economic activity is already predicted to be falling in the upcoming months opens a discussion about whether the current bank board acts in line with its constitutional duty of maintaining price stability. By interpreting this argument, we might conclude that the bank board did not increase the policy rates because it would result in a deeper recession. Nevertheless, according to Section 2 Paragraph 1 of the Act on the Czech National Bank, the central bank aims at the secondary targets only when it does not harm the primary target of price stability. If we follow the standard monetary policy horizon of 4-6 months, the Czech National Bank prognosis predicted that the inflation target can be reached at this horizon only with an increase in the interest rates. Therefore, the bank board breached the mentioned amendment when it preferred the secondary target of stable economic growth over the primary target of price stability.[21] Thirdly, it seems that the new bank board started to use foreign exchange interventions as its main monetary policy instrument. Because foreign exchange interventions are quite costly, I would suggest that *de lege ferenda* the Act on the Czech National Bank should explicitly amend that the interest rates are the main policy instrument and foreign exchange interventions can be used only as an additional instrument.[22]

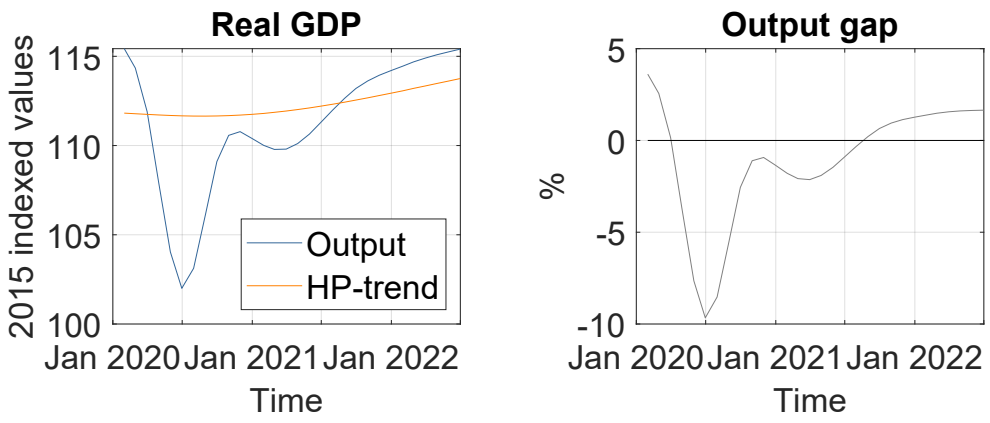
In the period of 2020-2022, the evolution of the real GDP was extremely volatile especially due to production shutdowns during the Covid-19 pandemic that caused a significant drop in overall production (see Figure 5.27). Note, however, that the forced production shutdowns had only a cyclical pattern as the potential output remained unaffected and remained somewhat stable. Although the economy has been growing again since the second half of 2020 (with an exception of the first half of 2021), it has not reached the pre-pandemic production at the end of the analysed data range.

[20] This is a room for future research which could provide empirical evidence on these expectations.

[21] This is a perfect example of an intended breach of the legal duty of the Czech National Bank that arises from the bank board decision which I suggested to be a *de lege ferenda* reason for relief of the bank board member when I discussed the independencies of the Czech National Bank in Chapter 2.

[22] See part 1.1.3 for more detailed discussion.

Figure 5.27: Output and output gap in January 2020 - June 2022 (quarterly data source: ARAD, monthly data source: own processes)

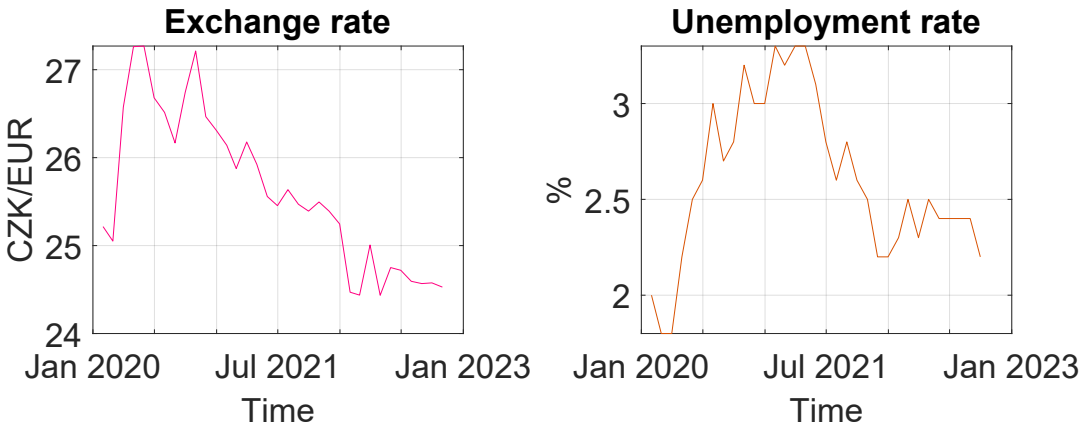


Note: This Figure shows the evolution of the output and potential output (left graph) and the evolution of the output gap (right graph) from January 2020 to June 2022. The data are in real terms with respect to the 2015 reference year. During this period, the Czech economy faced a rapid decline in production far below the potential of the economy due to production shutdowns implemented by the government in response to the Covid-19 pandemic. The quarterly data obtained from the ARAD database is interpolated into monthly data using cubic splines.[23]

When the pandemic emerged, foreign investors pulled back the investments that they possessed in Czech Koruna and the exchange rate depreciated above 27 CZK/EUR as shown in Figure 5.28. The dynamics of the exchange rate then complied with the evolution of the Covid-19 waves in the Czech Republic. When the pandemic receded, the exchange rate appreciated close to 26 CZK/EUR and since September 2020 depreciated back when the economy faced a second wave of Covid-19. When this wave subsided, the exchange rate gradually appreciated to approx. 24.5 CZK/EUR. This trend has been caused by the convergence of the Czech economy to the Eurozone countries level and mainly due to interest rate differential that relatively increased the yield of Czech assets compared to Eurozone assets. The depreciation pressures connected with the Russian-Ukrainian war that appeared in Hungary and Poland[24] were suppressed by the foreign exchange interventions of the Czech National Bank, which resulted in the approximately stable exchange rate.

[23]The interpolation method is described in the Appendix, Section A.3.
[24]See the Appendix Section A.4

Figure 5.28: Exchange rate and unemployment in January 2020 - October 2022 (data source: EUROSTAT, OECD)



Note: This Figure shows the evolution of the CZK/EUR exchange rate (left graph) and the evolution of unemployment (right graph) from January 2020 to October 2022. In this period, the exchange rate firstly fastly depreciated when the Covid-19 pandemic began and then appreciated even to lower values of approx. 24.5 CZK/EUR due to also foreign exchange interventions activity of the Czech National Bank. The unemployment followed with some delay the drop in production and returned to low values of approx. 2.3 %.

As depicted in Figure 5.28, the unemployment rate remained low despite the severity of the drop in the overall production depicted in Figure 5.27.[25] The following increase was only small (approximately 1.3 percentage points) and followed the trend of the evolution of real GDP with some delay. As production increased again, unemployment decreased close to the pre-pandemic 2% level.

At the beginning of this period, the Czech National Bank updated its main prediction model to g3+. It is hard to evaluate the predictions of the model in this unstable period when the economy faced many unexpected shocks. Except for predicting accurately the problems with global value chains and with the energy prices, the model did quite a decent job and supplied the bank board with quite accurate predictions (see the discussion above).

[25]This was caused by many supplementary legislation remedies adopted by the parliament (for example *kurzarbeit*) which allowed firms not to dismiss their employees.

Conclusion

The central banks hold a powerful mandate in performing monetary policy in the economy. The precise performance of monetary policy can sustain stable economic growth. When affecting the economic processes in the economy, the central banks dispose of conventional and unconventional instruments that are analysed and critically discussed in Chapter 1.

The consistency of a monetary policy is the key determinant of stable economic growth (Kydland & Prescott, 1977), as it allows economic agents to correctly anticipate the monetary policy changes and include them in their rational expectations that allow for correct economic decisions based on reliable information. This is the reason why many central banks adopted some monetary policy rule and stopped acting discretionary.

Due to a serious disruption of economic and legal relationships that is caused by high inflation or deflation (discussed in detail in Chapter 3), many central banks (the Czech National Bank in December 1997) adopted the inflation targeting policy. In this regime, the central bank aims to maintain price stability by setting policy rates that secure the stability of other economic variables which together promote stable economic growth (Svensson, 2010; Woodford, 2012).

Many papers, see Judd et al. (1998); Clarida et al. (2000); Kim and Nelson (2006); Baxa et al. (2014), documented that following a certain monetary policy rule might not be enough when the central bank changes its preferences over key variables in the economy. This hidden inconsistency can have similar effects as the discretionary monetary policy when the changes in the central bank's preferences are unknown to the economic agents. Such unexpected changes are not incorporated into their rational expectations and can lead to improper economic decisions based on invalid information.

One of the sources of discretion are the changes in preferences of the central bank's governing body. These can be driven by personnel changes in the bank board or caused by insufficient independence of the bank board when the members of the bank board are affected by political pressures. The institutional independence which refers to independence to legislative executive and judiciary powers; functional independence which is guaranteed by the autonomy when deciding upon inflation target and monetary policy instruments; financial independence which forbids to directly finance the public sector; and budgetary independence which is given by the separated budget of the Czech National Bank are quite well enforced by the current Czech legislation. Nevertheless, the current Czech legislation of personal independence, which should ensure that the bank board member executes his mandate according to his best knowledge and belief only, is rather poor. The problems that I discuss are threefold.

Firstly, the appointment of the bank board members is based on the monocratic decision of the Czech President only, who even does not have to be an economist. The President is restricted only by relatively weak conditions on the bank board candidate. In this thesis, I provide three possible solutions to this problem. In my opinion, the best solution is to make the president's appointment decision valid upon the senate's consent.[26]

[26]Therefore, the appointment of the bank board member would be the same as it is with the

Secondly, the legislation of a bank board member's relief is expressed rather vaguely and it is not clear what is considered to be serious misconduct that can lead to relief. Moreover, only the Governor is protected against relief when he can refer to the European Court of Justice for a review of the relief decision. In the current legislation, other members of the bank board do not have similar protection.

Thirdly, the personal independence is jeopardized by the fact that the bank board member might be influenced to decide on monetary policy such that it favours the President. Because the President can reappoint current bank board members that were appointed by the previous President, and also appoint Governor and his deputies from the current bank board members. These bank board members might decide differently than they would have, seeking reappointment. In the thesis, I provide two possible *de lege ferenda* solutions to this problem. In my opinion, the best solution is to restrict the reappointment such that no one can hold the bank board, Governor or Governor Deputy mandate in two consecutive terms. This amendment would also make it possible to decrease the term of the bank board members to five years in order to reach a more uniformity in the number of appointments of the bank board members.[27]

In Chapter 4 of this thesis, I empirically estimate simple inflation targeting interest rate rule similar to the Taylor rule derived in Clarida et al. (2000) which maps the preferences of the central bank. In this rule, the central bank sets the policy rates according to the policy-neutral rate, inflation gap and other relevant signals from the economy. In my specification of the Taylor rule, I add the output gap and the exchange rate gap to test whether the Czech National Bank truly focuses on its constitutional duty of maintaining price stability. The main purpose of this empirical analysis is that it maps how the preferences of the Czech National Bank and its inflation targeting policy changed over the observed period. To detect the changes, I estimate the mentioned monetary policy rule on two separate subsamples, following Judd et al. (1998); Clarida et al. (2000); Frömmel and Schobert (2006). Following Clarida et al. (2000) the estimation method used is the General Method of Moments. The data range is given by the available data and covers the period of 1996 Q3 - 2021 Q2.

The results show that the Czech National Bank followed its constitutional duty of maintaining price stability as its main policy target, because in both of the subsamples, the response parameters to the output gap and exchange rate gap are estimated insignificant. Moreover, the results show that the preferences of the Czech National Bank changed within the subsamples of 1996 Q3 - 2008 Q4 and 2009 Q1 - 2019 Q4.[28] Specifically, I find that the preference for interest rate smoothing is lower in the second subsample suggesting that the 2009-2019 bank boards were more open to vigorous changes in the interest rates. In advance, the weight on the inflation gap also decreased between the two subsamples. This might seem as if the bank boards in the second subsample were less focused on maintaining price stability, but the main reason why this parameter decreased is

Justices of the Constitutional Court.

[27]The current President Miloš Zeman will be able to make nine appointments in his second presidential term, while his successor will have the opportunity to make only one appointment.

[28]The second subsample is reduced to 2009 Q1 - 2019 Q4 because the shock given by the Covid-19 pandemic downgrades the prediction performance of the model.

the effect of anchored inflation expectations.[29]

In advance, in Chapter 5, I provide a detailed analysis of the monetary policy decisions in the Czech National Bank's history. The results obtained from the empirical analysis help to understand the development in the decision-making of the bank board. In this analysis, I find some inconsistent reactions of the bank board, specifically in times of the 2008 Great Recession and the 2022 personnel changes in the bank board. The personnel changes of summer 2022 show the weakest parts of the Czech National Bank's personal independence legislation, which can be overcomed by following the above-mentioned *de lege ferenda* recommendations.

The main contribution of this thesis is that it shows the problems of the current legislation of the personal independence of the Czech National Bank and that it provides *de lege ferenda* suggestions that can help overcome these problems by preventing from potential discretion in the decision making of the bank board caused by the unexpected changes in the bank board preferences.

The analysis provided in this thesis is motivated by the latest personnel changes in the bank board which disrupted the consistency with the previous bank board when the new board stopped increasing policy rates in spite of facing inflation above the inflation target at the standard monetary policy horizon of 4-6 quarters. The monocratic President's choice of the bank board members shows that the appointment process should be subject to legislative changes to prevent similar disruption in consistent preferences of the bank board that are, in light of Kydland and Prescott (1977), essential for long-term economic growth.

Further research could use more sophisticated estimation methods of Kalman filter or Kalman Smoother or Markov Chain Monte Carlo that allow for studying the changes in the central bank's preferences in every period of the data sample. Furthermore, it would be interesting to determine what amount of changes in the central bank preferences is expected and unexpected by the agents. As noted, unexpected changes in preferences can significantly harm economic stability. Moreover, further research should extend the analysis and create a third subsample, that would cover the mandate of the current bank board that expresses a completely different monetary policy strategy than the previous one.[30] Further research should also provide a detailed comparison of Czech legislation of personal independence with the legislation abroad and provide the legislative body with more *de lege ferenda* options.

[29]Having anchored inflation expectations, the central bank does not have to intervene in the economy using interest rates as firmly, because the inflation expectations self-enforce the inflation target.

[30]This analysis will be possible when we will dispose of sufficiently large subsample that can be properly analyzed.

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Abstract

Title: The Czech National Bank and Inflation Targeting as an Instrument of Maintaining Price Stability

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When performing monetary policy, the central bank can follow inflation targeting or other monetary policy rules. Following a rule, the central bank can efficiently stabilize economic development in the long run, because the changes in the monetary policy given by the policy rule are included in the rational expectations of agents. It might seem that the consistency of monetary policy is secured by following the policy rule only. The potential discretion, however, remains in the different preferences of the bank board members, which may completely change monetary policy decisions within the given monetary policy rule. Current legislation does not prevent this discretion by any means as the decision of bank board members' appointment is awarded to the Czech president exclusively, who can completely disrupt the monetary policy consistency with the previous bank board. The changes in the bank board preferences are analyzed using the GMM method on two subsamples in the period of 1996 Q3 - 2021 Q2. The empirical analysis shows that the Czech National Bank followed its constitutional duty and reacted with its policy rates to the development of the inflation gap only and that the preferences of the bank board significantly changed between the two subsamples. Following this empirical analysis and detailed analysis of the bank board monetary policy decisions I point out that the president's bank board members' appointment authotity is too dangerous for stable economic growth to be decided monocratically and without sufficient requirements on the bank board member candidates.

Keywords: the central bank, inflation, monetary policy, inflation targeting

JEL: E31, E37, E52, E58

Abstrakt

Název práce: Česká národní banka a inflační cílování jako nástroj udržení cenové stability

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Při provádění měnové politiky může centrální banka vedle dalších pravidel cílovat stabilní inflaci. Tím v dlouhém období efektivně stabilizuje hospodářský vývoj, neboť změny v měnové politice plynoucí z měnově politického pravidla zahrnují agenti do svých racionálních očekávání. Mohlo by se zdát, že konzistenci měnové politiky zajistí samotné dodržování měnově politického pravidla. Riziko diskrece však spočívá v odlišných preferencích členů bankovní rady, které může zcela ovlivnit rozhodování ohledně měnové politiky v rámci zvoleného měnově politického pravidla. Současná právní úprava této možné diskreci příliš nebrání, protože rozhodování o obsazení bankovní rady náleží výhradně prezidentovi republiky, který svým výběrem členů bankovní rady může zcela narušit kontinuitu měnově politických rozhodnutí předchozí bankovní rady. Změnu v preferencích bankovní rady mapuji pomocí metody GMM na dvou dílčích obdobích v rámci časového úseku 1996 Q3 - 2021 Q2. V rámci analýzy ukazuji, že Česká národní banka dodržovala svou ústavní úlohu a reagovala měnově politickými sazbami jen na vývoj inflační mezery. Preference České národní banky mezi analyzovanými obdobími se však významně změnily. Z této empirické analýzy a podrobné analýzy vývoje rozhodování bankovní rady vyplývá, že pravomoc prezidenta republiky jmenovat členy bankovní rady přináší příliš velké riziko pro stabilitu ekonomiky. Neměl by tak o něm rozhodovat zcela sám a výběr kandidátů by mu měl zákon více omezit.

Klíčová slova: centrální banka, inflace, měnová politika, inflační cílování

JEL: E31, E37, E52, E58

A. Appendix

A.1 Hodrick-Prescott filter

Hodrick and Prescott (1997) filter separates the growth (long-run trend) component g_t and cyclical component c_t of a time series such that:

$$y_t = g_t + c_t. \tag{A.1}$$

The separation is performed upon the estimation of the growth component, which is selected according to the following minimization problem with a growth component variance penalizing parameter λ:

$$\min_{\{g_t\}_{t-1}^{T}} \left\{ \sum_{t-1}^{T} c_t^2 + \lambda \sum_{t-1}^{T} \left[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2}) \right]^2 \right\}. \tag{A.2}$$

Following Hodrick and Prescott (1997), the parameter can be specified according to the data frequency f:

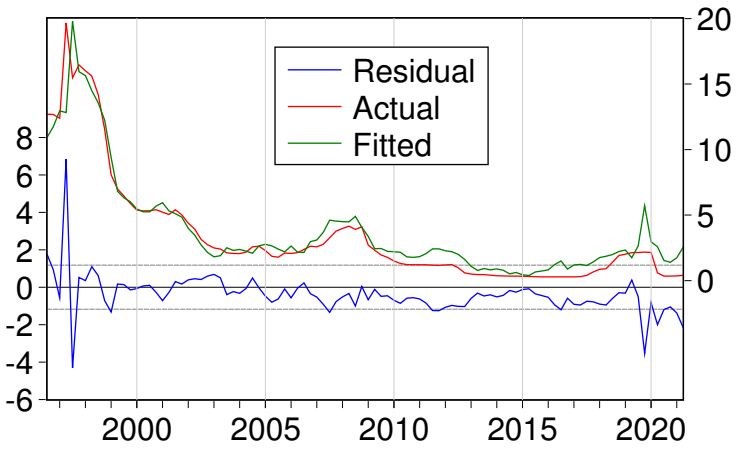
$$\lambda = f^a \times 1600, \tag{A.3}$$

where for the quarterly data $f = 1$. The empirical literature is not unanimous about what the size of a should optimally be. Hodrick and Prescott (1997) uses $a = 2$ but Ravn and Uhlig (2002) shows that $a = 4$ is more precise. Notice that my analysis is based on the quarterly data, where the size of a is completely independent of the results, thus I do not have to examine the discussion about optimal a further.

Hamilton (2018) provided a strong critique of the HP filter due to its feature that it possibly can generate a spurious dynamic relationship that does not describe the true data generating process. Furthermore, Hamilton (2018) suggested his own H filter which does not suffer from the same property. In Hodrick's (2020) reaction to the critique, he tested the H filter and HP filter as well as other filtering techniques. In his analysis, the H filter performed better only in the cases of simple time-series models. In the case of the more complex models, the HP filter seemed to predict the data better. As my model is not as simple as e.g. model of Random walk or similar models, I use the HP filter.

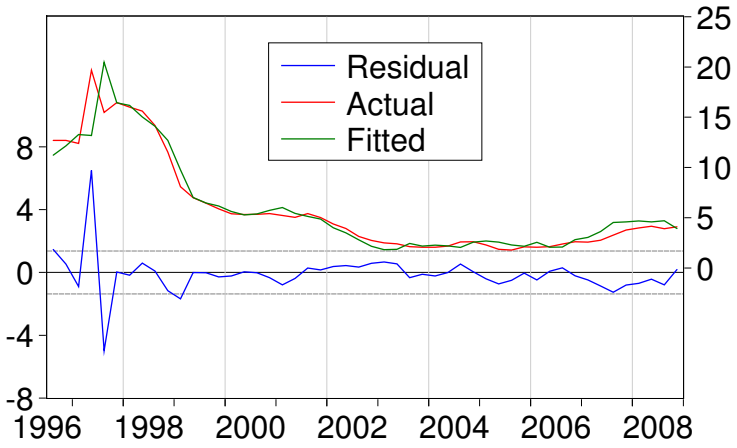
A.2 Prediction error

Figure A.1: Prediction error of the GMM estimation (1) 1996 Q3 - 2021 Q2



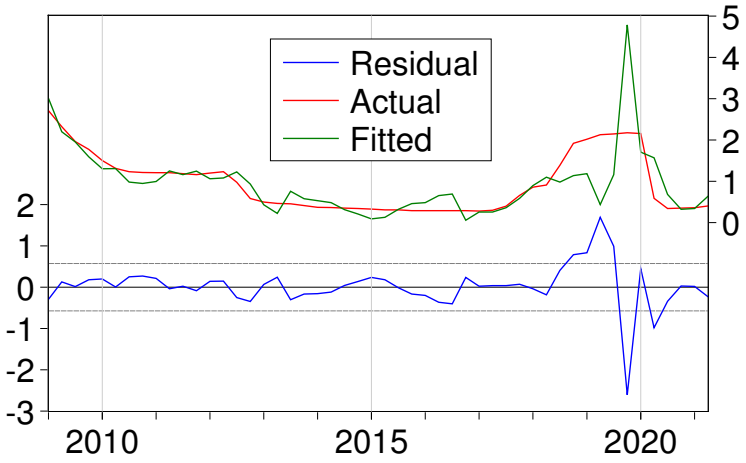
Note: This Figure shows the actual values of the dependent variable of the short-term interest rate and for comparison also the fitted values of the short-term interest rate based on the GMM estimation. Below these lines, the residuals are shown. The model fits the data well except for the crises years of 1997 and 2019. Notice that the model has a bigger problem with the 2020 crisis where it is unable to capture the data generating process well. Whereas the 1997 foreign exchange crisis does less harm as the model is able to capture the true pattern of the data, however, with a quarter delay.

Figure A.2: Prediction error of the GMM estimation (2) 1996 Q3 - 2008 Q4



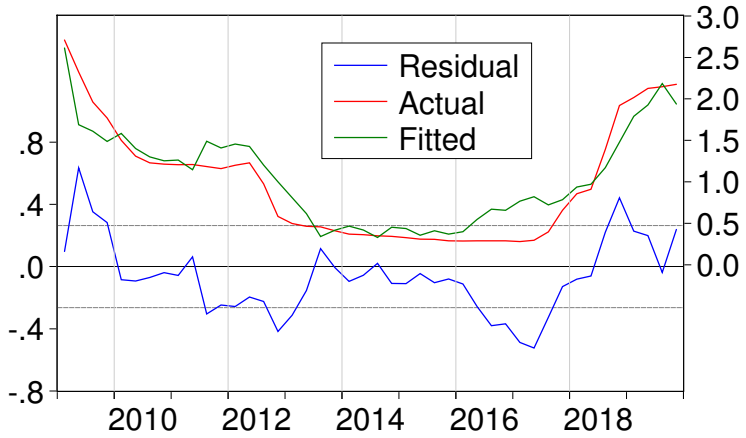
Note: This Figure shows the actual values of the dependent variable of the short-term interest rate and for comparison also the fitted values of the short-term interest rate based on the GMM estimation. Below these lines, the residuals are shown. The model fits the data well except for the 1997 foreign exchange crisis period where the model predicts the data pattern with a period delay.

Figure A.3: Prediction error of the GMM estimation (3) 2009 Q1 - 2021 Q2



Note: This Figure shows the actual values of the dependent variable of the short-term interest rate and for comparison also the fitted values of the short-term interest rate based on the GMM estimation. Below these lines, the residuals are shown. The model fits the data well except for the 1997 foreign exchange crisis period where the model is unable to capture the data generating process which seriously harms the estimated results. As the crisis caused by the Covid-19 pandemic production shutdowns was unsystematic and unpredictable, this behaviour of the model is not surprising.

Figure A.4: Prediction error of the GMM estimation (4) 2009 Q1 - 2019 Q4



Note: This Figure shows the actual values of the dependent variable of the short-term interest rate and for comparison also the fitted values of the short-term interest rate based on the GMM estimation. Below these lines, the residuals are shown. After omitting the crisis period of 2020 and 2021, the model predicts the data better.

A.3 Cubic spline interpolation of quarterly data on GDP

An interpolation method is a useful tool that allows approximating the values of a certain variable within the known values of this variable.

The cubic spline interpolation finds a polynomial function $p(X)$, which interpolates the given data from $x_0, x_1, ..., x_n$ distinct real data points that have associated function values of $y_0, y_1, ..., y_n$:

$$p(x_i) = y_i, \quad i = 0, 1, ..., n \tag{A.4}$$

Generally, the polynomial function for the polynomial degree of m can be written as follows:

$$p(X) = a_0 + a_1 X + ... + a_m X^m, \tag{A.5}$$

where the function contains $m + 1$ independent parameters $a_0, a_1, ..., a_m$. Note that for the cubic spline, the polynomial degree $m = 3$. As the equation A.4 imposes $n + 1$ conditions on the function $p(X)$ the cubic spline can be simplified by assigning $m = n$ which gives the following system of equations:

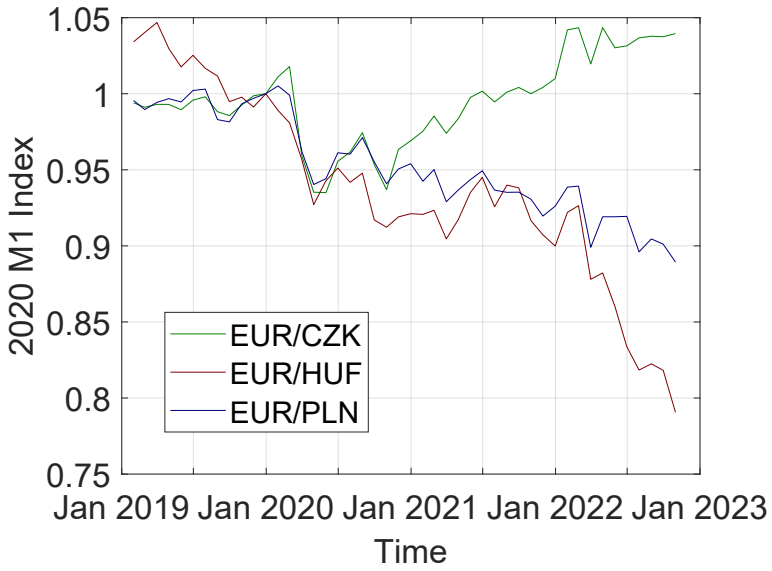
$$\begin{aligned} a_0 + a_1 x_0 + a_2 x_0^2 + a_3 x_0^3 &= y_0 \\ a_0 + a_1 x_1 + a_2 x_1^2 + a_3 x_1^3 &= y_1 \\ a_0 + a_1 x_2 + a_2 x_2^2 + a_3 x_2^3 &= y_2 \\ a_0 + a_1 x_3 + a_2 x_3^2 + a_3 x_3^3 &= y_3 \end{aligned} \tag{A.6}$$

As the system is given by $n + 1$ linear equations and $n + 1$ unknowns, it can be algebraically solved, see Atkinson (2008) for details.

Using this procedure, one can interpolate quarterly data to get the monthly data values.

A.4 Czech Koruna, Hungarian Forint and Polish Zloty development

Figure A.5: Evolution of Czech Koruna, Hungarian Forint and Polish Zloty indirectly quoted to Euro (data source: Eurostat)



Note: While the Hungarian Forint and the Polish Zloty depreciated after Covid-19 also in response to the Russian-Ukrainian war, the Czech Koruna appreciated also due to foreign exchange interventions of the Czech National Bank.