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BACHELOR'S THESIS

Quantifying the Effects of the CNB's Exchange Rate Commitment: A Synthetic Control Method Approach

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Declaration of Authorship

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Prague, May 11, 2016

Signature

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Abstract

In this thesis I evaluate the quantitative effects of the Czech National Bank's commitment to keep the Koruna from appreciating that were put in place in 2013. I focus its on the impact on output, unemployment, and inflation. I use the synthetic control method, which allows me to compute the counter-factual development of the Czech economy in the absence of the commitment. I find that, until the end of 2015, the commitment helped create about 100,000 jobs. The effect on overall output is also strongly positive, almost 2% for growth in 2015, but only marginally statistically significant, which might be connected to disturbances created by changes in excise taxes. The effect of the commitment on inflation is positive but not statistically significant at standard levels.

JEL Classification	E42, E47, E50, E51, E52, E58
Keywords	inflation, unemployment, output, currency, monetary policy, synthetic control method

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Abstrakt

V této práci kvantitativně vyhodnocuji závazek České národní banky z roku 2013, který zamezil posilování české měny. Zabývám se vlivem na celkový výstup, nezaměstnanost a inflaci. Používám syntetickou kontrolní metodu, která umožňuje vypočítat hypotetický vývoj české ekonomiky při absenci tohoto závazku. Zjišťuji, že do konce roku 2015, tento závazek pomohl vytvořit zhruba 100 000 pracovních míst. Vliv na celkový výstup je také silně pozitivní, ale pouze s marginální statistickou signifikancí, což může být spojeno s otřesy vytvořenými změnami spotřebních daní. Vliv závazku na inflaci je pozitivní, ale není statisticky signifikantní při standardní úrovni.

Klasifikace JEL	E42, E47, E50, E51, E52, E58
Klíčová slova	inflace, nezaměstnanost, celkový výstup, měna, monetární politika, syntetická kontrolní metoda

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Acronyms

RMSPE Root Mean Square Predicted Error

CNB Czech National Bank

ZLB Zero lower bound

HCPI Harmonized Consumer Price Index

GDP Gross Domestic Product

ECB European Central Bank

SCM the synthetic control method

Bachelor's Thesis Proposal

Author	Matěj Opatrný
Supervisor	Doc. PhDr. Tomáš Havránek, Ph.D.
Proposed topic	Quantifying the Effects of the CNB's Exchange Rate Commitment: A Synthetic Control Method Approach

Topic characteristics There has been recently a great deal of discussion on the topic of the impact of 2013 Koruna weakening by the Czech National Bank (CNB). In this bachelor thesis we will evaluate this idiosyncratic event by using the the synthetic control method (SCM), which has been applied, for example, in *Estimating the Effect of California's Tobacco Control Program* by Abadie *et al.* (2012).

Its key advantages are effective evaluation of the intervention in the absence of the event and, instead of comparative case studies, it allows for quantitative inference. The principle of using the method is constructing a counter-factual for the Czech economy without the intervention by finding the weighted average of countries that match the development of key Czech indicators before the intervention. In the first part of the thesis, we will provide the methodological background of SCM and introduce the monetary policy of CNB. Afterwards, we will estimate the impact of the intervention on Czech GDP per capita, HCPI, and unemployment. Finally, we will conclude with the implementation of the CNB policy with respect to SCM.

Outline

1. Introduction
2. Literature Review
3. Methodological aspects
4. Empirical Verification
5. Conclusion

Core bibliography

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Author Supervisor

Chapter 1

Introduction

The exchange rate commitment of the CNB had been a topic of policy and academic debate for a while when it was launched in the period Q4 2013. Since the CNB decreased the interest rate to "technical zero" in order to fight the falling of the HCPI, there was a demand for different monetary tool to achieve an inflation target set by CNB. Finally, in November 2013, CNB initiated a weakening of the Czech currency to the minimum level of 27 CZK per 1 Euro with the goal of increasing HCPI and therefore avoiding a risk of deflation.

The objective of this thesis is to evaluate the effect of the intervention on the Czech macroeconomic indicators – GDP per capita, unemployment rate and HCPI – using the synthetic control method. The method provides a possible development of Czech macroeconomic indicators in the absence of the intervention. The principle of using this method is constructing a counter-factual for the Czech economy without the intervention by finding the weighted average of countries that match the development of key Czech indicators before the intervention. The important fact is that the counter-factual is not constructed by extrapolating pre–event trends from the treated unit but rather, as Abadie & Gardeazabal (2003) proposed, by building a synthetic control group. So far, there can be found many empirical studies related to the evaluation of the exchange rate intervention on a small open economy. However, thanks to the synthetic control method, this empirical study provides quantitative inference without excluding the application of qualitative approaches.

From the outset, we would like to stress out that we are not testing the relationship between Czech macroeconomic indicators and exchange rate commitment introduced by CNB. Instead, we attempt to establish a possible path of macroeconomic indicators and magnitude of the effect of the intervention

on the Czech key macroeconomic indicators. As a result, we find that, thanks to CNB's exchange rate commitment, the unemployment rate decreased on the level of 4.5% until the end of the year 2015 – in other words creating around 100,000 working positions. Consequently, we demonstrate a slight positive effect on the GDP per capita and indecisive effect on HCPI.

This thesis is structured as follows. In chapter 2 we describe the core literature used to establish this empirical study. In chapter 3, we refer to the methodological background of the synthetic control method. There, the reader can also find a brief subsection discussing the inference provided by the synthetic control method. In chapter 4, we summarize historical aspects that triggered the exchange rate commitment and we introduce the monetary policy of CNB. Finally, we provide the results for GDP per capita, unemployment rate, and HCPI, respectively, computed by the synthetic control method. Moreover, for each variable there are included robustness tests to check the credibility of the results. The conclusion can be find in chapter 5.

Chapter 2

Applications of the Synthetic Control Method

In this section I will present core papers to familiarize the reader with the synthetic control method. Since the synthetic control method was developed in 2003 by Abadie & Gardeazabal (2003), there are several empirical studies using the method.

Abadie & Gardeazabal (2003) introduce the synthetic control method in *The economic costs of conflict: a case study of the Basque country*, where they present evidence of the negative economic impact of the terrorist conflict in the Basque Country. Moreover, the study shows a 10 % average gap between the synthetic control group per capita GDP and Basque per capita GDP over the period of twenty years.

Adopting the synthetic control method, Lee (2010) challenges if the inflation targeting tool is an effective policy in emerging economies. His study shows that inflation targeting helped reduce the inflation rate in Columbia, the Czech Republic, Hungary, and Poland, when they adopted such policies in 1990s and 2000s. On the other hand, his study finds that no significant effect was found when there was a later start date of the policy.

The next Abadie (2011) paper *Using Synthetic Controls to Evaluate an International Strategic Positioning Program in Uruguay: Feasibility, Data Requirements, and Methodological Aspects* thoroughly describes the use of the synthetic control method. Furthermore, this paper provides a potential way to adapt the synthetic control method if some of the requirements are not met.

Abadie *et al.* (2012) also use the synthetic control method to estimate the effect of California's tobacco control program - Proposition 99. In this paper,

they extend the synthetic control method by a procedure to produce inference that involves uncertainty about the validity of the control unit. Finally, they demonstrate that annual per-capita cigarette sales would have been about 26 packs higher in the absence of Proposition 99.

Billmeier & Nannicini (2013) apply SCM to find consequences of economic liberalization. They investigate the impact of economic liberalization on real per capita GDP in a worldwide sample of countries. As a result, they demonstrate positive effect in most regions, but they also mention that the most recent liberalization, mainly in Africa, had no significant impact.

The next application of SCM is on the estimation of a natural disaster on economic growth by Cavallo *et al.* (2013). In this paper, they focus mainly on large natural disaster and its consequences. By researching 196 countries covering the period 1970–2008 they find that natural disasters do not have any significant effect on subsequent economic growth.

Using the synthetic control method, Jinjarak *et al.* (2013) examine changes in Brazil's capital account regime during the period 2008–2011. They find that there is no evidence that any tightening of controls is effective in decreasing the level of capital inflows. On the other hand, they observe some modest success in preventing capital inflows when the capital controls are relaxed.

In the next paper related to SCM, Acemoglu *et al.* (2013) demonstrate the connectivity of financial firms with a political scene, namely with the Secretary of the Treasury in the USA. The paper shows that the announcement of Timothy Geithner as a nominee for the Secretary of the Treasury produced an abnormal cumulative return for financial firms connected with him. Expressed in numbers, this return was about 6% after the first day of trading and about 12% after 10 days of trading.

Aytug (2014) develops a model using the propensity score matching (PSM) and the synthetic control method techniques to evaluate the average effect of adopting the euro on economic growth. These techniques allow him to assess the effect for the member of Eurozone (using PSM) and also how each Eurozone member would have performed in the absence of the euro adoption (using SCM). As Aytug (2014) comments, the findings confirm the significant relationship between the exchange rate regimes and growth, even though the effect of adopting the euro on growth is negative.

Campos *et al.* (2014) present the economic benefits from membership with the European Union. They estimate GDP per capita and labour productivity for countries that joined the European Union in 1970s, 1980s, 1995 and 2004,

in the absence of membership with the European Union. They find that, without political and economic integration, GDP per capita would have been, on average, approximately 12% lower.

As Abadie *et al.* (2015) point out in the empirical study *Comparative Politics and the Synthetic Control Method* , the synthetic control method might be used as a bridge between qualitative and quantitative approaches in empirical case studies. The core merit of this method lies in a systematic way of choosing comparison units in comparative case studies. Consequently, Abadie *et al.* (2015) apply the synthetic control method on German reunification, which took place in 1990. Their results indicate a negative effect of reunification over the entire period 1990-2003 on West Germany per capita GDP by approximately 1,600 USD per year on average.

The next application of the synthetic control method is performed by Gomis-Porqueras *et al.* (2015), where they estimate the effect of joining the monetary union on per capita income. The results show that, in contrast with Belgium, France, Germany and Italy, where the income per capita would have been higher without the Euro, that of Ireland would have been lower. For the Netherlands they observe an indecisive effect. In addition, they provide an explanation for those income effects, claiming that those countries which had adopted the euro earlier, had synchronized business cycles with the union, and were more open in intra union trade and migration, lost less or gained more from the euro adoption.

In their paper *Examination of the Synthetic control method for evaluation health policies with multiple treated units*, Kreif *et al.* (2015) extend the original synthetic control method approach to a setting where there are multiple treated units. By using this improvement on the synthetic control method, they examine the effect of a pay-for-performance initiative, the Advancing Quality scheme, in contrast to difference-in-differences (DiD) estimation method. The main distinction between these two methods is that DiD estimation assumes constant effect of unobserved con-founders over time, while the synthetic control method allows changes in those effects over time.

Chapter 3

Technical Aspects of the Synthetic Control Method

In comparative case studies, there is often stress to choose comparison units because using improper comparisons may lead to faulty conclusions. The synthetic control method provides a systematic way of choosing comparison units (Abadie *et al.* 2012). In addition, as Abadie *et al.* (2015) pp. 2 claim:

> Formalizing the way comparison units are chosen not only represents a way of systematizing comparative case studies ..., but it also has direct implications for inference. We demonstrate that the main barrier to quantitative inference in comparative studies comes not from the small-sample nature of the data, but from the absence of an explicit mechanism that determines how comparison units are selected. By carefully specifying how units are selected for the comparison group, the synthetic control method opens the door to the possibility of precise quantitative inference in comparative case studies, without precluding qualitative approaches to the same data set.

3.1 Description of the Method

Suppose that we gather data for $J + 1$ countries. Without loss of generality, we assume that only the first country is exposed to the intervention of interest. Therefore, there are J countries remaining as eventual control units not influenced by the intervention. Also, without loss of generality, we assume that the first country is continuously exposed to the intervention from the period when the intervention was launched (Abadie *et al.* 2015).

Let Y_{it}^N denote the potential outcome of interest in the absence of the intervention for country i in period t where $i \in \{1, ..., J + 1\}$ and $t \in \{1, ..., T\}$.

Consequently, let T_0 be the number of pre-intervention periods fulfilling the condition $1 \leq T_0 \leq T$ (Abadie *et al.* 2015).

Let Y_{it}^I denote the outcome of interest for country i in period t under the intervention which takes place in periods $T_0 + 1$ to T . Naturally, we assume that the intervention has no effect on the outcome in pre-intervention periods, therefore $Y_{it}^N = Y_{it}^I$. When setting the intervention periods T_0 there is necessity to take into account any anticipation effect, so that T_0 can be reset to the period when the first effect of the intervention is assumed to appear (Abadie *et al.* 2015).

The constructing of control units requires certain attention. Firstly, the country which adopted the similar intervention should be excluded from a data set to avoid a potential bias of the output. For this reason, we omitted Switzerland[1] from a sample. Secondly, for a good fit of counter-factual outcome, there is a need for comparison units to have similar economic performance as a unit exposed to the intervention. Taking this assumption into account, we consider only European countries as suitable comparison units. Moreover, countries which may be affected by the intervention in the "treated" country should be excluded from a sample (Abadie *et al.* 2015).

The effect of the intervention with $t > T_0$ is represented as follows:

$$\upsilon_{it} = Y_{it}^I - Y_{it}^N \tag{3.1}$$

Given that Y_{it}^I is observed in equation (3.1), we must now estimate Y_{it}^N. The key aspect of a synthetic control is that it is defined as a weighted average of the control units with weights $w = \{w_2, ..., w_J\}$ with $0 \leq w_j \leq 1$ for $j = 2, ..., J$ and

$$\sum_{j=2}^{J} w_j = 1$$

These restrictions are made to avoid an extrapolation (Abadie & Gardeazabal 2003). Using given weights $\{w_2, ..., w_J\}$ the synthetic control estimators of Y_{it}^N and υ_{it}[2] are :

$$\hat{Y}_{it}^N = w_2\, Y_{2t} + \cdots + w_J\, Y_{Jt}$$

$$\hat{\upsilon_{it}} = Y_{it}^I - \hat{Y}_{it}^N$$

The next step is to choose weights $\{w_2, ..., w_J\}$. According to Abadie &

[1] See Data and Sample section in chapter 4 for more details.

[2] See Abadie *et al.* (2012) where it is proved that $\hat{\upsilon_{it}}$ is an unbiased estimator of υ_{it}.

Gardeazabal (2003) and Abadie *et al.* (2012), the weights should best reflect the pre-intervention features of the affected unit. Furthermore, Abadie & Gardeazabal (2003) and Abadie *et al.* (2012) choose $w^* = \{w_2^*, ..., w_J^*\}$ which minimizes:

$$v_1(X_{11} - w_2 X_{12} - \cdots - w_J X_{1J})^2 + \cdots + v_k(X_{k1} - w_2 X_{k2} - \cdots - w_J X_{kJ})^2 \quad (3.2)$$

where $\{v_1, ..., v_k\}$ represent the relative importance of the synthetic control assigned to predictors $\{X_{11}, ..., X_{k1}\}$.

Therefore, the problem comes down to choosing $\{v_1, ..., v_k\}$. In this paper,[3], the weights are chosen so that the synthetic controls minimize the size of the prediction error, $Y_{it}^I - \hat{Y}_{it}^N$, in a selected pre-intervention period, this can be done by solving a nested optimization problem with v selected so that w minimizes the root mean square predicted error RMSPE during a selected periods. Therefore, each choice of v results in different country weights $w(v)$, which then gives a value for the RMSPE[4].

3.2 Inference using the Synthetic Control Method

This thesis uses three inferential methods. Two of these methods were initially introduced by Abadie & Gardeazabal (2003), in which they run "placebo" effects. The third method is based on constructing of a confidence interval using RMSPE for the computation. As Abadie *et al.* (2015) note, these tests provide good results only if there is a sufficiently large number of periods when no significant shocks to the outcome of interest took place.

The first method to construct a placebo study suggests applying the synthetic control method to all control units. In this way, we obtain a synthetic control for countries not exposed to the intervention. This allows researchers to evaluate the estimation of the effect between the treated unit and the units not exposed to the intervention. In other words, the confidence about the result would decrease if the synthetic control method were to estimate a large effect to a unit where the intervention was not set up.

The second method related to the placebo study applies the synthetic control method to the period when the intervention did not occur in a treated unit. As Abadie *et al.* (2015) mention, a large placebo estimate would undermine the

[3]See Abadie (2011) which describes several methods for choosing the weights $\{v_1, ..., v_k\}$

[4]The RMSPE has following formula: $RMSPE = (\frac{1}{T_0} \sum_{t=1}^{T_0} (Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt})^2)^{\frac{1}{2}}$

credibility of a result. For example, if there is a significant effect of intervention in an earlier period,[5] the confidence of the effect would greatly diminish.

The third, and last, method is based on the construction of a 95% confidence interval. To create the confidence interval we assume that the outcome of interest follows the student's distribution due to small a number of pre-intervention periods.[6] Using the RMSPE calculated by the synthetic control method, we can construct respective confidence intervals. Using a generated confidence interval, if the outcome of the interest exceeds the bounds of the interval, we would infer that the intervention has the effect on the output. In the empirical section below, we can see that there is an effect on the unemployment rate, and also a slight effect on the GDP per capita in the Czech Republic.

[5] We can choose random periods prior to the intervention.

[6] The number of pre-intervention periods depends on the starting period of our data related to a chosen variable.

Chapter 4

Quantifying the Effects of the CNB's Exchange Rate Commitment

4.1 Historical Background

The Czech economy experienced stable economic growth during the period 2000–2008. Nevertheless, as a small open economy it is excessively influenced by key economic powerful countries. Since the Great Recession spread from the USA to Europe in 2008, Czech economic performance slowed down. GDP growth sharply decreased and can be seen in the figure 4.2 as a solid line. Moreover, the unemployment rate keenly increased during the year 2009 as seen in figure 4.7. Finally, as figure 4.11 shows, HCPI reached nearly zero during the year 2009. Therefore, there was a serious threat of deflation[1]. As Rogoff (2003) pp. 6, suggests:

> It is better to prevent deflation than to try to cure it, and monetary policy must take the lead. Since the risks of deflation are asymmetric, policy must be attuned to deflationary impulses in a low inflation environment. Further, because these impulses can also impede the monetary transmission mechanism, aggressive action is required. At the zero bound on nominal interest rates, additional unorthodox measures may be needed. Stimulatory fiscal policies can play an important complementary role; their beneficial effects could be enhanced if measures are adopted to raise the rate of return to the economy, so as to spur investment and output. Structural reforms, particularly those improving credit intermediation, could also be beneficial.

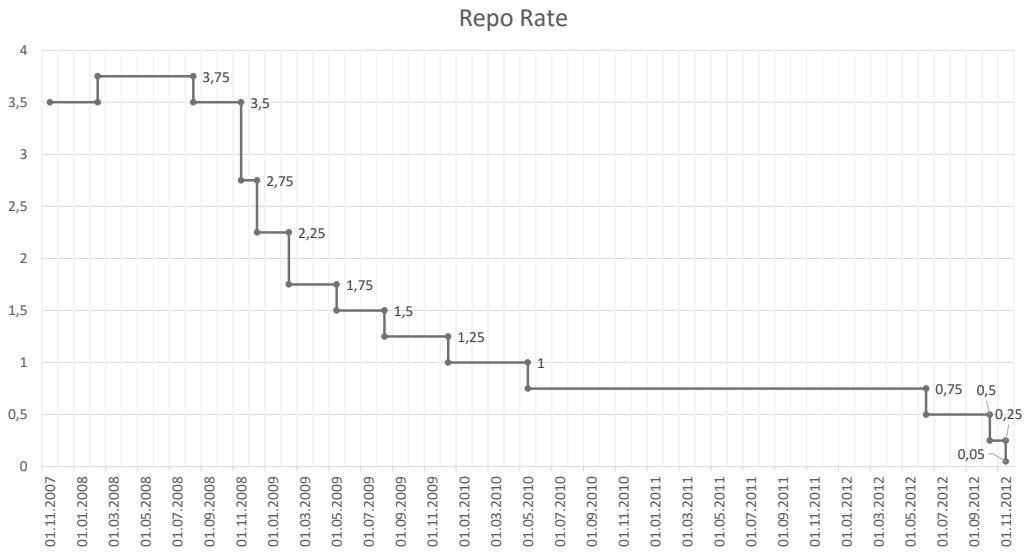
[1]Deflation is defined as a continuous decline in aggregate measures of prices such as HCPI or the GDP deflator.

As an answer to the threat of deflation, CNB used their repo rate as a common tool to maintain the inflation target. The idea behind using repo rate to affect an inflation is explained by Taylor's rule (Taylor 1993):

$$i = i^* + a(\pi - \pi^*) + b(y - y^*) \tag{4.1}$$

Where i is a target interest rate, i^* is equilibrium interest rate, π is inflation rate, π^* is inflation target, and finally $y - y^*$ is an output gap. The choosing of parameters a and b also has a high impact on the monetary policy. For example if $b = 0$, we can say that a bank focuses only on desired inflation target and does not take into account an economic growth. Following Taylor's rule, we can obtain recommended levels of interest rate responding to the inflation and economic performance. We can see in the figure 4.1 that the bank was continually decreasing the repo rate at a rate of 3.75% in early 2008 to "technical zero" in Q4 2012 in order to recover the Czech economy from its crisis. However, the desired effect did not occur and the conventional policies became ineffective. In addition, CNB lost their main monetary tool.

Figure 4.1: Repo Rate



Source: CNB–https://www.cnb.cz/cs/faq/vyvoj_repo_historie.txt.

4.2 Monetary Policy of the Czech National Bank

According to Czech law (Česká národní rada 1993) the CNB's primary goal is to maintain price stability. To achieve this, the CNB uses an inflation targeting tool aimed towards maintaining 2% of the inflation level. As Williams *et al.* (2014) point out, the main advantages of this tool are price stability, transparency of central bank decision, and the tendency to have stable inflation compared to other monetary policy regimes. According to CNB (2016),the four basic monetary policy regimes are as follows:

- A regime with an implicit nominal anchor, which, in fact, means targeting a particular nominal variable that is adopted only within CNB and is not being announced explicitly. Moreover, this policy requires high credibility of CNB, which, afterwards, leads to the desired inflation target (CNB 2016).

- Targeting money supply, which mainly focuses on the growth rate of a specific monetary aggregate. This thought is based on the idea that price level is affected by money supply level. CNB (2016) points out that the disadvantage is the difficult selection of the monetary aggregate due to an innovation in financial markets, globalisation, and computerization. These innovations show a weaker relationship between price level and monetary aggregate (CNB 2016).

- Exchange rate targeting, which basically means to peg the local currency to a foreign currency and, via interest rate changes and direct foreign exchange interventions, control the price stability. On one hand, it is necessary to own a sufficient level of foreign reserve to maintain this policy. On the other hand, the anchor country should have low inflation. The main disadvantage of this policy is the loss of monetary autonomy (CNB 2016).

- Inflation targeting, the most sophisticated of the policies, is based on announcing the inflation target in advance. To achieve the desired inflation target it is crucial to know the information about the labour market, import prices, producer prices, output gap, nominal and real interest rates, nominal and real exchange rate, and other macroeconomic indicators (CNB 2016). This monetary regime is currently used by CNB.

However, during the realization of the inflation targeting, two main challenges might appear: the first is the zero lower bound on nominal interest rate and the second is using a suitable monetary policy to sustain financial stability[2] (Williams *et al.* 2014).

Since the CNB decreased the Czech interest rate to "technical zero" in Q4 2012, CNB had to use another tool to maintain the 2% inflation targeting. Therefore, in Q4 2013 CNB, decided to use the stable exchange rate to achieve the inflation target. More precisely, CNB set the exchange rate of Czech koruna to euro on the minimum level of 27 CZK per 1 EUR. According to CNB (2013), using the exchange rate tool confirms that the weakness of Czech currency is, in the long-term, a highly effective mechanism with which to achieve the inflation target. Since there are 2 post-intervention years, we further challenge the effect in mid-term rather than in long-term.

[2]See Williams *et al.* (2014), which describes Zero lower bound (ZLB) the example of Japan in the 1900s. It also discusses the challenge of the suitable monetary policy to maintain financial stability.

4.3 Data and Sample

In this thesis we use quarter panel data collected from the Eurostat database for the periods Q1 2005–Q4 2015.[3] For the Seasonally Adjusted GDP per capita, however, we also provide additional results for the period Q1 2001–Q4 2015, and for HCPI for the period Q4 2007–Q4 2015. Our sample periods end in Q4 2015, because during the writing of this thesis it was the last available data.[4] The intervention of CNB occurred in Q4 2013, which means more than 35[5] pre-intervention quarters. As Abadie *et al.* (2015) mention, nearly a decade-long period after the intervention, in our case 8 post-intervention quarters, seems like a plausible span for a prediction.

The control units include 22 European states: Austria, Belgium, Bulgaria, Croatia, Denmark, Estonia, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Since the synthetic Czech Republic should reproduce the output in the absence of the intervention, we omitted Switzerland from the control units, because the Swiss Central Bank adopted the exchange rate mechanism in Q1 2015 to achieve the inflation target. Moreover, we exclude Norway, because there are no data for Index of Wage in the Industry Sector[6], which turn into the main predictor.[7] Furthermore, we omit Malta from the control units, because of the small size of its economy. We also exclude Finland due to its strong economical relationship with Russia[8], which could negatively affect the performance of the Czech Republic after the intervention.

As the output variables, we use Seasonally Adjusted GDP per capita, unemployment rate, and HCPI. A list of variables and their sources are provided in the appendix A.2. The set of predictors consists of Seasonally Adjusted GDP

[3]The starting period Q1 2005 is chosen because of the Czech economy's close convergence with the European Union economy. Moreover, the Czech Republic joined the EU in 2004.

[4]Data for explanatory variables – Final Consumption per Capita, Real Exchange Rate, and Index of Wage in Industry Sector are provided until the period Q2 2015, which, in fact, does not have an impact on the results. The synthetic control method averages predictors prior to the intervention. In our case, prior to the period Q4 2013.

[5]The number of pre-intervention periods depends on the starting period. The period Q1 2005 is used here.

[6]During the writing of this thesis, the Eurostat database did not provide data for the Index of Wage in Industry Sector for Norway.

[7]See tables 4.1,4.7, 4.4 for details.

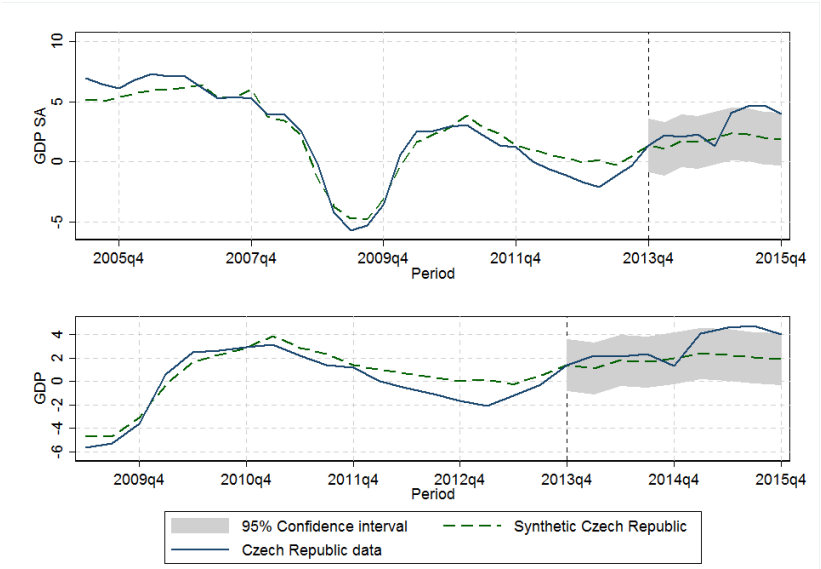
[8]The Ukrainian crisis and a fall in the price of oil caused Russian economy to slow down, which consequently negatively affected Finish economical performance.

per capita, HCPI, Final Consumption per Capita, Real Exchange Rate, Index of Wage in Industry Sector, and unemployment rate.[9]

4.4 Seasonally Adjusted GDP per Capita

In the figure 4.2 we can see per capita seasonally adjusted GDP and its synthetic counterpart during the period Q1 2005–Q4 2015. Moreover, the reader can see additional results for the period Q1 2001–Q4 2015 in the figure 4.3. Take in consideration that all tables provided in this section are related to the period Q1 2005–Q4 2015.[10]

Figure 4.2: Seasonally Adjusted GDP per capita Q1 2005–Q4 2015

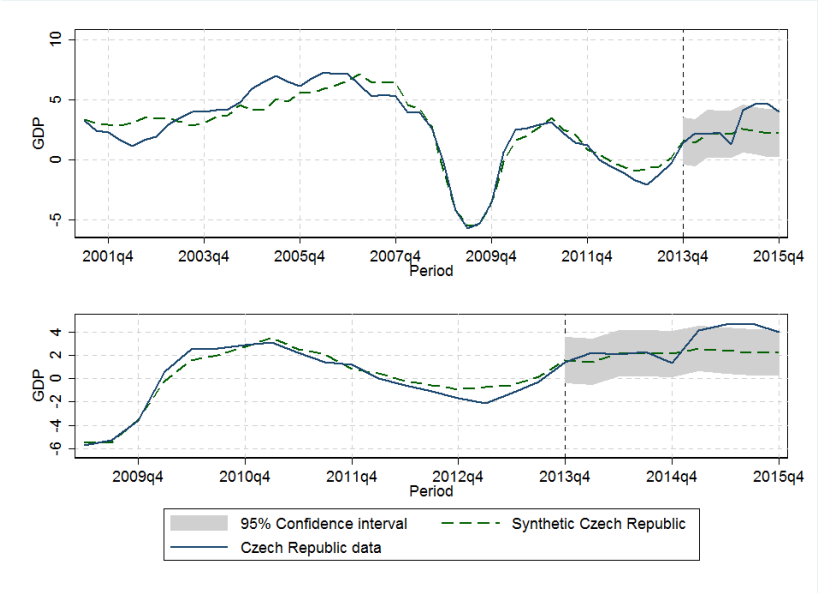


Source: Synthetic control method computation.

[9]See appendix for details about predictors.

[10]See Appendix A.1 for the results related to the figure 4.3 during the period Q1 2001–Q4 2015.

Figure 4.3: Seasonally Adjusted GDP per capita Q1 2001–Q4 2015



Source: Synthetic control method computation.

The difference between per capita GDP and its synthetic version is the effect of the intervention. Consequently, it can be seen in figure 4.2 that the synthetic per capita GDP precisely follows the real version until Q4 2014. After the period Q4 2014 the real per capita GDP significantly increases. Furthermore, it slightly exceeds the 95% confidence interval of the estimation of the synthetic counterpart. Therefore, we can recognize the effect of the intervention. Nevertheless, it is necessary to take into account that the increase in GDP per capita could be contributed to several idiosyncratic events, such as an accelerated pumping of European structural funds in the period Q4 2014, which is described in detail in Ministry of regional development (2014), and increasing indirect taxes on tobacco products, which is discussed in the end of this section.

Table 4.1 displays weights computed by the synthetic control method using the nested optimization process. As Abadie & Gardeazabal (2003) suggest, the outcome of interest can be included in synthetic control predictors during the pre-intervention period. We can see that the power of predictors decrease in the following order: Index of Wage in Industry Sector, Seasonally Adjusted GDP per capita, Real Exchange Rate, unemployment rate, HCPI, and Final Consumption per Capita.

Table 4.1: Predictor Weights

Country	Synthetic Control Predictor Weight
Seasonally Adjusted GDP per capita	0.0544
Final Consumption per Capita	0.0001
Real Exchange Rate	0.0013
Index of Wage in Industry Sector	0.9442
HCPI	0.0001
Unemployment Rate	0.0002

Source: Synthetic control method computations.

The Index of Wage in Industry Sector in table 4.1 obtains unusually high prediction weight. In other words, this high prediction weight indicates that the weight of countries is chosen mainly according to the Index of Wage in Industry Sector.[11] On the other hand, the outcome is very comparable to figure 4.3.

In table 4.2 we compare predictor means of the synthetic control units and those of the treated unit before the intervention. The synthetic control units provide very similar results in terms of Seasonally Adjusted GDP per capita, Real Exchange Rate and Index of Wage in Industry Sector. The magnitude of the differences between Final Consumption per Capita, HCPI, unemployment rate and its synthetic counterpart are slightly larger but, as can be seen in table 4.1, its predictive power is small.

Table 4.2: Predictor Means Before the Intervention

Country	Treated Unit	Synthetic Unit
Seasonally Adjusted GDP per capita	2.214	2.213
Final Consumption per Capita	0.840	1.776
Real Exchange Rate	113.451	113.012
Index of Wage in Industry Sector	88.060	87.977
HCPI	2.455	3.122
Unemployment Rate	6.590	7.884

Source: Synthetic control method computations.

In table 4.3 the reader can see weights of the control units related to the Seasonally Adjusted GDP per capita. The synthetic counterpart is created by combining the following countries: Netherlands, Bulgaria, Slovakia, Denmark,

[11] See Appendix A with the results related to figure 4.3.

and Estonia. Note that Ireland and Luxembourg are excluded from the initial control units. The reason for Ireland's exclusion is that, during the whole sample period, the Eurostat database does not provide values for the seasonally adjusted GDP per capita. Luxembourg is excluded from the control units because its economy is more highly developed than that of the Czech Republic in terms of per capita GDP.

Table 4.3: Country's Weights

Country	*Synthetic Control Weight*
Austria	0
Belgium	0
Bulgaria	0.227
Croatia	0
Denmark	0.130
Estonia	0.132
France	0
Germany	0
Hungary	0
Italy	0
Latvia	0
Lithuania	0
Netherlands	0.365
Poland	0
Portugal	0
Slovakia	0.145
Slovenia	0
Spain	0
Sweden	0
United Kingdom	0

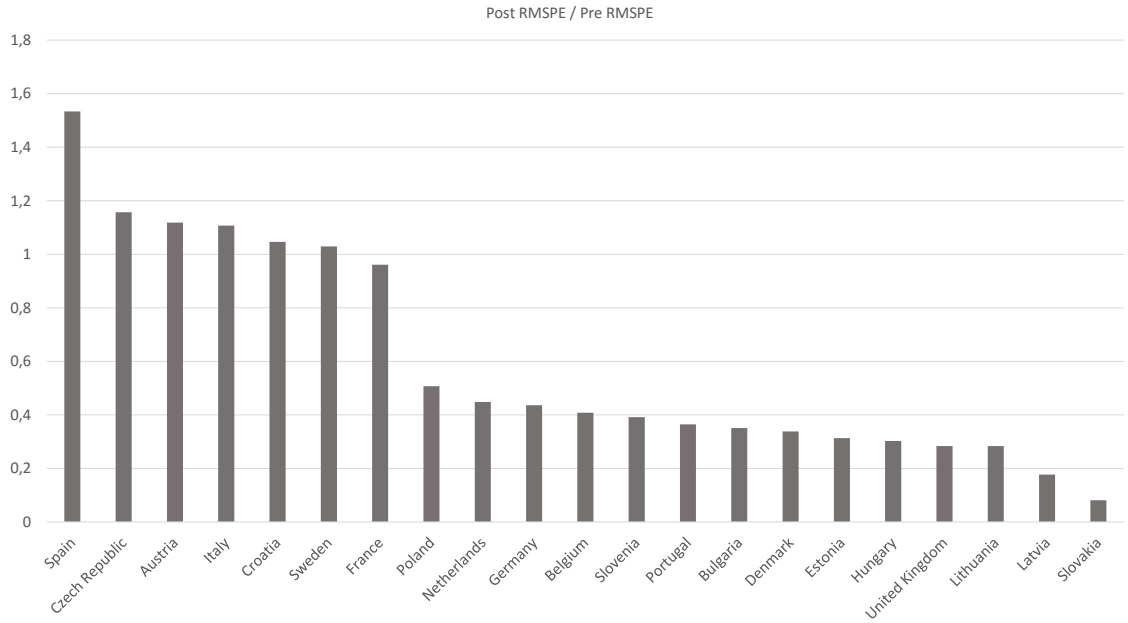
Source: Synthetic control method computations.

4.4.1 Robustness Tests

The credibility of the results can be clarified by running placebo studies, as described in Chapter 3. Firstly, we reassign the intervention to all control units and evaluate the ratio of post-intervention RMSPE to pre-intervention RMSPE. As Abadie *et al.* (2015) point out, a large post-intervention RMSPE is not indicative if the synthetic output of interest does not closely reproduce the real output of interest prior to the intervention. In other words, if the ratio between post-intervention RMSPE and pre-intervention RMSPE is large, then

the effect of the intervention is also large. In figure 4.4 we can see that the Czech Republic comes in second for the largest effect of the intervention. This indicates that the intervention has an impact on the Seasonally Adjusted GDP per Capita in the Czech Republic.

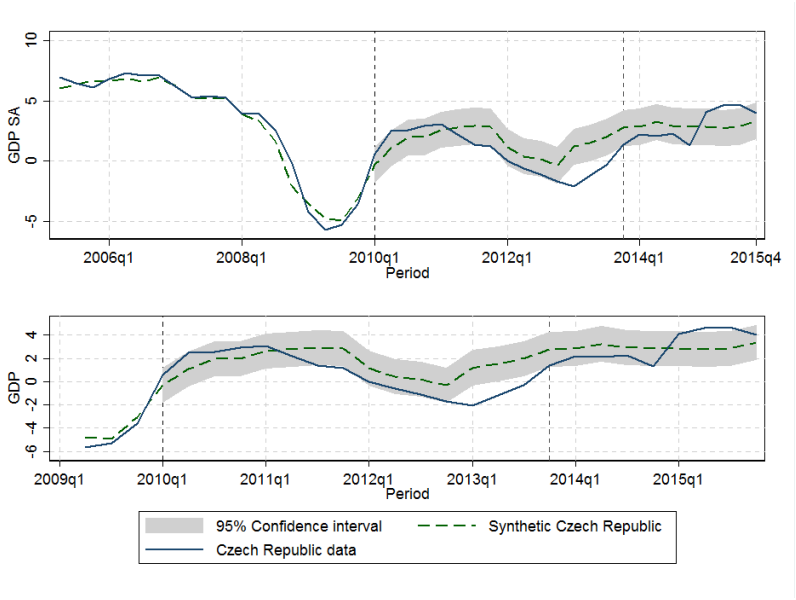
Figure 4.4: Ratio of Post-intervention RMSPE and Pre-intervention RMSPE related to Seasonally Adjusted GDP per Capita



Source: Synthetic control method computation.

Secondly, we change the period of the intervention to Q1 2010 using the same technique of choosing control units weights. Figure 4.5 displays the output of the interest when the intervention period is set to Q1 2010. It can be seen that before the period Q4 2013 (which indicates the non–labelled dash line) the real output exceeds a lower bound of the 95% confidence interval of its synthetic counterpart. This exceeding might be due to the difference between per capita GDP and its synthetic counterpart in figure 4.2 during the period Q3 2011 – Q4 2013. On the other hand, comparing figures 4.5 and 4.2, the fit is very analogous in period Q1 2010 – Q4 2013. Moreover, figure 4.5 shows that the real output exceeds an upper bound of the 95% confidence interval of its synthetic counterpart in the same period (Q1 2015) as in figure 4.2 with a very similar magnitude. This suggests that the effect of the intervention is not negligible in terms of Seasonally Adjusted GDP per Capita.

Figure 4.5: Seasonally Adjusted GDP per Capita Reassigned to the period Q1 2010.



Source: Synthetic control method computation.

Taking into account figures 4.2 and 4.4, there might be an effect of the intervention on per capita GDP. Nevertheless, there are several events which had an impact on the effect of the intervention. For instance, the changes in indirect taxes mainly for tobacco products. As Holub (2013) comments, the acceleration of GDP growth was largely due to the increased collection of duty on tobacco products.

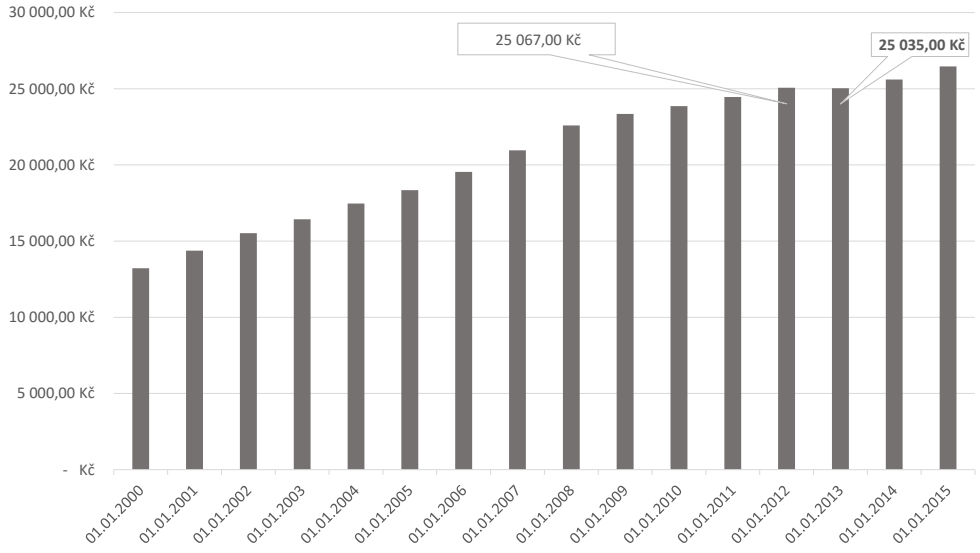
Another factor influencing the Czech economy is the restrictive fiscal policy at the beginning of the intervention. Together with the intervention, the restrictive policy might lead to an increase in net export and, therefore, to an increase in GDP growth.

Holub (2015) pp. 2 also adds:

> The Czech economy did not begin 2013 in good shape: it was still in a prolonged recession and falling ever deeper below its potential. In the middle of the year it reached the bottom of the economic downturn; nonetheless, even subsequent to this milestone it was still not possible to point to any significant recovery. At the same time, the growth of wages significantly slowed and unemployment increased. The anti-inflationary domestic conditions caused a decline of inflation at the beginning of the year below the 2% CNB target, despite a January increase in indirect taxes, while at the same time core inflation remained negative.

Moreover, as can be seen in figure 4.6, the nominal wages decreased in the year 2013.

Figure 4.6: Annual Nominal Wage



Source: CNB ARAD time series database.

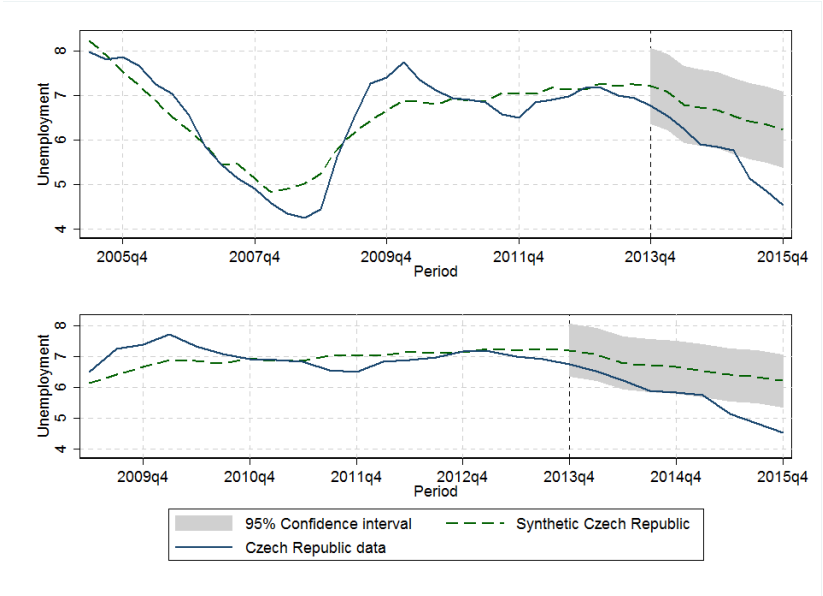
In summary, all of these idiosyncratic events had an undoubted impact on the performance of the Czech Republic. Therefore, these events should be considered when evaluating the synthetic counterpart in figures 4.2 and 4.5.

4.5 Unemployment

Figure 4.7 displays the effect of the intervention on the unemployment rate in the Czech Republic during the period Q1 2005–Q4 2015. The synthetic Czech Republic data mildly fit that of the real unemployment data in the pre-intervention period. Together with the close fit of predictor means (HCPI, Seasonally adjusted GDP per capita, Index of Wage in Industry Sector, and unemployment rate itself) in table 4.5, we can conclude that there exists a combination of other European countries that reproduces economic characteristics of the Czech Republic before the intervention. Moreover, there is a significant positive effect of the intervention on the unemployment rate.

According to Český statistický úřad (2016), the exact number of unemployed people[12] in the Czech Republic is 239 000 (4.5% in terms of unemployment rate) at the end of the period Q4 - 2015. The synthetic Czech Republic in figure 4.7 indicates that the unemployment rate would be 6.3% without the intervention at the end of the period Q4 - 2015. In other words, there are 95 600[13] fewer unemployed people in the Czech Republic than there would be without the intervention, with a 95% level of significance.

Figure 4.7: Unemployment Rate



Source: Synthetic control method computation.

[12]Any person between 15 and 64 years old. See chapter A.1 for detailed information.

[13]Based on the author's computation, assuming that 4.5% is equal to 239 000, meaning that 6.3% is equal to 334 600. Finally, after deduction, the result is 95 600.

In table 4.4 we can see the predictor weights, which are computed by the nested optimization process. The weights selected by the process indicate that the most important predictors are unemployment rate, Seasonally Adjusted GDP per capita, HCPI, Real Exchange Rate, Final Consumption per Capita, and Index of Wage in Industry Sector in this order.

Table 4.4: Predictor Weights

Country	Synthetic Control predictor weight
Seasonally Adjusted GDP per capita	0.285
Final Consumption per Capita	0.007
Real Exchange Rate	0.014
Index of wage in Industry Sector	0.003
HCPI	0.206
Unemployment Rate	0.486

Source: Synthetic control method computations.

Table 4.5 compares the pre-intervention characteristics of the Czech Republic to those of the synthetic Czech Republic. The synthetic units is very similar to the treated units in terms of Seasonally Adjusted GDP per Capita, Index of wage in Industry Sector, HCPI, Final Consumption per Capita, and unemployment rate. On the other hand, the differences between the Real Exchange Rate and its synthetic counterpart is larger. However, as table 4.4 indicates, its predictive power is nearly negligible.

Table 4.5: Predictor Means Before the Intervention

Country	Treated Unit	Synthetic Unit
Seasonally Adjusted GDP per capita	2.214	1.967
Final Consumption per Capita	0.840	0.915
Real Exchange Rate	113.451	105.544
Index of wage in Industry Sector	88.060	90.373
HCPI	2.455	2.468
Unemployment Rate	6.590	6.601

Source: Synthetic control method computations.

Table 4.6 shows the weights of each country from the control units. The synthetic Czech Republic related to the unemployment rate is a weighted aver-

age of Denmark, Luxembourg, Poland, and Germany with weights decreasing in this order. All other countries[14] obtain zero weights.

Table 4.6: Countries Weights

Country	*Synthetic Control Weight*
Austria	0
Belgium	0
Bulgaria	0
Croatia	0
Denmark	0.362
Estonia	0
France	0
Germany	0.054
Hungary	0
Italy	0
Latvia	0
Lithuania	0
Luxembourg	0.362
Netherlands	0
Poland	0.222
Portugal	0
Slovakia	0
Slovenia	0
Spain	0
Sweden	0
United Kingdom	0

Source: Synthetic control method computations.

4.5.1 Robustness tests

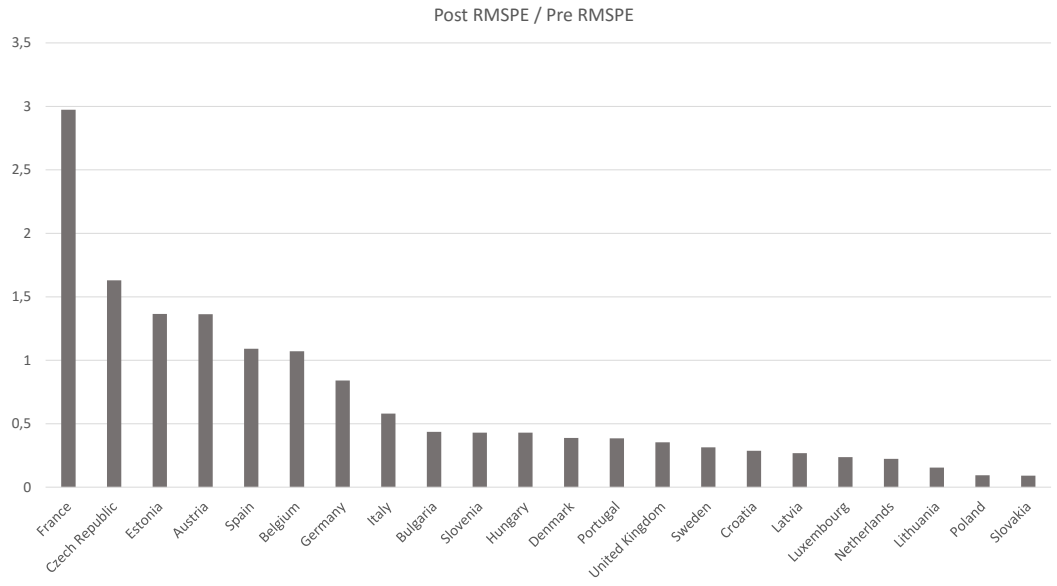
To evaluate the significance of our estimates, we run placebo studies in the same manner as used to determine the Seasonally Adjusted GDP per capita.

Firstly, we reassign the intervention to each country in its control unit. Therefore, we obtain the RMSPE for both pre-intervention and post-intervention periods. Figure 4.8 shows the ratio of the post-intervention RMSPE and pre-intervention RMSPE. In this case, the Czech Republic has the second highest ratio. In other words, figure 4.8 indicates that the effect of the intervention

[14] Again we exclude Ireland because of missing values for Seasonally Adjusted GDP per capita for whole sample period.

on the unemployment rate is large in comparison with other countries in the control unit.

Figure 4.8: Ratio of Post-intervention RMSPE and Pre-intervention RMSPE Related to the Unemployment Rate



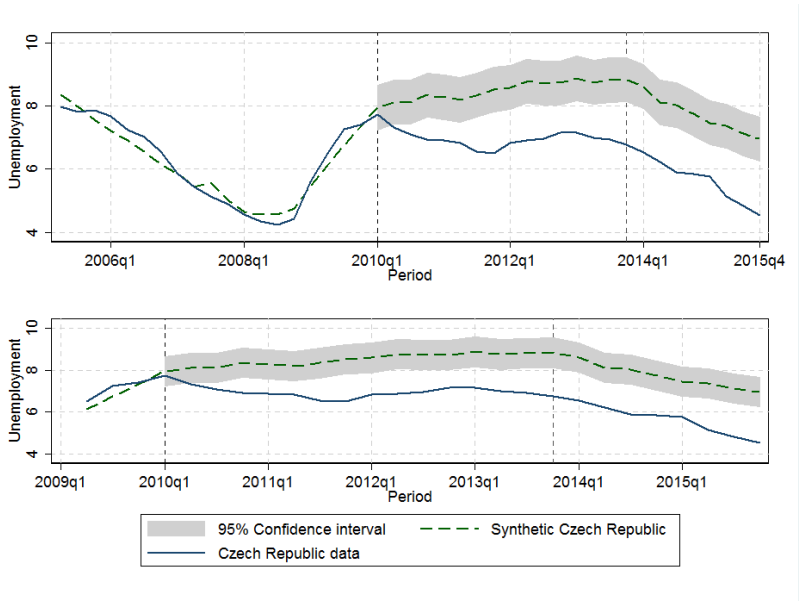
Source: Synthetic control method computation.

Secondly, we rerun the model with the intervention reassigned to the period Q1 2010, which is about 13 quarters earlier than when the intervention was launched. Again, we use the same technique for choosing the weights for the control units. In figure 4.9 we can see the results.

The synthetic Czech Republic precisely reproduces the trajectory of the unemployment rate until the period Q1 2010. Nevertheless, unemployment rate trajectories of the Czech republic and its synthetic counterpart do differ during the period Q1 2010 - Q4 2013[15] period. The possible reason might be low unemployment rate in the Czech republic in comparison with the average unemployment rate of countries in control unit during Q1 2010 - Q4 2013, what indicates figure 4.10. However, the trajectory of the synthetic Czech republic follow the same path as that in figure 4.7 during the period Q4 2013 - Q4 2015. This supports the finding of positive effect from figure 4.7.

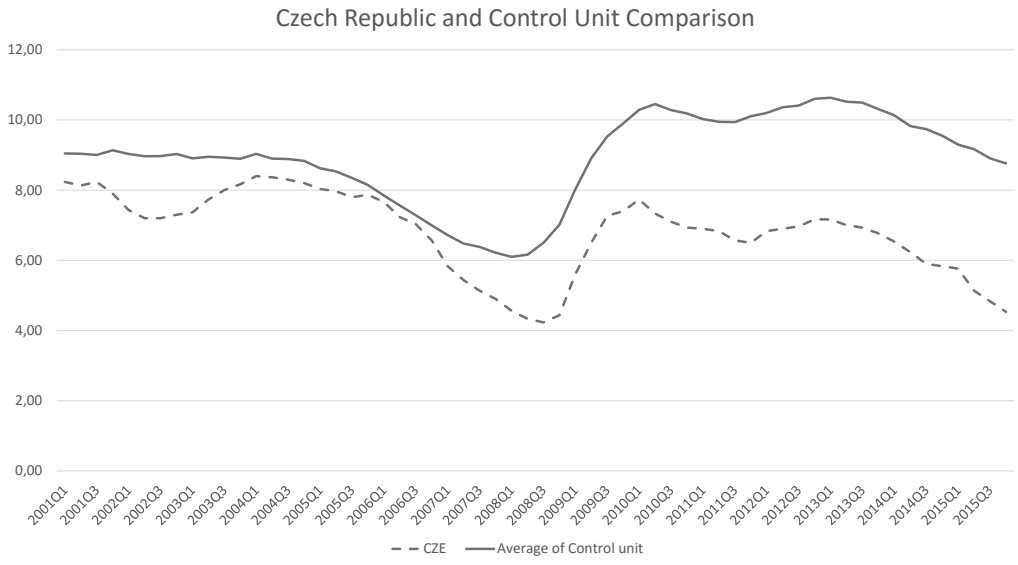
[15]Indicated as a non–labelled dash line on figure 4.9

Figure 4.9: Unemployment Reassigned to the Period Q1 2010.



Source: Synthetic control method computation.

Figure 4.10: Comparison of Unemployment



Source: Based on author's computation using data from Eurostat database.

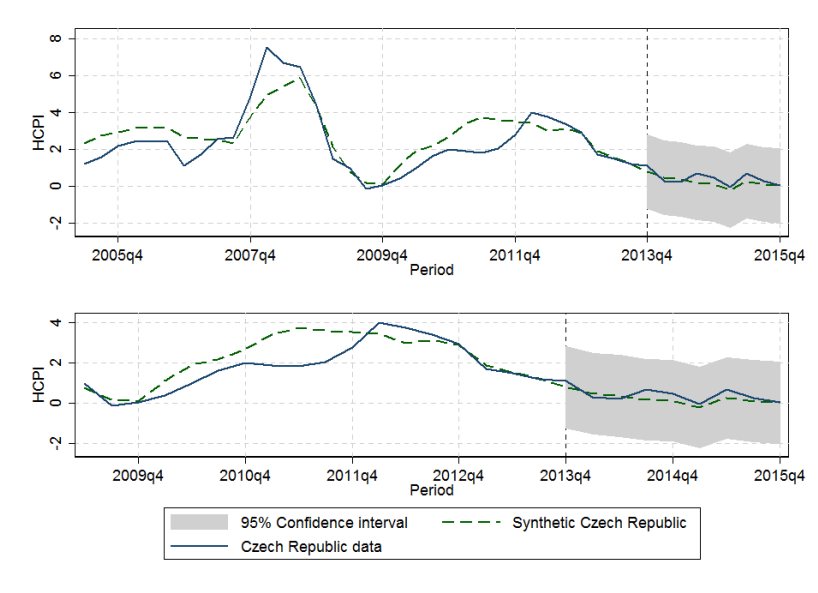
In conclusion, figures 4.7, 4.8, and 4.9 show that there is an effect of the intervention on the unemployment rate in the Czech Republic. Moreover, compared to the GDP per capita in section 4.4, the effect is relatively large. This could be due to the fact that the unemployment rate is less dependant on the

idiosyncratic events mentioned in the end of section 4.4.1. For instance, in contrast with GDP per capita, increasing the indirect tax on tobacco products and intensified pumping of structural funds from the EU did not have direct impacts on the unemployment rate.

4.6 Harmonized Consumer Price Index

In this section, we provide the results of the impact of the intervention on HCPI. In figure 4.11, the reader can see the estimation of the HCPI synthetic counterpart during the period Q1 2005–Q4 2015. Additionally, we show the estimation for the period Q4 2007–Q4 2015 in figure 4.12.[16] Keep in consideration that all tables below are related to the period Q1 2005–Q4 2015.

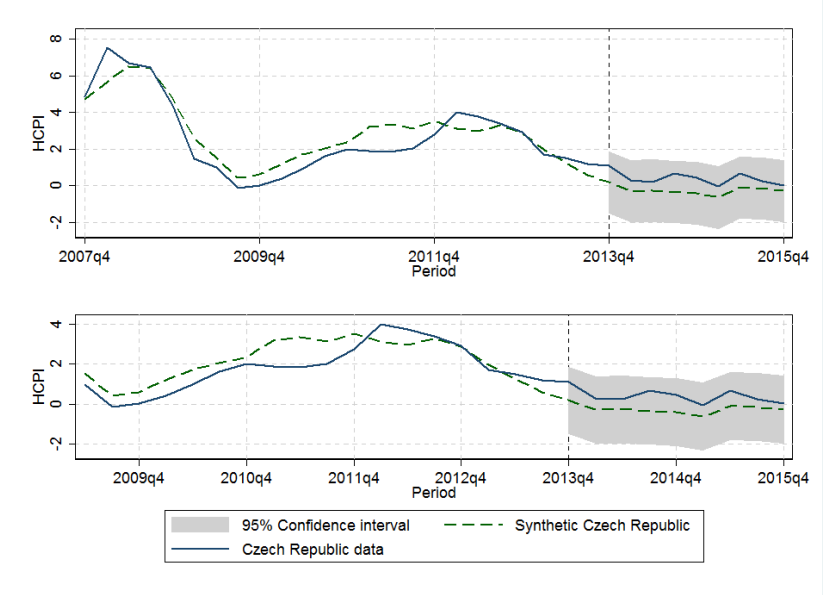
Figure 4.11: Harmonized Consumer Price Index Q1 2005–Q4 2015



Source: Synthetic control method computation.

[16] Appendix A provides related tables with weights of countries and predictors.

Figure 4.12: Harmonized Consumer Price Index Q4 2007–Q4 2015



Source: Synthetic control method computation.

Both figures indicate that the Czech Republic's synthetic counterpart would touch level zero of the HCPI from the negative side of y–axis. Furthermore, it remains below the real Czech Republic's HCPI after the intervention, which suggests the positive effect of the intervention on the HCPI in the Czech Republic. On the other hand, the real Czech data does not exceeds the 95% confidence interval of its synthetic counterpart, which should be considered when interpreting the result.

Table 4.7 displays weights of predictors. The prediction power of the predictors decrease in following order: Seasonally Adjusted GDP per capita, Real Exchange Rate, HCPI, Index of Weight in Industry Sector, Final Consumption per Capita, and unemployment rate.

Table 4.7: Predictor Weights

Country	Synthetic Control predictor weight
Seasonally Adjusted GDP per capita	0.743
Final Consumption per Capita	0.001
Real Exchange Rate	0.256
Index of Wage in Industry Sector	0.001
HCPI	0.001
Unemployment rate	0.001

Source: Synthetic control method computations.

In table 4.8, the reader can see the difference between the predictor means of a treated unit and a synthetic one. As explained in Section 3, we use the nested optimization process to calculate the weight of predictors. The table 4.7 shows that unemployment rate, Final Consumption per Capita, HCPI, and Index of Wage in Industry Sector obtain very small prediction weights. As Abadie *et al.* (2012) say, a small prediction power explains the discrepancy between the variables.

Table 4.8: Predictor Means Before the Intervention

Country	Treated Unit	Synthetic Unit
Seasonally Adjusted GDP per capita	2.214	2.214
Final Consumption per Capita	0.840	1.490
Real Exchange Rate	113.451	113.445
Index of Wage in Industry Sector	88.060	90.263
HCPI	2.455	2.763
unemployment rate	6.590	8.294

Source: Synthetic control method computations.

In the next table, 4.9, we can see the weights of countries computed by the synthetic control method. The weights reported in the table indicate that the HCPI in the Czech Republic is best reproduced by a combination of Denmark, Slovakia, Estonia, and Luxembourg with weights decreasing in this order. Note that Ireland is excluded from control units, because of its missing values for Seasonally Adjusted GDP per capita during the whole period Q1 2005–Q4 2015.

Table 4.9: Countries Weights

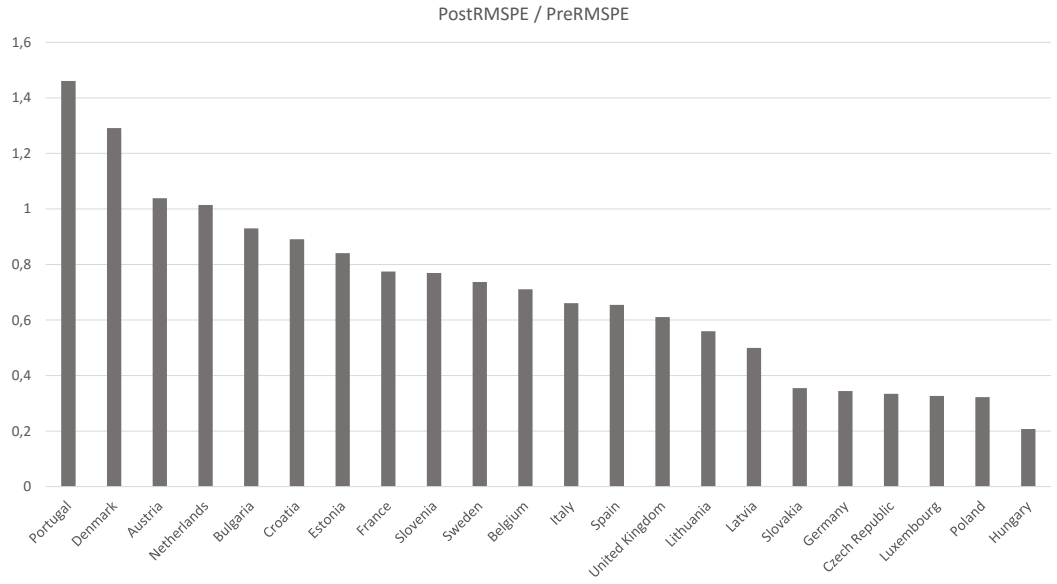
Country	*Synthetic Control Weight*
Austria	0
Belgium	0
Bulgaria	0
Croatia	0
Denmark	0.487
Estonia	0.200
France	0
Germany	0
Hungary	0
Italy	0
Latvia	0
Lithuania	0
Luxembourg	0.061
Netherlands	0
Poland	0
Portugal	0
Slovakia	0.252
Slovenia	0
Spain	0
Sweden	0
United Kingdom	0

Source: Synthetic control method computations.

4.6.1 Robustness tests

In this subsection we provide robustness tests of results related to the HCPI. As can be seen in figure 4.13, the Czech Republic stands fourth to last. This indicates that the magnitude of the intervention's effect on the HCPI is not large in comparison to other countries in the control unit. At the end of this subsection, we provide discussion about possible factors that might make the detection of the effect more difficult.

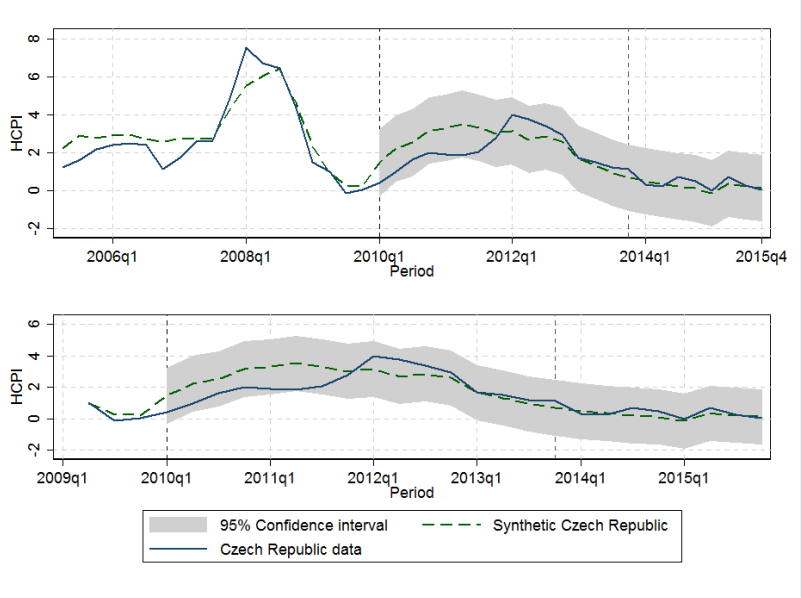
Figure 4.13: Ratio of Post-intervention RMSPE and Pre-intervention RMSPE Related to the HCPI



Source: Synthetic control method computation.

Figure 4.14 shows the result of the synthetic Czech Republic when the intervention period is reassigned to the period Q1 2010.

Figure 4.14: HCPI Reassigned to the Period Q1 2010.



Source: Synthetic control method computation.

Trajectories of real the output and its synthetic counterpart during the

period Q1 2010–Q3 2013 do not differ substantially compare to figure 4.11. This indicates that reassignment of the intervention has no significant effect on the output. Moreover, the output after the intervention is very similar to the one in figure 4.11.

When evaluating the effect of the intervention on the HCPI, we should consider several idiosyncratic events that affected both the Czech economy, and also other economies in the control unit. Some of the events that influenced the performance of the Czech economy were mentioned in section 4.4.1, such as an accelerated pumping of EU funds in the year 2014 and increasing indirect tax on tobacco products. On the other hand, the non–standard steps taken by the European Central Bank (ECB) during the crisis had an impact on the economies of the countries in the control unit.

As Mersch (2013) pp. 2 said in his speech at the UniCredit Business Dialogue, Hamburg, 17 June, 2013, the ECB introduced non-standard steps to support economies in the synthetic control unit:

> One of these non-standard measures is the policy of full allotment in our refinancing operations against appropriate collateral. We have also extended the maturities of our refinancing operations up to three years and have expanded the collateral framework. These measures are geared towards bank's refinancing conditions, which in turn make it easier for credit institutions to provide sufficient credit to the economy at favourable terms.
>
> Last summer we decided on more far-reaching measures - notably the announcement of the Outright Monetary Transactions. Prior to this announcement, we had to observe that market financing conditions were increasingly characterised by the fears among market participants that Member States would revert back to their national currencies. The markets hence priced in a conversion risk premium. Owing in part to this premium, the refinancing conditions of many commercial banks - and thereby the real economy - deteriorated dramatically.
>
> The monetary policy of ECB is committed to maintaining price stability in the euro area as a whole. So we had to take measures that would ensure that our single monetary policy would take effect in all Member States.

All mentioned idiosyncratic events should be considered when interpreting the results of this thesis related to the Harmonized Consumer Price Index.

Chapter 5

Conclusion

In this thesis we examine the impact of the Exchange Rate Commitment introduced by the CNB in the period Q4 2013. By using the synthetic control method developed by Abadie & Gardeazabal (2003), we estimate an effect of the intervention on the Seasonally Adjusted GDP per capita, unemployment rate, and Harmonized Consumer Price Index. The procedure involves identifying the effect by comparing the real path of the outcome of interest with its synthetic counterpart computed by the SCM.

Our estimates show a positive significant effect of the intervention on the unemployment rate, which created around 100,000 working positions by the end of the year 2015. We also demonstrate a slight positive significant effect on the GDP per capita and an insignificant effect on the Harmonized Consumer Price Index. However, in the case of GDP per capita and HCPI, there are several idiosyncratic events that might make the visibility of the magnitude of the effect more difficult. The accelerated pumping of EU structural funds in the year of 2014 and increasing an indirect tax on tobacco products might overestimate the results. On the other hand, the restrictive fiscal policy at the beginning of the intervention, the decreasing of the nominal wage in the year 2013, and the deflation expectation might underestimate the effect of the intervention. Moreover, the introduction of the non–standard steps of the ECB during the crisis in order to fight the falling economies of the Eurozone plays a negative role in discovering the effect of the exchange rate commitment.

Overall, the estimated effects of the Czech National Bank's Exchange Rate Commitment are positive to neutral for selected macroeconomic predictors. However, the decisiveness of the results related to GDP per capita and HCPI are negatively affected by idiosyncratic events influencing the Czech economy

before and after the intervention of the Czech Nation Bank. The long term effects are subject to be observed.

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Appendix A

Additional results and data

A.1 Additional results

Tables related to the Seasonally Adjusted GDP per capita for the period Q1 2001–Q4 2015 in figure 4.3.

Table A.1: Predictor Weights for period Q1 2001–Q4 2015

Country	Synthetic Control predictor weight
Seasonally Adjusted GDP per capita	0.986
Final Consumption per Capita	0.002
Real Exchange Rate	0.001
Index of Wage in Industry Sector	0.010
HCPI	0.001
Unemployment Rate	0.001

Source: Synthetic control method computations.

Table A.2: Predictor Means Before the Intervention for period Q1 2001–Q4 2015

Country	Treated unit	Synthetic Unit
Seasonally Adjusted GDP per capita	2.537	2.538
Final Consumption per Capita	1.754	2.208
Real Exchange Rate	106.489	106.812
Index of Wage in Industry Sector	79.675	80.331
HCPI	2.347	3.611
Unemployment Rate	6.997	8.271

Source: Synthetic control method computations.

Table A.3: Countries Weights for period Q1 2001–Q4 2015

Country	*Synthetic Control Weight*
Austria	0
Belgium	0
Bulgaria	0.172
Croatia	0
Denmark	0
Estonia	0.094
France	0
Germany	0
Hungary	0
Italy	0
Latvia	0
Lithuania	0
Netherlands	0.338
Portugal	0
Slovakia	0.132
Slovenia	0.264
Spain	0
Sweden	0
United Kingdom	0

Source: Synthetic control method computations.

Tables related to the HCPI in the period Q4 2007–Q4 2015 in figure 4.12.

Table A.4: Predictor Weights for period Q4 2007–Q4 2015

Country	Synthetic Control predictor weight
Seasonally Adjusted GDP per capita	0.001
Final Consumption per Capita	0.935
Real Exchange Rate	0.065
Index of Wage in Industry sector	0.001
HCPI	0.001
Unemployment Rate	0.001

Source: Synthetic control method computations.

Table A.5: Predictor Means Before the Intervention for period Q4 2007–Q4 2015

Country	Treated Unit	Synthetic Unit
Seasonally Adjusted GDP per capita	0.464	0.756
Final Consumption per capita	0.208	0.208
Real Exchange Rate	117.599	117.706
Index of Wage in Industry Sector	93.888	94.526
HCPI	2.679	2.890
Unemployment Rate	6.369	9.571

Source: Synthetic control method computations.

Table A.6: Countries Weights for period Q4 2007–Q4 2015

Country	*Synthetic Control Weight*
Austria	0
Belgium	0
Bulgaria	0
Croatia	0
Denmark	0.214
Estonia	0
France	0
Germany	0
Hungary	0
Italy	0.299
Latvia	0.046
Lithuania	0
Luxembourg	0
Netherlands	0
Portugal	0
Slovakia	0.242
Slovenia	0
Spain	0
Sweden	0
United Kingdom	0

Source: Synthetic control method computations.

A.2 Data

Table A.7: Description of variables

Variable	Description	Code in Eurostat
Seasonally Adjusted GDP per capita	Gross domestic product at market prices. Seasonally adjusted and adjusted data by working days. Chain linked volumes, percentage change compared to same period in previous year. For Slovakia data from ECB.	namq_10_gdp
Final Consumption per Capita	Main GDP aggregates per capita.Chain linked volumes, percentage change compared to same period in previous year, per capita. Not seasonally adjusted data.	namq_10_pc
Real Exchange Rate	Real effective series are a measure of the change in competitiveness of a country, by taking into account the change in costs or prices relative to other countries. A rise in the index means a loss of competitiveness.	ert_eff_ic_q

Source: Eurostat database.

Variable	Description	Code in Eurostat
Index of Wage in Industry Sector	Wage index 2012=100. Wages and salaries. Industry, construction and services (except activities of households as employers and extra-territorial organisations and bodies).	lc_lci_r2_q
HCPI	All–items HCPI. HCPI (2005 = 100) - monthly data (annual rate of change) – recalculated to quarterly data by author.	prc_hicp_manr
Unemployment rate	Age and sex in total, monthly avarage percentage – recalculated to quarterly data by author.	une_rt_m

Source: Eurostat database.

Table A.8: Descriptive statistics summary

Variable	Obs	Mean	Std. dev	Min	Max
SA GDP per capita	1493	2.10	3.56	-17.90	14.20
Final Consumption per Capita	1500	1.70	3.45	-17.70	24.80
Real Exchange Rate	1508	104.39	12.31	78.01	161.25
Index of Wage in Industry Sector	1306	87.02	18.15	29.00	125.30
HCPI	1560	2.44	2.20	-3.87	17.53
Unemployment Rate	1560	8.75	4.16	1.83	26.23

Source: Stata software computation.

Table A.9: Data availability

Country	GDP per capita SA	Final consumption per capita	Unemployment rate
Austria	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Belgium	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Bulgaria	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Croatia	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Denmark	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Estonia	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
France	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Germany	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Hungary	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Ireland	NA	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Italy	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Latvia	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Lithuania	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Luxembourg	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Netherlands	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Poland	Q1 2003–Q4 2015	Q1 2003–Q2 2015	Q1 2001–Q4 2015
Portugal	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Slovakia	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Slovenia	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Spain	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
Sweden	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015
United Kingdom	Q1 2001–Q4 2015	Q1 2001–Q2 2015	Q1 2001–Q4 2015

Source: Eurostat database.

Table A.10: Data availability

Country	Real Exchange Rate	Index of Wage in IS	
Austria	Q1 2001–Q2 2015	Q1 2009–Q2 2015	Q1 2001–Q3 2015
Belgium	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Bulgaria	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Croatia	Q1 2001–Q2 2015	Q1 2008–Q2 2015	Q2 2008–Q3 2015
Denmark	Q1 2001–Q2 2015	Q1 2001–Q4 2008 and Q1 2011–Q2 2015	Q1 2001–Q3 2015
Estonia	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
France	Q1 2001–Q2 2015	Q1 2008–Q2 2015	Q1 2001–Q3 2015
Germany	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Hungary	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Ireland	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Italy	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Latvia	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Lithuania	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Luxembourg	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Netherlands	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Poland	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Portugal	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Slovakia	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Slovenia	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015
Spain	Q1 2001–Q2 2015	Q1 2006–Q2 2015	Q1 2001–Q3 2015
Sweden	Q1 2001–Q2 2015	Q1 2008–Q2 2015	Q1 2001–Q3 2015
United Kingdom	Q1 2001–Q2 2015	Q1 2001–Q2 2015	Q1 2001–Q3 2015

Source: Eurostat database.

Appendix B

Content of Enclosed weblink

There are web–links that contains empirical data and Stata source codes.

- Folder 1: Source code as a STATA dofile[1] – https://drive.google.com/file/d/0B19QDPEjcz9tR0YwbVlYU3BJX2s/view?usp=sharing
- Folder 2: Empirical data – https://docs.google.com/spreadsheets/d/1wNH9VlZVk-7CBWxk9WfN79NU8Dd3Fl4RbI0OJRxQyOY/edit?usp=sharing

[1]Stata software at least version 13.0 is needed to open the file.