Mendel University in Brno

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Comparison of inflation rates between Czech Republic and Slovakia

BACHELOR THESIS

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ABSTRACT

Kratochvíl, J. Comparison of inflation rates between Czech Republic and Slovakia. Bachelor thesis. Brno: Mendel University in Brno, 2015.

The bachelor thesis deals with the main inflationary factors of Czech Republic and Slovakia and their influence on inflation. It is focused on analysis of the time series macroeconomic quarterly data from the first quarter 2000 to the third quarter 2014 using GRETL software. Inflationary factors were selected using other papers and Autoregressive Distributed Lag Models were created. The results prove that, the most significant long-term factors are exchange rate and nominal wage in both models. The results form the basis for discussion.

Key words: prices, inflation, inflationary factors, macroeconomic data, monetary policy, ARDL.

ABSTRAKT

Kratochvíl, J. Srovnání inflace České Republice a na Slovensku. Bakalářská práce. Brno: Mendlova Universita v Brně, 2015.

Bakalářská práce pracuje s hlavními inflačními faktory České Republiky a Slovenska a jejich vliv na inflaci. Je zaměřena na analýzu makroekonomických čtvrtletních dat ve formě časových řad od prvního čtvrtletí roku 2000 do třetího čtvrtletí 2014 s použitím softwaru GRETL. Inflační faktory byly zvoleny pomocí jiných prací a byly vytvořeny Autoregresně Distribuované Lag Modely. Výsledky dokázaly, že nejvíce důležité dlouhodobé faktory jsou měnový kurz a nominální mzda pro oba modely. Výsledky dále formují základ pro diskuzi.

Klíčová slova: ceny, inflace, inflační faktory, makroekonomická data, monetární politika, ARDL.

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1. INTRODUCTION

Inflation is usually defined as an average increase in general price level of goods and services in an economy and in a given time period. Inflation can be equivalently defined as a decrease in purchasing power of money. As inflation targeting countries, the main goal of monetary policy in both countries is, price stability or stable inflation around 2% (ECB and CNB). In the Czech Republic and Slovakia inflation is measured by Consumer Price Index (CPI), GDP deflator and Harmonized Index of Consumer Prices (HICP) which is the price index of European Central Bank used for comparing inflation of European Union Counties. The most used indicator by National Central Banks is CPI. At the end of the fiscal year 2014, inflation of Czech Republic was about 0.4% using CPI. It was 1.4% the year before. It means there has been marginal decline in inflation and the value is on very low level. There is a possibility of deflation (opposite case of inflation) which can negatively affect economy when it appears for a longer time period. At the end of the fiscal year 2014 inflation of Slovakia was about -0.1% using CPI. It was 1.4% the year before. Therefore, there has also been marginal decline in inflation and the value is below zero. This means deflation already appears. Reasons for this are mainly cheaper resources, especially fuel.

The Czech National Bank (CNB) predicted that inflation will be negative from second to fourth quarter of 2015 then it will rise. At the end of the fiscal year 2015, inflation will be around 1.1%.

The National Bank of Slovakia (NBS) predicted that, deflation will occur in Slovak economy but at the end of the fiscal year 2015 inflation will be around 1.6%.

Czech National Bank in early November decided to intervene in the foreign exchange market and depreciate the Czech Koruna to the level 27 CZK/EUR. Last

time this occurred CNB fought against appreciation of the Czech Koruna in 2002. Now the main aim was to increase inflation to 2% (back to the CNB's inflation target). But interventions were not only reasons why inflation has remained positive, significant was also unexpected rise in price level of alcohol, housing (in December the price level of electricity was lower by 9.6 % and in January only by 0.3%) or holidays (in January compared to December prices of winter holiday increased by 6%).

In response to imminent deflation, the European Central Bank (ECB) will be buying bonds in large volume until September 2016 (so-called quantitative easing). ECB chairman Mario Draghi (2015) admits that quantitative easing is not a miracle cure, but at least it is a way to facilitate the recovery of the European economy.

The first Finance Minister Alois Rašín separated Czechoslovak currency from the post-war inflation and withdrew a large amount of money from circulation. He tried to solidify the exchange rate to foreign currencies by deflation, with success. Between 1921 and 1923, the price level in Czechoslovakia decreased by 43%, but export fell by 53% and unemployment rose from 72 to 207 thousand people. Parliament in 1925 cancelled his deflationary policies.

High inflation in general devalues money. For individuals it is a disadvantage, because it reduces savings. For investors it is a disadvantage, because it reduces profitability of investments. And for economists and governments it makes it difficult to predict the behavior of the market. Just like high inflation, deflation is bad for any economy. It usually indicates recession.

But there can also be healthy inflation which is called moderate. Moderate inflation occurs in growing economies and the inflation rate is usually less than 10%. Another type of inflation is hyperinflation which is considered to be an extreme case. Money

is devalued, no longer perform their function. It occurred in 1923 in Germany, in 1946 in Hungary, in 1992 in Russia or even in 2007 in Zimbabwe.

Inflation may come from both the demand and the supply side. Demand-pull inflation increases the aggregate demand, which induces higher performance and higher price level. Supply-push inflation, as the name suggests, is a case where the background of the price increase is supply.

The work is divided into several chapters. The first focuses on the introduction, where it explains the topic and the issue of the thesis. The second chapter describes the broad objective and specific objectives of the thesis. The third chapter is devoted to methodology and the data used for the study. The aim of the third part is literature review. The fourth chapter explains the results. The sixth chapter focuses on the discussion. And finally the last chapter is conclusion.

2. OBJECTIVES

The main objective of the study is to examine monthly statistical data of the average inflation rates of the Czech Republic and Slovakia from January 1998 to August 2014. Create econometric models using Ordinary Least Square (OLS), verify them and compare them.

The secondary objective is to create econometric model for the specific market from the specific country, where the inflation rate has been developing differently than in the other markets and compare it with the average.

2.1. *Identification of the problem*

Inflation is one of the most important macroeconomic indicators. It influences the behavior of all economic subjects. Individuals, investors and governments watch this indicator in order to adapt their actions in the markets. In the Czech Republic and Slovakia prices for example in fuel market are unstable. There exists loss of confidence of domestic investors, because of huge amount of foreign competition (there is an open market in whole Europe due to European Union).

2.2. *Extent and limitations of the thesis*

The study will be mainly focused on inflation in the Czech Republic and Slovakia and similar studies in other countries. There are also limitations that can cause biased results such as:

- The sample size can be defined as small; it is difficult to find relationships between data.
- Although statistical office can be determined as a reliable source, we cannot entirely trust that provided data are not corrupted.
- Models could be designed better (higher R^2 would be better)
- Absence of unemployment rate in models due to unsatisfactory results

3. LITERATURE REVIEW

Kateřina Klubíčková (2011) in her thesis calculated the correlation between actual and perceived inflation in the euro area. It has shown a very high correlation between the first in the time period before the adoption of euro in 2002. After this event correlation was for several years significantly reduced. But after few years the correlation coefficient was again quite high. So either a certain relationship between the actual and perceived inflation was restored as it was before the changeover, or after the adoption of the euro new relationship has been gradually established between actual and perceived inflation.

3.1. *Inflation of the Czech Republic (CNB)*

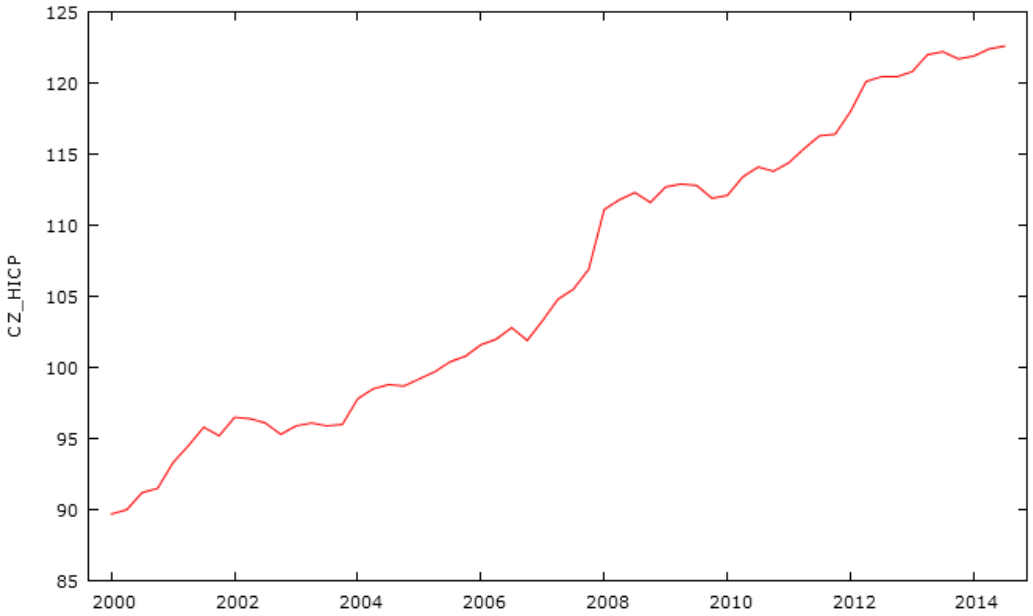
Czech National Bank exercises supervision and regulation in the monetary field within the monetary policy. The main objective of the CNB is price stability. It can focus on the other monetary targets only when fulfillment of the main goal is not jeopardized. The central bank is independent; the Bank Board decisions are not subject to the government's measures but they should not be in conflict with the economic objectives set by government, if these objectives are not in conflict with the objective of price stability. Decision-making in the field of monetary policy is based on the current macroeconomic forecast.

In 1998 the CNB adopted direct inflation targeting system. Instead of maintaining the exchange rate of the Czech Koruna within a specified band, the Czech Koruna's exchange rate was left to flee freely and CNB committed itself to keep inflation at the announced inflation target within a tolerance band. Board votes what changes of monetary policy instruments are necessary to achieve the objective after taking into account the actual development compared with the forecast. The central bank for this

purpose uses changes in the repo rate, thereby affecting changes in market interest rates. Repo rate is the rate at which the central bank lends money to commercial banks.

"When comparing development of actual CPI and CNB's forecasts, there were sometimes significant differences in actual and predicted outcome. Nevertheless, although forecasts were not regularly in line with actual development, economic subjects took them as the main indicator for their predictions. When examining character of financial market's expectations, there was observable significant decline, signalizing that expectations are well anchored and also have tendency to move at lower level. Regarding the development of financial market's expectations together with targeted path, difference between expectations and the middle of the targeted path tend to decline over time, which implies high credibility of CNB's monetary policy", according to Chytilová (2007).

Figure 1 – CZ inflation



Source: obtained from GRETL, data from Eurostat

In the Figure 1 can be seen development of inflation of Czech Republic from the investigated period in form of index, where 2005=100.

"In comparison with the CNB's forecasts at the start of the year 2000, the macroeconomic framework in Q2 indicated a continuing low-inflation environment with respect to domestic inflation factors. At the same time, there was a relatively rapid increase in imported inflation. The Czech economy saw an accelerated recovery within a low-inflation environment. Demand-pull inflationary pressures remained subdued, and anti-inflationary effects strengthened in the wage-cost area. Conversely, growth in import prices brought about chiefly by rising prices of energy raw materials on world markets and accompanied by a temporary weakening of the Czech Koruna's exchange rate against the US dollar, exerted upward pressure on inflation. The inflation expectations of all economic agents remained low during Q2", according to CNB (2000).

CNB (2001) revealed that economic development in the first quarter of 2001 was characterized by a continued recovery in both the supply and demand sides at a stabilized development of overall inflation. In relation to foreign countries the first quarter of 2001 confirmed the long-term trends asserting in previous quarters, in particular the gradual widening of the trade deficit and exchange rate appreciation of the Czech Koruna against the euro. Wage cost inflation pressures remained subdued.

Stated by CNB (2002) the development of the Czech economy in the first quarter of 2002, in spite of the contradictory effect of some factors, was assessed generally as positive. Inflation continued to fall within the CNB's target band. Published data on GDP growth in the fourth quarter of 2001 were slightly lower than in the previous quarter. Aggregate GDP growth for the whole year 2001 had been the highest since 1996. In the first quarter of 2002 continued long-term trend of increasing public

deficit. The rapid rate of appreciation of the Czech Koruna against the euro had been re-evaluated as inadequate given state of the Czech economy.

CNB (2003) informed that low inflation and indistinct economic growth remained the main attributes of the Czech economy in the first quarter of 2003. Inflation fell into negative values and remained below the target band. Annual GDP growth in the fourth quarter of 2002 also slowed slightly. Declining economic growth rate during 2002 resulted in a lower GDP growth that year compared with the previous two years. The widening mismatch between labor demand and supply remained the dominant factor influencing development, unemployment and wages.

Given by CSB (2004) inflation reached the lower boundary of the CNB's target band. The Czech economy grew in the fourth quarter of 2003 slightly slower than in the previous quarter. But compared to the fourth quarter of 2002 the rate of growth doubled. The persistent mismatch between labor demand and supply, which in the end of 2003 and the first quarter of 2004 deepened, remained the key factor in the development of unemployment and wages.

CNB (2005) reported that the slowdown in growth of consumer prices during the first quarter of 2005 led to a fall in inflation below the lower limit of the target band. Czech economic growth in the fourth quarter of 2004, as well as throughout 2004, slightly accelerated. The situation in the labor market during the fourth quarter of 2004 and first quarter of 2005 improved. The decline in interest rates, especially at longer maturities, continued in the first quarter of that year. The Czech Koruna exchange rate during this period was reinforcing.

Stated by CNB (2006) inflation in the first quarter of 2006 grew and moved just below the point inflation target. Czech economy in the fourth quarter of 2005 grew at the highest rate ever. Favorable economic development so far has not led to a significant

decline in unemployment and wage growth acceleration and did not demand inflation pressures. Market interest rates in the first two months of 2006 fell and in March increased. The Czech Koruna exchange rate for two major currencies in comparison with the previous quarter became stronger.

CNB (2007) announced that inflation in the first quarter of 2007 continued to move below the lower limit of the inflation target. Czech economy in the whole year 2006 grew rapidly, although the rate of growth during the year was gradually decreasing. Employment growth compared to the previous quarter slightly increased and the unemployment rate fell. Interest rate on the money market was during the first quarter of 2007 stable. The Czech Koruna exchange rate against the two major currencies weakened during this period.

Given by CNB (2008) inflation in the fourth quarter of 2007 increased and was situated above the upper boundary of the inflation target. Mainly food prices and regulated prices contributed to the acceleration of consumer price growth. The Board, in accordance with the October forecast in late November increased policy interest rates by 0.25 percentage points. Employment growth increased and the unemployment rate fell same as in the previous period. The November increase in repo rates was reflected in a rise in interest rates in the money market.

CSN (2009) reported that annual inflation during 2008 decreased significantly and after thirteen months returned to the inflation target tolerance band. In the third quarter of 2008 continued a gradual decline in the rate of economic growth. There had been a significant economic downturn in the fourth quarter due to the global financial and economic crisis. The Board in the fourth quarter decreased the repo rate in two steps by a total of 1.25 percentage points. The annual growth rate of the Czech economy in the third quarter of 2008 continued in gradual decline. Annual employment growth in 2008 in terms of slowing economic growth declined as well.

CSN (2010) informed that inflation, after the October decline to slightly negative values, in the remaining months of the fourth quarter of 2009 gradually increased. However, it continued to stay deep below the lower limit of the tolerance band of 3% inflation target valid until the end of 2009. The annual fall in the Czech economy in the third quarter of 2009 has slowed and the economy grew by rate almost 1%. The Board in December decreased repo rate by 0.25 percentage points. The Czech Koruna exchange rate against the euro in the fourth quarter of 2009 weakened, the decrease at the end of December compared to the end of September had been 5%. There had been a further decline in employment and an increase in the unemployment rate.

Stated by CSN (2011) Czech economy's recovery continues and is temporarily driven mainly by investment. Overall inflation in December 2010 slightly increased over CNB's inflation target level due to rising global commodity prices, while inflationary pressures from the domestic economy are significant. Czech economy in the third quarter of 2010 further accelerated its annual growth to 2.8%.

CSN (2012) announced that overall inflation is above the CNB's inflation target level. The sources of inflation are mainly regulated prices, food prices and decline of the exchange rate. Czech economy in the third quarter of 2011 and further slowed down its annual growth to 1.2%. Board at its monetary policy meeting in February unanimously decided to leave interest rates unchanged.

Given by CSN (2013) the annual decline in the Czech economy in the third quarter of 2012 further increased by 1.3%, while the negative contribution to its development had investment and household consumption. Overall inflation in the fourth quarter was in the upper half of the tolerance band. Exchange rate against the euro was very slowly strengthening.

CNB (2014) stated that Czech economy in the third quarter of 2013 decreased by 1.2% due to a decrease in net exports and a continuing decline in gross fixed capital formation. Other components of demand showed a zero or slightly positive contributions. Overall inflation in the fourth quarter 2013 average was found in the lower half of the CNB target. There was stability of market interest rates at the very low level and stability in exchange rate of the Czech Koruna.

CNB (2015) informed that Czech economy in the third quarter of 2014 grew by 2.4% with the contribution of all components of domestic demand; net exports contributed a negative effect. Overall inflation during the fourth quarter of 2014 declined far beyond the lower limit of the target tolerance band of the CNB. Slight increase occurred only in adjusted inflation excluding fuels, which exhibited the influence of weakened the Czech Koruna and domestic economic growth and wages.

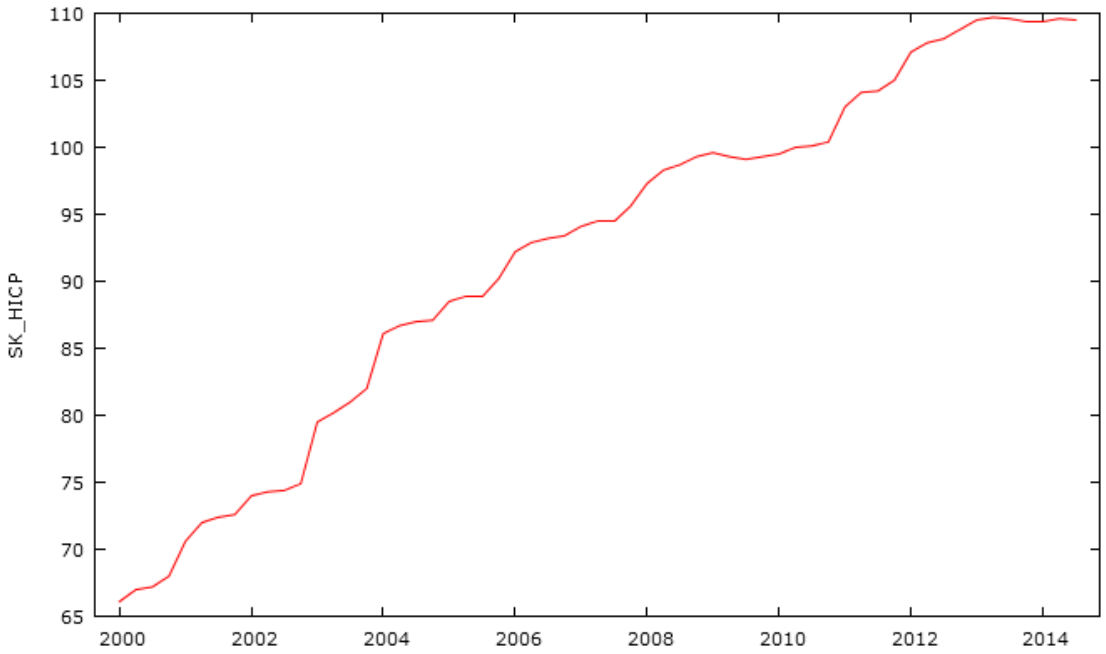
3.2. *Inflation of Slovakia (NBS)*

National Bank of Slovakia was established on January 1993 as an independent central bank of the Slovak Republic. From January 2009 - the date of introduction of the euro in the Slovak Republic it became part of the Eurosystem, forming the central banking system of the euro zone within the European System of Central Banks.

The Eurosystem bears the responsibility for determination and performance of monetary policy in the euro area. Performance of monetary policy operations are mainly carried out in the financial markets. It regulates the conditions for the money market by controlling the amount of money in circulation. It can affect the development of the euro exchange rate and also the solvency of the Eurozone using foreign exchange operations. It manages foreign exchange reserves of the national central banks for purposes of foreign exchange operations. The concept of the Eurosystem is based on the long experience and existing capacities of national central

banks. It considers the relationship between bank communities in individual countries and their national central banks.

Figure 2 – SK inflation



Source: obtained from GRETL, data from Eurostat

In the Figure 2 can be seen development of inflation of Slovakia from the investigated period in form of index, where 2010=100.

SNB (2000) reported that the price level compared with 1999 was more moderate and annual rate of inflation in the second half of 2000 was reduced to single-digit levels. Inflationary impulses during the year included at most increased energy prices and the continued rise in oil prices. There was a lower growth of nominal wages, the decline in real wages and employment and the development of unemployment

SNB (2001) informed that in the view of development of basic macroeconomic indicators in 2001 the growth of performance of economy occurred, it is reflected in the increase in employment rate and real wages, in a decline in growth of market

prices, prices of manufactures and the continuing growth of profitability. Year-to-year comparison showed decline in overall inflation. Within the whole year the year-to-year inflation was moving under the lower level of the inflation target.

From the perspective of SBN (2002) the development of performance of Slovak economy continued to progress. Growth of consumer price level in 2001 decreased and overall inflation rate was about 3.3%. The development of consumer price level was influenced by changes in taxes of tobacco and cigarettes. This change influenced overall inflation by 0.41%. Compared with 2001, employment growth declined by 1.4% to 0.1%. The employment growth had the same value as average value of whole 2002 in the last quarter 2001.

Stated by SBN (2003) macroeconomic and monetary development in 2003 was affected by the measures related to Slovakia's upcoming entry into the European Union. The average inflation rate corresponded to 8.5% (in 2002 it was 3.5%). Prices were driven mainly by domestic factors. These factors include the VAT increase and the excise tax increase. Dynamic development of the Slovak economy continued due to the increase in GDP of 4.2%

SBN (2004) announced that macroeconomic development in Slovakia in 2004 was influenced by several important factors, which mainly included Slovakia's accession to the European Union, as well as the completion of the tax reform. The average inflation rate for the whole year was 7.5%. Real GDP increased by 5.5% and became the fastest growth in the last eight years. Compared to 2003, the rate of economic growth accelerated by 1 percentage point. Employment in 2004 grew at a slower rate than in 2003. The number of workers in the national economy (includes employees, entrepreneurs and contributing family workers) increased by 0.3%

NBS (2005) had started to implement the strategy of inflation targeting under the ERM II since the beginning of 2005 in line with the NBS Monetary Program. Inflation rate reached 2.8% on average. Gross domestic product grew by 6.0% and reached only the fastest rate of growth since 1996. There was also a rise of the number of workers on year average of 2.1%. The average nominal wage in the Slovak economy achieved dynamic growth of 9.2%.

NBS (2006) informed that Slovak economy was developing in 2006 in the environment of relatively strong growth of the world economy. Lending continued developing despite the rise in interest rate. Inflation rate reached 4.3%. GDP grew by 8.3% compared to 2005. The rate of economic growth achieved 2.3%. The number of workers increased by 3.8%, representing an acceleration of growth compared to 2005 by 1.7 percentage points. The average monthly nominal wage rose by 8.0%.

NBS (2007) and its monetary policy operated in 2007 in an environment of dynamic economic growth and in accordance with the Monetary Program. The inflation reached 1.9%. GDP grew in 2007 by 10.4%. The favorable economic development in 2007 was also reflected in the development of employment. Employment grew by 2.1%. The average nominal wage in the Slovak economy grew by 7.2%

Given by NBS (2008) development of economic fundaments in 2008 in Slovakia took place in the external environment of the financial crisis, which caused a slowdown in real economic activity. Slovakia's economic growth in 2008 reached 6.4%, while during its growth gradually slowed from 9.3% in the first quarter to 2.5% in the fourth quarter. Inflation on average had value of 3.9%. Employment grew by 2.8%. The average nominal wage grew by 8.1%.

NBS (2009) reported that development of economic fundaments in 2009 in Slovakia was mainly influenced by two most significant factors. From 1 January Slovakia

joined the euro area and adopted euro; the National Bank of Slovakia became part of the Eurosystem, bringing together the central banks of the euro area countries and the ECB. On the other hand, economic development was negatively affected by the ongoing financial crisis, which caused the most significant drop in global economic activity since the Great Depression. Inflation on average reached value of 0.9%. GDP dropped by 4.7%. The decline in economic activity was also reflected in the development of employment, which dropped by 2.4%. The impact of the economic crisis was also reflected in the evolution of the average nominal wage growth which in comparison with 2008 slowed by 5.1% and reached 3.0%.

From the NBS (2010) perspective macroeconomic development in Slovakia in 2010 was influenced by the fading effects of the global financial and economic crisis. The economic recovery was reflected by a relatively strong economic growth. GDP grew by 4.0%. The average inflation slowed its dynamics from 0.9% to 0.7%. Employment dropped by 1.4 %. The average nominal wage growth reached 3.2 %.

NBS (2011) announced that the positive trend of Slovak economic growth continued in 2011. Annual rate of economic growth slowed compared with the previous year. GDP increased by 3.3%. The dynamics of HICP average inflation increased from 0.7% in 2010 to 4.1%. Employment grew by 1.8%. The average nominal wage growth was 2.2%.

NBS (2012) reported that in 2012 Slovak economy development compared to the previous year slowed. Gross domestic product rose by 2.0%. The dynamics of HICP average inflation slowed from 4.1% to 3.7%. Employment grew only by 0.1%. Employers were able to produce a higher volume of value added and total GDP with practically unchanged employment. Average nominal wage growth compared to the previous year accelerated by 0.2% and reached 2.4%.

NBS (2013) informed that in 2013 there was a further cooling of economic dynamism. Gross domestic product rose over the year by 0.9%. The dynamics of HICP average inflation slowed from 3.7% to 1.5%. In terms of comparison of the levels of the main macroeconomic indicators to pre-crisis year 2008, it is clear that the state before the crisis had not been achieved only in employment. Employment fell by 0.8%. The average nominal wage growth reached the same dynamics as in the previous year - 2.4%.

According to NBS (2015) "The Slovak economy maintained a steady growth momentum of 0.6% quarter-on-quarter throughout the last quarter of 2014. Gross domestic product increased in the fourth quarter of 2014 by 0.6% quarter-on-quarter and by 2.4% year-on-year. A slowdown was recorded in the annual rate of growth. The year-on-year dynamics of compensation per employees is currently at the level of 2.5%. Wage dynamics in the fourth quarter weakened from 4.2% to 3.5%. "

3.3. *Selection of variables*

Alexová (2012) in her paper focuses on the factors of inflation for some European Union members (Czech Republic and Slovakia included) during the period from 1996 to 2011. Variables for the models were nominal wage, productivity and unemployment rate. Except unemployment rate, which was not used in this thesis due to unsatisfactory results, all variables which Alexová used were used also in models of this thesis.

Cigan, Jevčák, Pradelle and Žáková (2008) were determining relationship of exchange rate and inflation rate in Slovakia. The results show that exchange rate pass-through to inflation.

Babecká-Kucharčkuková (2009) was estimating the exchange rate pass-through (ERPT) for the Czech Republic. It was reported here that the transmission rate of the exchange rate shock to all prices is quite fast. In absolute terms, but the projection of the exchange rate does not exceed 25-30%. Thus the exchange rate was used in process of designing of the model of inflation of Czech Republic.

According to Folger "In general, as interest rates are lowered, more people are able to borrow more money. The result is the spending is increased, economy grows and inflation increases." Thus the nominal exchange rate was also used in process of designing the models.

4. MATERIALS AND METHODS

In March 2007 CNB declared a new inflation target of 2%. It was effective from January 2010. CNB endeavors to ensure that actual inflation does not differ from the target by more than one percentage point on both sides.

The role of the NBS, as a member of the euro area, is to participate in the common monetary policy which is determined by the ECB. The primary objective of the euro area monetary policy is to maintain price stability. Quantitative definition of price stability is according to the Governing Council "Year-on-year increase in the HICP for the euro area of below 2%".

The methodology from thesis assignment had to be adjusted, because OLS was too simple for the analysis of inflation rates. Thus there had to be used Autoregressive Distributed Lag Model (ARDL) of different orders - I(0) and I(1). The broad objective was specified. Its aim was to determine the relationship between monetary policy activities and inflation in both countries, identify factors influencing inflation and describe the relationships between them and inflation. There was also a problem with the time period and its frequency, because it was impossible to find suitable monthly data. Therefore there were found quarterly data from the first quarter 2000 to the third quarter 2014. Also the methodology for the secondary objective was edited. For the purpose of this objective did not have to be created econometric model, the comparison was therefore performed just from the plotted values. Frequency of time period was monthly, the country Czech Republic, the specific market was communication market and time period from 2004 to 2014.

The thesis utilized as a source statistical data obtained from Eurostat and OECD, which are in the form of time series. It examined the development of inflation calculated using HICP in the Czech Republic after 2000 and also compared it with

the inflation in Slovakia in the same time period. The data were chosen in order to compare development of inflation before and in Global Financial Crisis which started in 2008. This crisis is a result of subprime mortgage crisis in USA. In September 2008 stock markets worldwide experienced a deep slump.

4.1. *Methodology*

The study uses both qualitative and quantitative method. Since the variables were integrated of different orders, then the study used an Autoregressive Distributed Lag Model (ARDL) of different orders - I(0) and I(1) and they have one cointegrating relationship in case of Czech model and two cointegrating relationship in case of Slovak model. I(0) means the variable was stationary at level form and I(1) means the variable was stationary after first order differencing. All variables were tested using Augmented Dickey-Fuller test invented by Dickey and Fuller (1979). The variables which were not stationary were first order differenced to remove unit roots.

The variables were also tested for cointegration using the Johansen Cointegration test which was introduced by Johansen (1988). The optimum lag length was decided using Akaike Information Criterion (AIC) introduced by Akaike (1974), Bayesian Information Criterion (BIC) developed by Schwarz (1978) and Hannan-Quinn Criterion (HQC) introduced by Hannan and Quinn (1979).

The data was tested for seasonality. There was found from the plotted values that seasonality did not occur among data.

Software GRETL was used for modeling and verifying the model. GRETL is an open source computer statistical system, mainly used in econometrics. The name originated as an acronym for "Gnu Regression, Econometrics and Time-series Library", which express the determination of the system.

Two sample regression models of inflation between Czech Republic and Slovakia were compared. The variables of each model were the same for each country and they include: the real exchange rate (e), real GDP growth (g), nominal interest rate (I) and nominal wage (W).

The form of the models is given by:

$$\Delta\pi_t = \beta_0 + \sum \beta_i \Delta\pi_{t-i} + \sum \gamma_j \Delta e_{t-j} + \sum \delta_k \Delta g_{t-k} + \sum \varphi_l \Delta I_{t-l} + \sum \omega_m \Delta W_{t-m} + \theta_0 \pi_{t-1} + \theta_1 e_{t-1} + \theta_2 g_{t-1} + \theta_3 I_{t-1} + \theta_4 W_{t-1} + \varepsilon_t \quad (1)$$

Where β_0 is a constant, $\beta_i, \gamma_j, \delta_k, \varphi_l$ and ω_m are regression coefficients, Δ means difference of the first order and i, j, k, l and m determine number of lags. ε_t is a random disturbance term.

4.2. *Additional methodology*

The ARDL models were verified by specification, heteroskedasticity and autocorrelation. Arshed (2014) noted that if the sample size is higher than 30, then the normality issue can be ignored as per central limit theorem. Both, Czech and Slovak models have sample size higher than 30 and thus Normality test was not performed. But even then there were some problems with the models thus the models were adjusted to meet the requirements.

Regression Equation Specification Error Test (RESET) test introduced by Ramsey (1969) was used to test for model specification and Non-linearity test for verifying the specification of the model, Non-linearity test could not be used when number of observations was less than number of parameters. For testing the heteroskedasticity there were used White test introduced by White (1980) and Breusch–Pagan test introduced by Breusch and Pagan (1979) in case when number of observations was less than number of parameters and thus White test could not be performed. There

was also used Durbin-Watson test introduced by Durbin and Watson (1971) for testing autocorrelation. And last test which was used was Collinearity test.

After designing the model it was found that the level form variables in the ARDL model had long-run relationship after Bounds testing introduced by Pesaran, Shin and Smith (2001). Therefore an Error Correction Model was used to estimate their short-run relationships. The long run relationships were estimated as elasticities calculated as:

$$E_i = -\frac{\theta_0}{\theta_i} \quad (2),$$

where θ_0 is coefficient of the lagged level form inflation and θ_i is coefficient of the certain lagged level form independent variable. The variable is determined by i.

There was performed simple analysis of plotted values of inflation in communication market compared with average market.

5. RESULTS AND DISCUSSION

5.1. *Results*

The data was tested for unit roots using the Augmented Dickey Fuller method. The result can be seen in tables 1 and 2.

Table 3 - ADF test table – Czech republic

ADF test table – Czech republic			
Variable	Level form p-value	First order difference p-value	Result
HICP inflation	0.966	0.005	I(1)
Real exchange rate	0.275	p<0.001	I(1)
Nom. interest rate	0.579	0.028	I(1)
Real GDP growth	0.011		I(0)
Nom. wage	0.049		I(0)

Source: obtained from GRETL

The table 4 shows on what orders variables of Czech model are integrated.

Table 5 - ADF test table – Slovakia

ADF test table – Slovakia			
Variable	Level form p-value	First order difference p-value	Result
HICP inflation	0.243	0.043	I(1)
Real exchange rate	0.002		I(0)
Nom. interest rate	0.600	p<0.001	I(1)
Real GDP growth	0.021		I(0)
Nom. wage	0.010		I(0)

Source: obtained from GRETL

The table 6 shows on what orders variables of Slovak model are integrated. Models were also tested for cointegration using the Johansen test. The result can be seen in tables 7 and 8.

Table 9 - Johansen test – Czech Republic

Johansen test – Czech Republic					
Rank	Eigenvalue	Trace test	p- value	Lmax test	p-value
0	0.671	104.76	[p<0.001]	61.099	[p<0.001]
1	0.362	43.665	[0.117]	24.697	[0.1123]
2	0.216	18.968	[0.506]	13.415	[0.429]
3	0.071	5.553	[0.749]	4.025	[0.850]
4	0.027	1.528	[0.216]	1.528	[0.216]

Source: obtained from GRETL

The Czech p-value shows that these variables have at most one cointegration relationship.

Table 10 - Johansen test – Slovakia

Johansen test – Slovakia					
Rank	Eigenvalue	Trace test	p- value	Lmax test	p-value
0	0.428	74.449	[0.019]	30.693	[0.114]
1	0.290	43.756	[0.115]	18.872	[0.437]
2	0.238	24.884	[0.171]	14.977	[0.303]
3	0.107	9.907	[0.293]	6.191	[0.595]
4	0.065	3.711	[0.054]	3.711	[0.054]

Source: obtained from GRETL

The Slovak p-value shows that these variables have at most one cointegration relationship.

The optimum lag length was decided using AIC, BIC and HQC. The result can be seen in tables 11 and 12.

Table 13 - VAR lag selection – Czech Republic

VAR lag selection – Czech Republic					
lags	loglik	p(LR)	AIC	BIC	HQC
1	-306.446		13.194	14.330*	13.628
2	-263.056	p<0.001	12.473	14.556	13.269
3	-240.430	0.008	12.566	15.596	13.724
4	-208.736	p<0.001	12.303	16.281	13.823
5	-162.975	p<0.001	11.490	16.413	13.371
6	-139.191	0.004	11.537	17.408	13.781
7	-85.990	p<0.001	12.461	17.249	13.036
8	2.064	p<0.001	7.958*	15.723	10.926*

Source: obtained from GRETL

The optimum lag length for Czech model was decided to be 8.

Table 14 - VAR lag selection – Slovakia

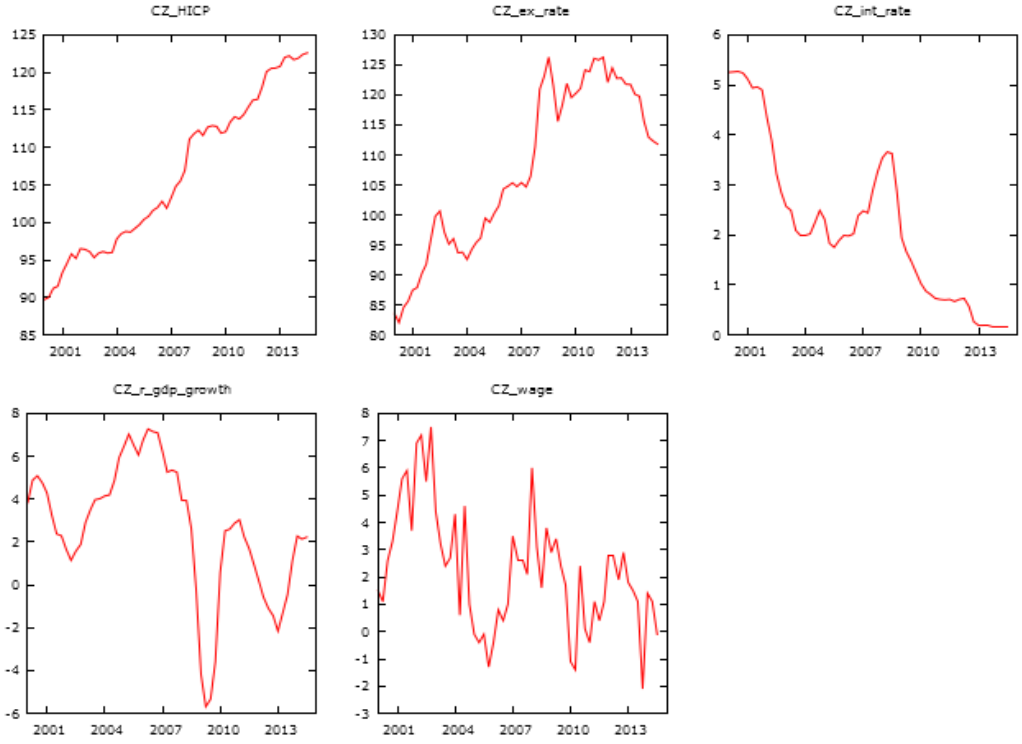
VAR lag selection – Slovakia					
lags	loglik	p(LR)	AIC	BIC	HQC
1	-442.272		18.520	19.657*	18.955
2	-416.394	0.001	18.486	20.569	19.282
3	-399.293	0.104	18.796	21.826	19.954
4	-381.503	0.078	19.079	23.056	20.598
5	-328.143	p<0.001	17.966	22.891	19.848
6	-272.760	p<0.001	16.775	22.646	19.018
7	-199.929	p<0.001	14.899	21.717	17.505
8	-117.030	p<0.001	12.629*	20.394	15.596*

Source: obtained from GRETL

The optimum lag length for Slovak model was decided to be 8.

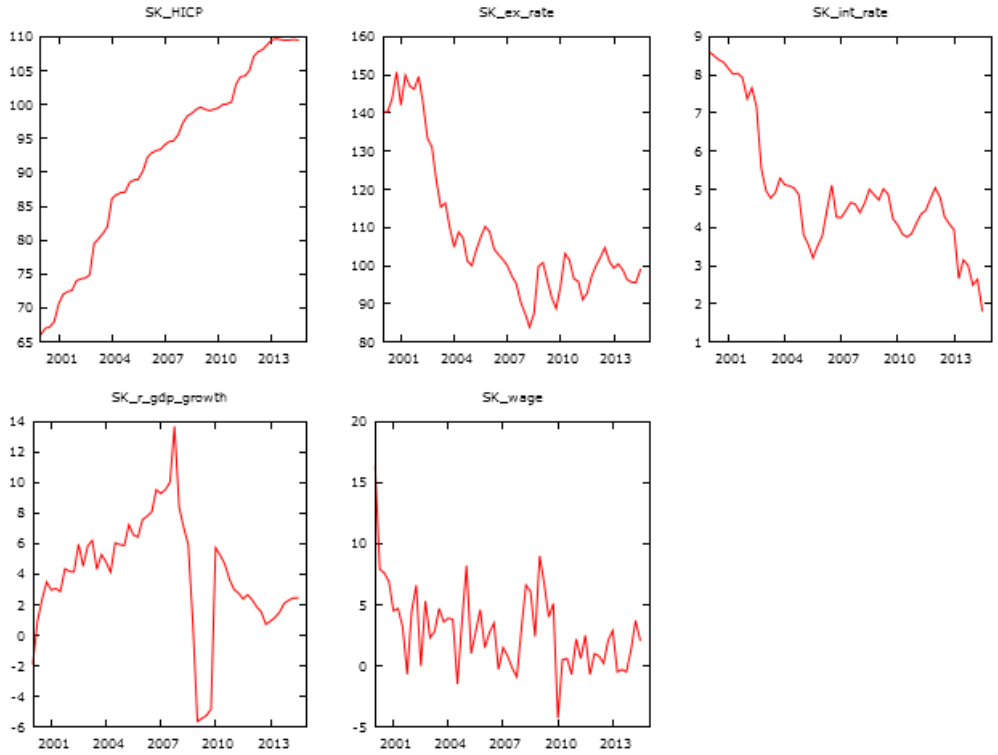
Data was checked for seasonality using plotted values of the data. They can be seen in figures 3 and 4.

Figure 5 – Plotted values of the Czech data



Source: obtained from GRETL

Figure 4 – Plotted values of the Czech data



Source: obtained from GRETL

From the plotted values is obvious that there is no seasonality.

5.1.1. Designing the Czech model

The study designed model for Czech HICP using ARDL method. Number of lags was decided to be 8 and that is why model has high amount of variables. The model with only significant variables designed by sequential elimination of variables using two-sided p-value = 0.10 can be seen in table 15.

Table 16 – CZ ARDL 1

Model: ARDL, using observations 2002:2-2014:3 (T = 50)
Dependent variable: d_CZ_HICP

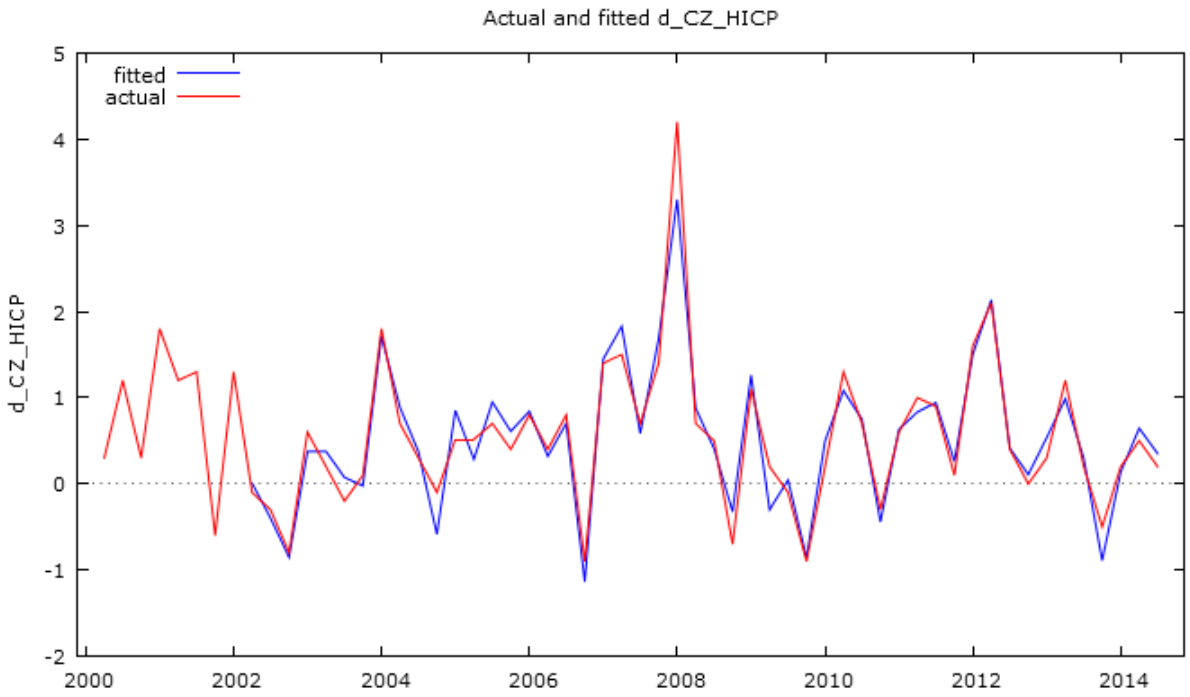
Variable	Coefficient	Std. error	t-ratio	p-value
const	-12.307	1.940	-6.343	p<0.001
CZ_HICP_1	0.446	0.061	7.259	p<0.001
CZ_ex_rate_1	-0.293	0.046	-6.299	p<0.001
CZ_int_rate_1	-0.678	0.119	-5.706	p<0.001
CZ_r_gdp_gr_1	0.189	0.050	3.801	0.002
CZ_wage_1	-0.326	0.066	-4.914	p<0.001
d_CZ_ex_rat_1	0.502	0.069	7.234	p<0.001
d_CZ_ex_rat_2	0.359	0.059	6.085	p<0.001
d_CZ_ex_rat_3	0.458	0.069	6.592	p<0.001
d_CZ_ex_rat_4	0.498	0.062	8.067	p<0.001
d_CZ_ex_rat_5	0.374	0.062	5.996	p<0.001
d_CZ_ex_rat_6	0.449	0.069	6.554	p<0.001
d_CZ_int_ra_4	2.915	0.394	7.396	p<0.001
d_CZ_int_ra_6	-2.088	0.444	-4.700	p<0.001
d_CZ_int_ra_7	-1.730	0.592	-2.920	0.011
d_CZ_int_ra_8	-5.138	0.489	-10.517	p<0.001
d_CZ_r_gdp__1	-0.376	0.072	-5.201	p<0.001
d_CZ_r_gdp__2	-0.524	0.148	-3.552	0.003
d_CZ_r_gdp__3	-1.864	0.236	-7.916	p<0.001
d_CZ_r_gdp__4	-1.232	0.165	-7.482	p<0.001
d_CZ_r_gdp__6	-0.619	0.077	-8.043	p<0.001

d_CZ_r_gdp__7	0.299	0.086	3.490	0.004
d_CZ_r_gdp__8	-0.622	0.116	-5.346	p<0.001
d_CZ_wage_2	-0.170	0.042	-4.067	0.001
d_CZ_wage_3	-0.215	0.031	-6.852	p<0.001
d_CZ_wage_4	0.211	0.057	3.679	0.002
d_CZ_wage_5	0.300	0.053	5.649	p<0.001
d_CZ_wage_6	0.457	0.075	6.074	p<0.001
d_CZ_wage_7	0.256	0.047	5.429	p<0.001
d_CZ_HICP_1	-0.428	0.085	-5.039	p<0.001
d_CZ_HICP_2	-0.518	0.112	-4.633	p<0.001
d_CZ_HICP_3	-0.854	0.112	-7.600	p<0.001
d_CZ_HICP_4	-0.881	0.131	-6.743	p<0.001
d_CZ_HICP_5	-1.427	0.204	-7.013	p<0.001
d_CZ_HICP_6	-1.867	0.166	-11.241	p<0.001

$R^2 = 0.92$, $F(35, 14) = 211.693$ and P-value(F) <0.001 *Source: obtained from GRETL*

Plotted first model of inflation can be seen in figure 5.

Figure 5 – CZ Actual vs. fitted values 1



Source: obtained from GRETL

The ARDL model was diagnosed (specification, heteroskedasticity, autocorrelation and multicollinearity). The results can be seen in table 17.

Table 18 – CZ Diagnostics 1

Test	p-value	Discussion
RESET test (squares & cubes)	p<0.001	Problem with specification
Non-linearity test		Could not be performed
White test		Could not be performed
Breusch-Pegan test	0.002	Problem with heteroskedasticity
Durbin-Watson test	0.701	Autocorrelation is not present
Collinearity test		Problem with multicollinearity

Source: obtained from GRETL

There were some problems with the model thus the model was adjusted by omitting some of the variables to meet the requirements. The final model designed by sequential elimination of variables using two-sided p-value = 0.10 can be seen in table 9.

Table 19 - CZ ARDL 2

Model: ARDL, using observations 2001:4-2014:3 (T = 52)

Dependent variable: d_CZ_HICP

Variable	Coefficient	Std. error	t-ratio	p-value
const	3.640	0.922	3.946	p<0.001
CZ_HICP_1	-0.054	0.015	-3.651	0.001
CZ_ex_rate_1	0.038	0.011	3.398	0.002
CZ_wage_1	-0.109	0.038	-2.888	0.007
d_CZ_ex_rat_2	-0.082	0.034	-2.402	0.022
d_CZ_ex_rat_5	-0.062	0.035	-1.790	0.082
d_CZ_int_ra_4	1.612	0.444	3.633	0.001
d_CZ_int_ra_6	0.942	0.311	3.030	0.005
d_CZ_r_gdp__3	-0.417	0.118	-3.522	0.001
d_CZ_r_gdp__4	0.316	0.121	2.619	0.013
d_CZ_r_gdp__6	-0.177	0.068	-2.608	0.013
d_CZ_wage_4	0.261	0.081	3.203	0.003
d_CZ_wage_5	0.228	0.087	2.620	0.013
d_CZ_wage_6	0.130	0.055	2.361	0.024
d_CZ_HICP_3	-0.457	0.104	-4.408	p<0.001
d_CZ_HICP_5	-0.499	0.185	-2.703	0.011
d_CZ_HICP_6	-0.565	0.080	-7.099	p<0.001

R^2 = 0.607, F(16, 35) = 8.475 and P-value(F) <0.001 *Source: obtained from GRETL*

This ARDL model was also diagnosed (specification, heteroskedasticity, autocorrelation and multicollinearity). The results can be seen in tables 20 and 21.

The table 22 shows results of specification, heteroskedasticity and correlation tests.

Table 23 – CZ Diagnostics 2

Test	p-value	Discussion
RESET test (squares & cubes)	0.055	No problem with specification
Non-linearity test (squares)	0.674	No problem with specification
White test	0.816	No problem with heteroskedasticity
Durbin-Watson test	0.495	Autocorrelation is not present

Source: obtained from GRETL

The table 24 shows results of collinearity test. Values > 10.0 may indicate a collinearity problem.

Table 25 – CZ Diagnostics 3

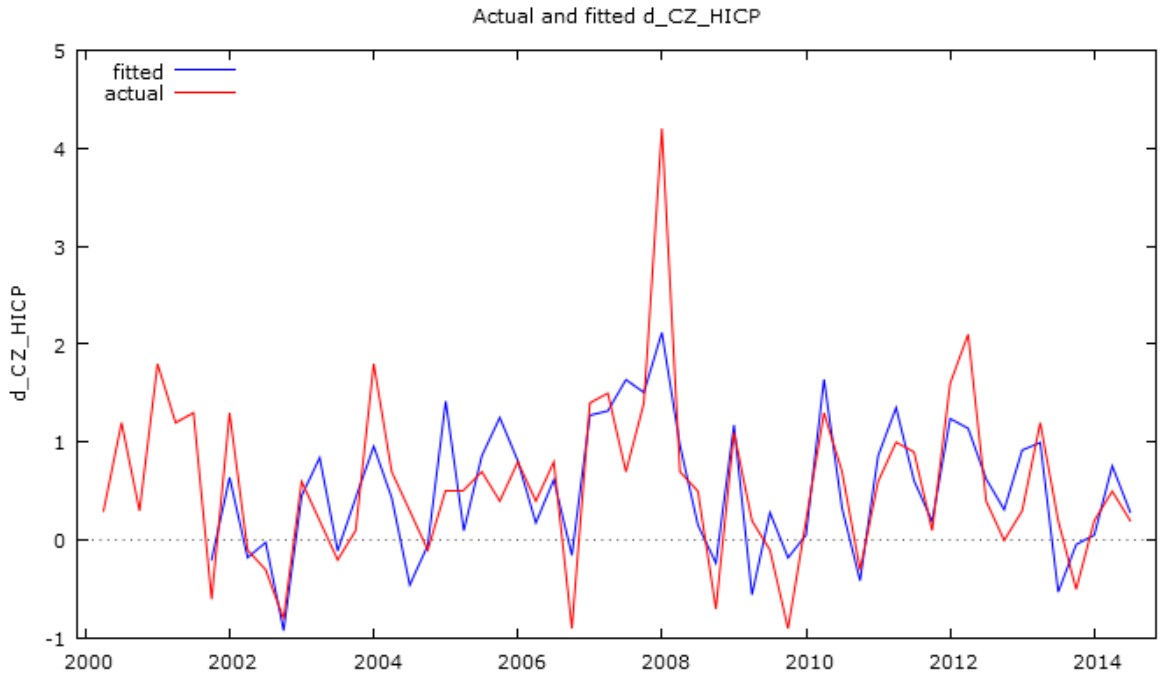
	Collinearity test
CZ_HICP_1	9.209
CZ_ex_rate_1	7.824
CZ_wage_1	1.842
d_CZ_ex_rat_2	1.987
d_CZ_ex_rat_5	2.258
d_CZ_int_ra_4	2.229
d_CZ_int_ra_6	2.025
d_CZ_r_gdp__3	3.902
d_CZ_r_gdp__4	3.982
d_CZ_r_gdp__6	1.772
d_CZ_wage_4	2.417
d_CZ_wage_5	2.666
d_CZ_wage_6	2.013
d_CZ_HICP_3	1.853
d_CZ_HICP_5	2.256
d_CZ_HICP_6	1.966

Source: obtained from GRETL

There are no issues in the ARDL model.

Plotted final model of inflation of Czech Republic can be seen in figure 6.

Figure 6 – CZ Actual vs. fitted values 2



Source: obtained from GRETL

After modeling ARDL model there have been omitted level form variables to determine long-run relationship using Bounds test. There were all five level form variables therefore it were used Critical Values Bounds for F-statistics with no intercept with significance level 0.05 and k=3, where k is number of omitted variables. I(0) Critical Value Bounds is 2.45 and I(1) Critical Value Bounds is 3.63. After omitting the variables GRETL calculated F-statistics, which was F(3, 35) = 8.57. This means there is long-run relationship in the model.

After Bounds test there was created OLS model with inflation as dependant variable and all other level form variables as independent variables. This model can be seen in table 26.

Table 27 – CZ OLS

Model: OLS, using observations 2000:1-2014:3 (T = 59)
Dependent variable: CZ_HICP

Variable	Coefficient	Std. error	t-ratio	p-value
const	64.645	6.812	9.491	p<0.001
CZ_ex_rate	0.446	0.055	8.141	p<0.001
CZ_int_rate	-2.031	0.492	-4.131	p<0.001
CZ_r_gdp_growth	-0.465	0.200	-2.338	0.024
CZ_wage	-0.246	0.286	-0.861	0.393

R^2 = 0.888, F(4, 54) = 106.735 and P-value(F) < 0.001 *Source: obtained from GRETL*

There were saved residuals from this model.

Another task was to complete Error Correction Model. This model has as dependant variable first order differenced inflation (not lagged) and all other first order differenced variables (lagged by 1 to 4, because the thesis is working with quarterly data and this model works with one lagged year) and saved residuals from previous model (lagged by 1) as independent variables. The model can be seen in table 28.

Table 29 – CZ - ECM

Model: ECM, using observations 2001:2-2014:3 (T = 54)
Dependent variable: d_CZ_HICP

Variable	Coefficient	Std. error	t-ratio	p-value
const	0.794	0.157	5.049	p<0.001
d_CZ_ex_rat_2	-0.109	0.028	-3.835	p<0.001
d_CZ_int_ra_2	1.448	0.525	2.761	0.008
d_CZ_int_ra_4	0.802	0.372	2.155	0.036
d_CZ_wage_4	0.116	0.058	1.989	0.052
cz_e_1	-0.06	0.029	-2.076	0.043

R^2 = 0.247, F(5, 48) = 3.497 and P-value(F) = 0.009 *Source: obtained from GRETL*

It can be determined from the regression coefficient of the residuals from previous model that 6% of deviations of inflation are restored in one quarter from the equilibrium.

From the ARDL model, which is visible in table 9, can be calculated elasticity for all present variables in the model using their regression coefficients.

Elasticity of exchange rate is calculated by:

$$E_1 CZ = -\left(\frac{\theta_0}{\theta_1}\right) = -\left(\frac{-0.0537854}{0.0376038}\right) = 1{,}430 \ (3)$$

Where θ_0 is the coefficient of the lagged level form inflation and θ_1 is coefficient of the lagged level form real exchange rate. The result can be interpreted so that change in exchange rate by 1 point causes change in inflation by 1.430 point.

Elasticity of nominal wage is calculated by:

$$E_4 CZ = -\left(\frac{\theta_0}{\theta_4}\right) = -\left(\frac{-0.0537854}{-0.109263}\right) = -0{,}492 \ (4)$$

Where θ_0 is the coefficient of the lagged level form inflation and θ_4 is coefficient of the lagged level form nominal wage. The result can be interpreted so that change in nominal wage by 1 point causes change in inflation by -0.492 point.

5.1.2. Designing the Slovak model

The study designed model for Czech HICP using ARDL method. Number of lags was decided to be 8 and that is why model has high amount of variables. The model with only significant variables designed by sequential elimination of variables using two-sided p-value = 0.10 can be seen in table 30.

Table 31 – SK ARDL 1

Model: ARDL, using observations 2002:2-2014:3 (T = 50)

Dependent variable: d_SK_HICP

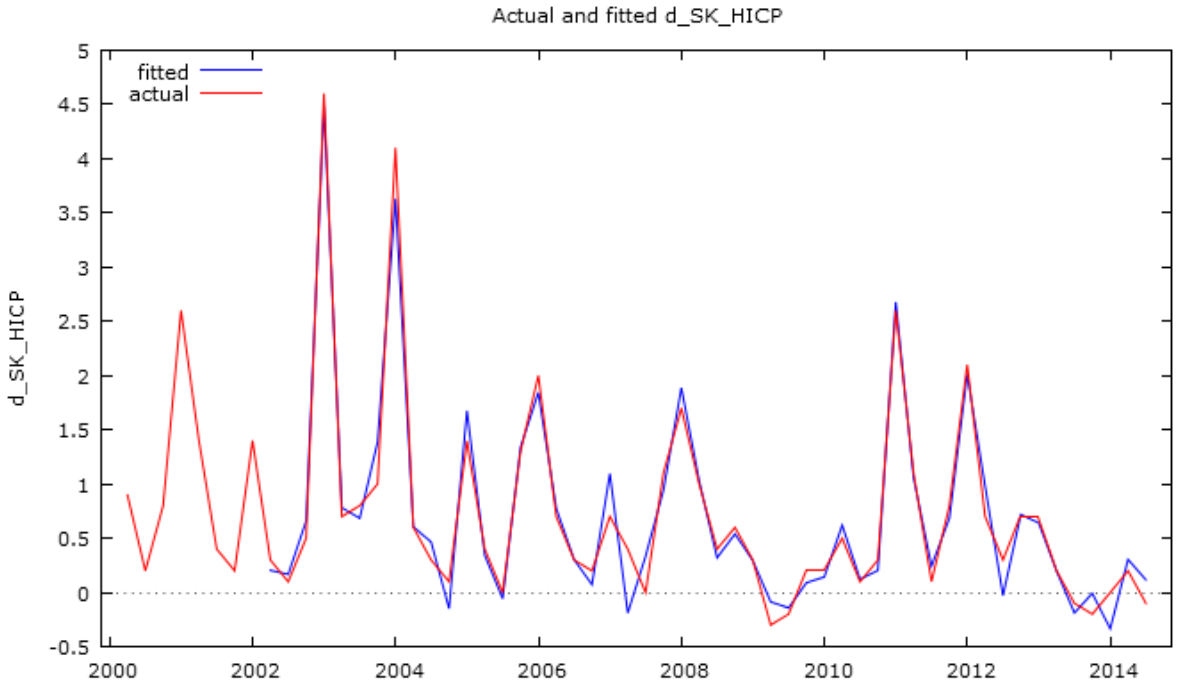
Variable	Coefficient	Std. error	t-ratio	p-value
const	31.215	2.688	11.611	p<0.001
SK_HICP_1	-0.234	0.019	-12.305	p<0.001
SK_ex_rate_1	0.053	0.011	4.880	p<0.001
SK_int_rate_1	-2.025	0.194	-10.451	p<0.001
SK_r_gdp_gr_1	-0.351	0.033	-10.554	p<0.001
SK_wage_1	-0.741	0.091	-8.113	p<0.001
d_SK_ex_rat_1	-0.268	0.042	-6.366	p<0.001
d_SK_ex_rat_2	0.117	0.031	3.743	0.003
d_SK_ex_rat_3	-0.144	0.042	-3.417	0.006
d_SK_ex_rat_4	0.135	0.027	4.991	p<0.001
d_SK_ex_rat_5	-0.205	0.033	-6.179	p<0.001
d_SK_ex_rat_6	-0.127	0.013	-9.418	p<0.001
d_SK_int_ra_1	1.763	0.248	7.122	p<0.001
d_SK_int_ra_2	1.801	0.274	6.563	p<0.001
d_SK_int_ra_3	1.895	0.259	7.317	p<0.001
d_SK_int_ra_4	1.201	0.131	9.172	p<0.001
d_SK_int_ra_5	1.491	0.200	7.475	p<0.001
d_SK_int_ra_6	0.878	0.151	5.828	p<0.001
d_SK_int_ra_7	1.321	0.270	4.883	p<0.001
d_SK_int_ra_8	0.555	0.136	4.086	0.002
d_SK_r_gdp__1	0.449	0.043	10.529	p<0.001
d_SK_r_gdp__2	0.360	0.043	8.385	p<0.001
d_SK_r_gdp__3	0.083	0.035	2.368	0.037
d_SK_r_gdp__5	-0.155	0.026	-6.042	p<0.001
d_SK_r_gdp__6	-0.492	0.056	-8.820	p<0.001
d_SK_r_gdp__8	-0.179	0.037	-4.880	p<0.001
d_SK_wage_1	0.791	0.087	9.140	p<0.001
d_SK_wage_2	0.864	0.088	9.832	p<0.001
d_SK_wage_3	0.995	0.085	11.746	p<0.001
d_SK_wage_4	0.754	0.065	11.612	p<0.001
d_SK_wage_5	0.259	0.050	5.229	p<0.001

d_SK_wage_6	-0.303	0.040	-7.497	p<0.001
d_SK_wage_7	-0.163	0.031	-5.288	p<0.001
d_SK_wage_8	-0.146	0.020	-7.196	p<0.001
d_SK_HICP_2	0.649	0.107	6.083	p<0.001
d_SK_HICP_3	0.189	0.059	3.230	0.008
d_SK_HICP_5	-0.255	0.038	-6.759	p<0.001
d_SK_HICP_6	-0.770	0.054	-14.283	p<0.001
d_SK_HICP_7	-0.403	0.069	-5.842	p<0.001

$R^2 = 0.959$, $F(38, 11) = 462.792$ and P-value(F) < 0.001 *Source: obtained from GRETL*

Plotted model of inflation can be seen in figure 6.

Figure 7 – SK Actual vs. fitted values 1



Source: obtained from GRETL

The ARDL model was diagnosed (specification, heteroskedasticity, autocorrelation and multicollinearity). The results can be seen in table 32.

Table 33 – SK Diagnostics 1

Test	p-value	Discussion
RESET test (squares & cubes)	0.022	Problem with specification
Non-linearity test		Could not be performed
White test		Could not be performed
Breusch-Pegan test	0.077	No problem with heteroskedasticity
Durbin-Watson test	0.991	Autocorrelation is not present
Collinearity test		Problem with multicollinearity

Source: obtained from GRETL

There were some problems with the model thus the model was adjusted by omitting some of the variables to meet the requirements. The final model designed by sequential elimination of variables using two-sided p-value = 0.25 can be seen in table 34.

Table 35 – SK ARDL 2

Model: ARDL, using observations 2001:4-2014:3 (T = 52)
Dependent variable: d_SK_HICP

Variable	Coefficient	Std. error	t-ratio	p-value
const	6.685	2.575	2.596	0.013
SK_HICP_1	-0.044	0.018	-2.494	0.017
SK_ex_rate_1	-0.018	0.010	-1.808	0.078
SK_wage_1	-0.103	0.034	-2.996	0.005
d_SK_int_ra_4	-0.546	0.177	-3.082	0.004
d_SK_wage_1	0.067	0.047	1.417	0.164
d_SK_wage_3	0.044	0.028	1.583	0.121
d_SK_HICP_1	0.112	0.084	1.343	0.186
d_SK_HICP_2	-0.105	0.082	-1.282	0.207
d_SK_HICP_3	-0.105	0.090	-1.173	0.247
d_SK_HICP_4	0.440	0.144	3.059	0.004

$R^2 = 0.498$, $F(10, 43) = 9.876$ and P-value(F) < 0.001 *Source: obtained from GRETL*

This ARDL model was also diagnosed (specification, heteroskedasticity, autocorrelation and multicollinearity). The results can be seen in tables 36 and 37.

The first table shows results of specification, heteroskedasticity and correlation tests.

Table 38 – SK Diagnostics 2

Test	p-value	Discussion
RESET test (squares & cubes)	0.175	No problem with specification
Non-linearity test (squares)	0.713	No problem with specification
White test	0.182	No problem with heteroskedasticity
Durbin-Watson test	0.212	Autocorrelation is not present

Source: obtained from GRETL

The second table shows results of collinearity test. Values > 10.0 may indicate a collinearity problem.

Table 39 – SK Diagnostics 3

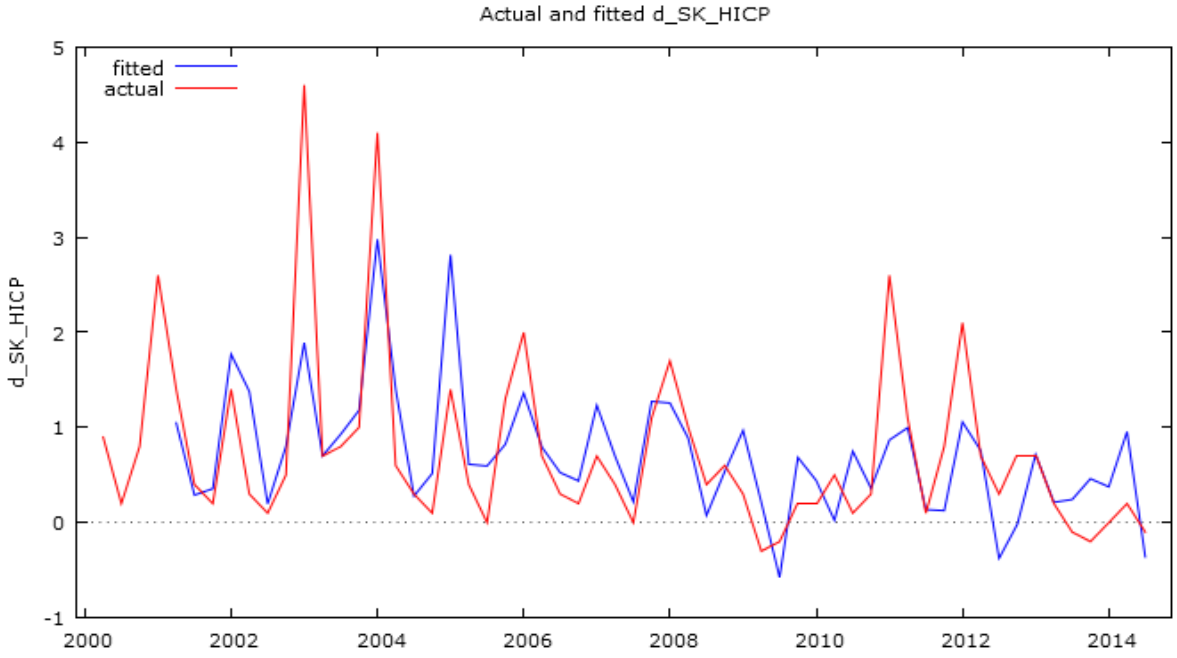
	Collinearity test
SK_HICP_1	4.227
SK_ex_rate_1	3.358
d_SK_int_ra_4	1.076
SK_wage_1	2.015
d_SK_wage_1	1.856
d_SK_wage_3	1.106
d_SK_HICP_1	1.205
d_SK_HICP_2	1.184
d_SK_HICP_3	1.154
d_SK_HICP_4	1.131

Source: obtained from GRETL

There are no issues in the ARDL model.

Plotted final model of inflation of Slovakia can be seen in figure 8.

Figure 8 – SK Actual vs. fitted values 2



Source: obtained from GRETL

After modeling ARDL model there have been omitted level form variables to determine long-run relationship using Bounds test. There were all five level form variables therefore it were used Critical Values Bounds for F-statistics with no intercept with significance level 0.05 and k=3, where k is number of omitted variables. I(0) Critical Value Bounds is 2.45 and I(1) Critical Value Bounds is 3.63. After omitting the variables GRETL calculated F-statistics, which was F(3, 43) = 3.67. This means there is long-run relationship in the model.

After Bounds test there was created OLS model with inflation as dependant variable and all others level form variables as independent variables. This model can be seen in table 40.

Table 41 – SK OLS

Model: OLS, using observations 2000:1-2014:3 (T = 59)
Dependent variable: SK_HICP

Variable	Coefficient	Std. error	t-ratio	p-value
const	152.268	4.274	35.630	p<0.001
SK_ex_rate	-0.368	0.061	-6.007	p<0.001
SK_int_rate	-2.577	0.734	-3.510	0.001
SK_r_gdp_growth	-1.095	0.179	-6.117	p<0.001
SK_wage	-1.027	0.232	-4.420	p<0.001

R^2 = 0.884, F(4, 54) = 103.583 and P-value(F) < 0.001 *Source: obtained from GRETL*

There were saved residuals from this model.

Another task was to complete Error Correction Model. This model has as dependant variable first order differenced inflation (not lagged) and all other first order differenced variables (lagged by 1 to 4 – because the thesis is working with quarterly data and this model works with one lagged year) and saved residuals from previous model (lagged by 1) as independent variables. The model can be seen in table 42.

Table 43 – SK ECM

Model: ECM, using observations 2001:2-2014:3 (T = 54)
Dependent variable: d_SK_HICP

Variable	Coefficient	Std. error	t-ratio	p-value
const	0.693	0.113	6.158	p<0.001
d_SK_int_ra_3	0.500	0.270	1.855	0.070
d_SK_int_ra_4	-0.613	0.300	-2.044	0.046
d_SK_r_gdp__4	0.154	0.034	5.256	p<0.001
sk_e_1	-0.048	0.032	-2.101	0.041

R^2 = 0.261, F(4, 49) = 7.590 and P-value(F) < 0.001 *Source: obtained from GRETL*

It can be determined from the regression coefficient of the residuals from previous model that 2% of deviations of inflation are restored in one quarter from the equilibrium.

From the ARDL model, which is visible in table 16, can be calculated elasticity for all chosen variables using their regression coefficients.

Elasticity of exchange rate is calculated by:

$$E_1SK = -\left(\frac{\theta_0}{\theta_1}\right) = -\left(\frac{-0.0444193}{-0.0175869}\right) = -2.526 \text{ (5)}$$

Where θ_0 is the coefficient of the lagged level form inflation and θ_1 is coefficient of the lagged level form real exchange rate. The result can be interpreted so that change in exchange rate by 1 point causes change in inflation by -2.53 point.

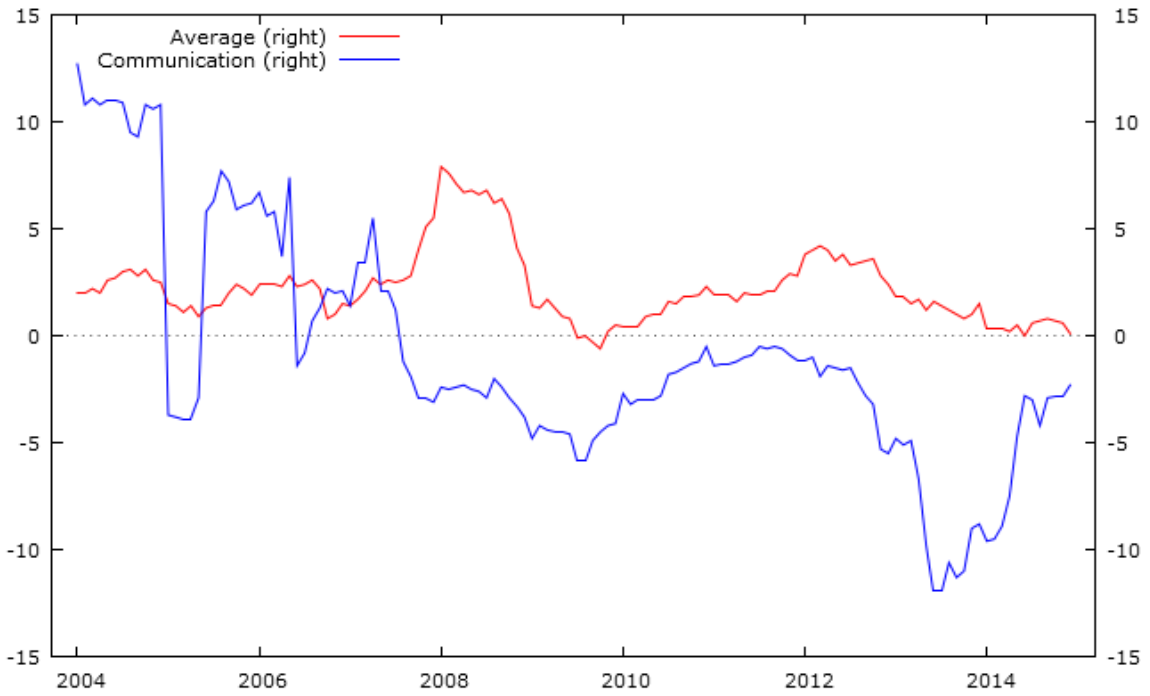
Elasticity of nominal wage is calculated by:

$$E_4SK = -\left(\frac{\theta_0}{\theta_4}\right) = -\left(\frac{-0.0444193}{-0.103262}\right) = -0.430 \text{ (6)}$$

Where θ_0 is the coefficient of the lagged level form inflation and θ_4 is coefficient of the lagged level form nominal wage. The result can be interpreted so that change in nominal wage by 1 point causes change in inflation by -0.43 point.

The comparison of communication market and average was performed using plotted values. They can be seen in figure 9.

Figure 9 – Inflation in communication market and the average



Source: obtained from GRETL, data from Eurostat

From the plotted values is obvious that inflation in this market differs with the average almost for the whole period. In the beginning of the period prices of communication were growing faster than the average. In 2007 the prices were moving almost the same as the average, but then the prices started rapidly decreasing. In 2014, after 7 years, prices were finally getting close to the average.

5.2. *Discussion*

It can be seen in the results that inflation of Czech Republic is influenced by same long-term factors as inflation of Slovakia. These factors are nominal wage and exchange rate. In Czech model change in nominal wage by 1 point causes change in

inflation by -0.49 point and exchange rate by 1 point causes change in inflation by 1.43 point. In Slovak model change in nominal wage by 1 point causes change in inflation by -0.43 point and change in exchange rate by 1 point causes change in inflation by -2.53 point. The result is strange in case of Czech and Slovak nominal wage, because when wage is higher, consumption should increase and therefore inflation should increase as well. But it can occur.

According to Alexová (2012) "In the Czech Republic and Hungary, prices are mainly determined by developments in domestic markets, mostly by developments in unit labour costs. Price changes in Slovakia are 70% attributable to unit labor cost fluctuations and almost 30% is related to import prices." This result proves that inflation is connected with nominal wage same as result of this study.

Cigan, Jevčák, Pradelle and Žáková (2008) and Babecká-Kucharčkuková (2009) reported that exchange rate pass-through to inflation in those countries. With respect to their work and work of Alexová (2012) it can be assumed results of this thesis from this point of view are correct.

Although the models predominate factors listed at the beginning of the work are domestic factors. It must be taken into account that they are influenced by foreign influences (GDP growth was inter alia caused by foreign demand). Inflationary effects of domestic factors are largely influenced by external factors. According to the results and results of other studies inflation is actually rather a consequence of global price trends in the context of world events. Regulated prices and changes in revenue from VAT seem to also have an influence on inflation. The impact in the period before the crisis was not possible to determine and compare with the crisis period. The fact that results from studies from different period differ and models can contain other factors suggest that the factors affecting inflation evolves over time.

The situation of the Czech economy when inflation rate is below target and declining CNB should contribute foreign exchange interventions to increase price level back to inflation target. Lowering interest rates is not possible; the rate reached almost its minimum. But in the long run foreign exchange intervention causes the growth of money supply.

In case of inflation of Slovakia the situation is nearly identical. The results show that in both models are same factors influencing inflation in a long-run. Therefore it can be assumed development of these two countries is influence by similar factors.

6. CONCLUSION

The main objective of this work was to identify the main inflationary factors in the Czech Republic and Slovakia and to compare them.

The main goal of the work was subsequently met by fulfillment of sub-objectives. Main concepts related to inflation, the theoretical foundations of the relationship of inflation with other macroeconomic variables and the effects of inflation on economic subjects were mentioned in the introduction and literature review.

Inflation was also described from the perspective of the CNB and also macroeconomic indicators that CNB uses were given.

The practical part is based on empirical analysis, which was performed by ARDL models. Using this type of models the main inflationary factors in the Czech Republic and Slovakia were identified. It confirmed that one factor is not enough for the clarification of inflation, but it was needed a combination of several factors. Identified factors describe the inflation rate from 50 to 61%, which are reasonable numbers considering how complex phenomenon inflation is and how many influences are involved in its development. The resulting models are well specified; they were not difficult to build and are clearly interpretable.

Discussion was held based on the identified factors, which dealt with the accuracy of the results.

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8. APPENDIX

Table 44 – Original data

TIME/ GEO	CZ HICP	CZ ex.rat	CZ int.rat	CZ gdp.gr	CZ wage	SK HICP	SK ex.rat	SK int.rat	SK gdp.gr	SK wage
00Q1	89.7	83.5	5.3	3.8	1.5	66.1	140.3	8.6	-1.8	16.3
00Q2	90.0	82.0	5.3	4.9	1.1	67.0	140.4	8.5	0.9	7.9
00Q3	91.2	84.6	5.3	5.1	2.6	67.2	143.7	8.4	2.4	7.6
00Q4	91.5	85.6	5.2	4.8	3.3	68.0	150.7	8.3	3.5	6.9
01Q1	93.3	87.5	5.1	4.3	4.4	70.6	142.1	8.2	3.0	4.5
01Q2	94.5	87.9	4.9	3.3	5.6	72.0	149.9	8.0	3.1	4.7
01Q3	95.8	90.2	5.0	2.4	5.9	72.4	147.1	8.0	2.9	3.2
01Q4	95.2	91.8	4.9	2.3	3.7	72.6	146.3	7.9	4.4	-0.7
02Q1	96.5	95.8	4.4	1.6	6.9	74.0	149.5	7.4	4.2	4.5
02Q2	96.4	99.7	3.9	1.1	7.2	74.3	142.5	7.7	4.2	6.6
02Q3	96.1	100.7	3.2	1.6	5.5	74.4	133.3	7.2	6.0	0.0
02Q4	95.3	97.1	2.8	1.9	7.5	74.9	131.1	5.6	4.5	5.3
03Q1	95.9	95.1	2.6	2.9	4.4	79.5	122.1	5.0	5.9	2.3
03Q2	96.1	96.0	2.5	3.5	3.2	80.2	115.3	4.8	6.2	2.8
03Q3	95.9	93.7	2.1	4.0	2.4	81.0	116.4	4.9	4.3	4.7
03Q4	96.0	93.8	2.0	4.0	2.7	82.0	110.1	5.3	5.3	3.6
04Q1	97.8	92.6	2.0	4.1	4.3	86.1	104.8	5.1	4.8	3.9
04Q2	98.5	94.2	2.0	4.2	0.6	86.7	108.8	5.1	4.1	3.8
04Q3	98.8	95.4	2.3	4.9	4.6	87.0	107.2	5.0	6.0	-1.5
04Q4	98.7	96.2	2.5	5.9	1.0	87.1	101.2	4.9	5.9	3.7
05Q1	99.2	99.5	2.3	6.5	-0.1	88.5	100.0	3.8	5.9	8.2
05Q2	99.7	98.8	1.8	7.0	-0.4	88.9	104.2	3.6	7.2	1.0
05Q3	100.4	100.3	1.8	6.5	-0.1	88.9	107.5	3.2	6.6	2.8
05Q4	100.8	101.5	1.9	6.1	-1.3	90.2	110.2	3.5	6.4	4.6
06Q1	101.6	104.3	2.0	6.8	-0.4	92.2	108.9	3.8	7.6	1.5
06Q2	102.0	104.8	2.0	7.3	0.8	92.9	104.3	4.5	7.8	2.7
06Q3	102.8	105.3	2.0	7.1	0.4	93.2	102.9	5.1	8.1	3.5
06Q4	101.9	104.7	2.4	7.1	1.0	93.4	101.6	4.3	9.5	-0.3
07Q1	103.3	105.4	2.5	6.2	3.5	94.1	100.0	4.3	9.3	1.5
07Q2	104.8	104.7	2.4	5.3	2.6	94.5	97.2	4.4	9.5	0.8
07Q3	105.5	106.4	2.9	5.4	2.6	94.5	95.3	4.7	10.0	-0.2
07Q4	106.9	111.3	3.3	5.3	2.1	95.6	90.4	4.6	13.7	-0.9
08Q1	111.1	120.9	3.5	3.9	6.0	97.3	87.4	4.4	8.4	3.0

08Q2	111.8	123.1	3.7	3.9	3.1	98.3	83.9	4.6	7.1	6.6
08Q3	112.3	126.3	3.6	2.6	1.6	98.7	87.4	5.0	5.9	6.1
08Q4	111.6	121.6	2.9	-0.2	3.8	99.3	99.7	4.9	0.8	2.4
09Q1	112.7	115.6	1.9	-4.2	2.9	99.6	100.8	4.7	-5.6	9.0
09Q2	112.9	118.3	1.7	-5.7	3.4	99.3	96.2	5.0	-5.4	6.7
09Q3	112.8	121.9	1.5	-5.3	2.4	99.1	91.6	4.9	-5.3	4.0
09Q4	111.9	119.6	1.3	-3.6	1.7	99.3	88.7	4.2	-4.8	5.1
10Q1	112.1	120.3	1.0	0.6	-1.1	99.5	94.8	4.1	5.7	-4.3
10Q2	113.4	121.1	0.9	2.5	-1.4	100.0	103.1	3.8	5.3	0.5
10Q3	114.1	124.2	0.8	2.6	2.4	100.1	101.4	3.8	4.7	0.6
10Q4	113.8	123.9	0.7	2.9	0.1	100.4	96.6	3.8	3.7	-0.7
11Q1	114.4	126.1	0.7	3.0	-0.4	103.0	95.8	4.1	3.0	2.2
11Q2	115.4	125.8	0.7	2.2	1.1	104.1	91.1	4.4	2.8	0.6
11Q3	116.3	126.3	0.7	1.7	0.4	104.2	92.8	4.5	2.4	2.5
11Q4	116.4	122.1	0.7	1.0	1.1	105.0	97.2	4.8	2.7	-0.7
12Q1	118.0	124.5	0.7	0.2	2.8	107.1	100.0	5.0	2.3	1.0
12Q2	120.1	122.8	0.7	-0.6	2.8	107.8	102.2	4.8	1.9	0.8
12Q3	120.5	122.8	0.6	-1.1	1.9	108.1	104.7	4.3	1.5	0.2
12Q4	120.5	121.8	0.3	-1.4	2.9	108.8	101.0	4.1	0.7	2.1
13Q1	120.8	121.7	0.2	-2.2	1.8	109.5	99.3	3.9	0.9	2.9
13Q2	122.0	120.1	0.2	-1.3	1.5	109.7	100.4	2.7	1.2	-0.5
13Q3	122.2	119.8	0.2	-0.5	1.1	109.6	99.0	3.2	1.5	-0.3
13Q4	121.7	115.5	0.2	1.1	-2.1	109.4	96.3	3.0	2.1	-0.5
14Q1	121.9	112.9	0.2	2.3	1.4	109.4	95.7	2.5	2.3	1.3
14Q2	122.4	112.3	0.2	2.1	1.1	109.6	95.5	2.6	2.4	3.7
14Q3	122.6	111.8	0.2	2.2	-0.1	109.5	99.0	1.8	2.5	2.1

Source: obtained from Eurostat. OECD

8.1. *List of Figures*

8.2. *List of Tables*

8.3. *List of Abbreviations*

CNB ..... Czech National Bank

ECB ..... European Central Bank

NBS ..... National Bank of Slovakia

CPI ..... Consumer Price Index

GDP ..... Gross Domestic Product

CNB ..... Czech National Bank

HICP ..... Harmonized Index of Consumer Prices

CZK ..... Czech Koruna

EUR ..... Euro

OLS ..... Ordinary Least Square

ARDL ..... Autoregressive Distributed Lag Models

VAT ..... Value Added Tax

ERM II ..... European Exchange Rate Mechanism II

AIC ..... Akaike Information Criterion

BIC ..... Bayesian Information Criterion

HQI ..... Hannan-Quinn inforarion Criterion

RESET ..... Regression Equation Specification Error Test

ADF test ..... Augmented Dickey–Fuller Test

VAR ..... Vector Autoregressive

CZ ..... Czech Republic

SK ..... Augmented Dickey–Fuller test

Ex. rate, ex.rate ..... Exchange rate

Int. rate, int.rate.....Interest rate

R. GDP, gdp.gr ..... Real Gross Domestic Product

D ..... The first differencies

ECM ..... Error correction model

E ..... Elasticity