Mendel University in Brno
Faculty of Business and Economics

Wage rigidities in chosen EU countries

DIPLOMA THESIS

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Brno 2015

Acknowledgement

I would like to express my sincere gratitude to my supervisor doc. Ing. Petr Rozmahel, Ph.D. for his valuable advices and recommendations that helped me to elaborate this thesis.

Statutory declaration

Herewith I declare that I have written my final thesis: "Wage rigidities in chosen EU countries" by myself and all sources and data used are quoted in the list of references. I agree that my work will be published in accordance with Section 47b of Act No. 111/1998 Sb. On Higher Education as amended thereafter and in accordance with the *Guidelines on the Publishing of University Student Theses*.

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Abstract

The objective of this thesis is to estimate the real wage rigidities in chosen EU countries and their influence on long term unemployment. Two main approaches used in this thesis are multiple regression analysis applied on Phillips curve and Structural VAR. The results show the development of wage flexibility before and after the crisis, heterogeneity of wage flexibility across the chosen EU countries and positive correlation between wage flexibility and low long-term unemployment rate.

Keywords

Nominal and real wage rigidity, unemployment, Phillips curve, multiple regression, SVAR, Impulse Response Function, Variance Decomposition, Correlation analysis

Abstrakt

Cílem této práce je posoudit velikost mzdových rigidit ve vybraných zemích Evropské unie a zjistit jejich vliv na dlouhodobou nezaměstnanost. Mezi dva hlavní přístupy použité v této práci patří vícenásobná regresní analýza aplikovaná na Phillipsovu křivku a strukturální VAR modely. Výsledky zaznamenávají vývoj mzdových rigidit v období před krizí a v období krize, různorodost výsledků napříč vybranými zeměmi EU a pozitivní korelaci mezi mzdovou flexibilitou a nízkými mírami dlouhodobé nezaměstnanosti.

Klíčová slova

Nominální a reálné mzdové rigidity, nezaměstnanost, Phillipsova křivka, vícenásobná regrese, SVAR, impulzní odezvová funkce, varianční dekompozice, korelační analýza

Content

1 Introduction

In 2004 the Czech Republic entered the European Union and automatically committed to accept EURO as a currency. Even the fact that the date is not settled yet, it is obvious that it will be one of the most important decisions for the Czech economy.

Giving up the sovereignty over the monetary and exchange rate policy could be very costly if the Czech economy wouldn't have synchronized business cycles with other member states or wouldn't have flexible labor markets.

Namely, flexible labor markets are one of the basic conditions for Optimum Currency Area (OCA). Once the economy of a certain country is hit by an asymmetric shock and there is no option of monetary or exchange rate operations, the labor markets should adjust and bring the economy back to equilibrium.

We distinguish between nominal and real wage flexibility. However, in the macroeconomic point of view only aggregate real wage flexibility plays the role in equilibrating labor supply and demand. Real wages are usually flexible upwards when the economy is doing well the wages are increasing. On the other hand in the times of the crisis the wages become rigid. It can have several reasons such as long term labor contracts, price rigidity, negotiating power of labor unions, minimum wages laws etc., but the results are the same. If the wages are downward rigid, the involuntary unemployment may exceed its equilibrium rates during the recession. Wage rigidities were identified as important determinants of the cyclical adjustment dynamics of output as well. Together with vacancies and unemployment that are difficult to rationalize with models with flexible wages.

My motivation for this thesis is to find out, what is the position of the Czech Republic compared to the other states of the EU and how wage flexibility influences the long-term unemployment in the chosen EU countries. This thesis should describe the wage rigidities in chosen EU countries using methods of multiple regression analysis and SVAR approach, describe the relation between the wage rigidity and long-term unemployment and help to answer the question what is the relation between wage flexibility and long-term unemployment.

2 Objectives

The goal of this thesis is to examine real wage rigidities. The aim is to evaluate the wage flexibility as a potential adjustment mechanism under conditions of current ongoing economic and monetary integration process in Europe. Findings of this thesis should help to answer the research question:

- *What is the relation between the wage rigidity and the long-term unemployment?*

The hypothesis is that: *"the higher the real wage rigidity, the higher is the long-term unemployment rate."*

The thesis should also compare the countries among themselves in the flexibility point of view and answer whether the countries in the Eurozone have better adjusting mechanisms on the labor markets that the countries entering the Eurozone.

3 Methodology

The goal of this thesis is to estimate the real wage rigidities in chosen EU countries and their influence on long term unemployment. The hypothesis examined in this thesis is that the countries with higher wage rigidity are experiencing higher long-term rate of unemployment. The twelve chosen countries are further divided into three more homogeneous groups. First group are Visegrad countries also referred as Visegrad group or V4 which represent the eastern economies. Second group can be referred as PIGS countries which represent the countries hit the most by the crisis. Last group are the well established core countries of the European Union. We will study them closely in two time periods referred as the period before the crisis 2000Q1 – 2007Q4 and after the crisis 2008Q1 – 2014Q2.

The chosen countries are:

1. Czech Republic, Slovak Republic, Hungary and Poland.
2. Portugal, Italy, Greece and Spain.
3. France, Germany, Netherlands and United Kingdom.

Firstly, we want to estimate wage flexibility using two different methods. We use methods of multiple regression applied on Phillips curve and methods of bi-variate structural vector auto regression (SVAR) to measure the responsiveness of real wages to real shocks. In some parts of the thesis we also use Hedrick Prescott filter to remove the cyclical trend from the data.

Secondly, after estimating the real wage rigidities we compare the results from both methods and evaluate our hypothesis.

Software used in this thesis is mainly Gretl and JMulti for econometric calculations and Excel and Gimp for further interpretation of the results.

3.1 Multiple regression applied on Phillips curve

For estimation of parameters of expectation-augmented Phillips curve we used methodology of Alogoskoufis and Smith (1991). Authors use this equation for multiple regression model:

$$\Delta w_t = c_1 + c_2 u_t + c_3 \Delta p_{t-1} + \varepsilon_t$$

Where $\Delta w_t = \ln(w_t) - \ln(w_{t-1})$,$\Delta p_{t-1} = \ln(p_{t-1}) - \ln(p_{t-2})$ and $u_t = \ln(u_t)$. W_t is nominal unit labor cost seasonally adjusted and adjusted by working days with 2008 as a base year. P_t represents harmonized index of consumer prices (HICP) based in 2008. U_t is seasonally adjusted rate of unemployment, ε_t is an error term assumed to be white noise.

We are interested in coefficient c_2 which represents the elasticity of real wages to unemployment rate. Even the fact that on the left side of equation nominal wages are presented, the c_2 shows elasticity of real wages because of price inflation situated on the right side of the equation. Rest of the variance of wages is expressed by coefficient c_1.

All data are quarterly and seasonally adjusted taken from Eurostat and from Organization for Economic Cooperation and Development (OECD).

3.2 Structural vector auto regression (SVAR)

For calculation of real wage flexibility is used methodology of Moore and Pentecost (2006) that used SVAR models for assessing the suitability of entering EU member states into Eurozone. The idea is to identify real and nominal shocks, using the SVAR approach proposed by Blanchard and Quah (1989), and then measure the responsiveness of real wages to real and nominal shocks. The higher is the percentage of changes of real wages explained by the real shocks, the higher is the flexibility on the labor market.

3.2.1 Identifying shocks

Shocks in this thesis are identified using the methodology proposed by Blanchard and Quah (1989). There is an assumption that the variables are first difference stationary. First we estimate the following VAR model with two variables:

$$\Delta wr_t = b_{01} + \sum_{k=1}^{K} b_{11k}\Delta wr_{t-k} \sum_{k=1}^{K} b_{12k}\Delta w_{t-k} + e_t^{wr}$$

$$\Delta w_t = b_{02} + \sum_{k=1}^{K} b_{21k}\Delta wr_{t-k} \sum_{k=1}^{K} b_{22k}\Delta w_{t-k} + e_t^{w}$$

Where wr_t and w_t are natural logarithms of real and nominal wages. Term “wages” is used in the meaning of total labor cost data seasonally adjusted and adjusted by

working days. Real wages are calculated from nominal wages using the HICP deflator. e_t^{wr} and e_t^{w} are white noise disturbances, b_{ijk} are coefficients and K is the lag length where e_t^{wr} and e_t^{w} are not serially correlated. The max lag length is chosen based on the Akaike and Schwarz information criteria and the serial correlation is tested by Ljung-Box test and normality by Jarque-Bera test. Time series are at the beginning tested for stationarity by augmented Dickey-Fuller test (ADF test) and Kwiatowski-Phillips-Schmidt-Shin test (KPSS test).

At this moment, the disturbances e_t^{wr} and e_t^{w} are not structural. For economic interpretation of shocks these two relationships are proposed:

$$e_t^{wr} = c_{11}\varepsilon_t^N + c_{12}\varepsilon_t^R$$

$$e_t^{w} = c_{21}\varepsilon_t^N + c_{22}\varepsilon_t^R$$

Where ε_t^N and ε_t^R are nominal (transitory) and real (permanent) disturbances. It means that the movements of real and nominal wage growth are linear combinations of structural shocks. To get the coefficients of C matrix there have to be four restrictions in which the first three are the normalization conditions:

1. Variance of nominal shock is unity: $Var\ (\varepsilon^N) = 1$
2. Variance of real shock is unity: $Var\ (\varepsilon^R) = 1$
3. Nominal and real shocks are orthogonal: $Cov(\varepsilon^N, \varepsilon^R) = 0$
4. Nominal shocks have no long term impact on real wages. It influences one coefficient in C matrix.

First three conditions are met in software JMulti by default. Coefficients of the C matrix can be calculated in Gretl using the Choleski decomposition or also in JMulti.

After the shocks are identified we further inspect the dynamic effects of shocks on real wages using the Impulse Response Functions (IRF). IRF visually represents the responses of time series to unit change of different shocks.

At the end of analysis we use the variance decomposition to calculate the relative contribution of real and nominal shocks to fluctuation in real wages. Wages will be identified as flexible if their variation will be explained mainly because of real shocks.

Wage data used in this part of the thesis are hourly labor cost indices (NACE Rev. 2) from Eurostat at quarterly frequency. Eurostat provided only nominal labor cost data therefore to obtain real labor cost data we used HICP indices as a de-

flator also from Eurostat. Labor cost data include compensation of employees and taxes minus subsidies. All the indices are based in 2008.

Time period examined by this method is the same as in the previous one starting in 2000Q1 and ending in 2014Q2. We also divided the time into two sub periods from 2001Q1 to 2007Q4 and from 2008Q1 to 2014Q2.

3.3 Hodrick-Prescott filter

The Hodrick-Prescott filter (or Hodrick-Prescott decomposition) is used for removing the cyclical component of the time series to make it look smoother for better evaluation of the trend. Hodrick and Prescott (1997) suppose that the time series y_t composes of the sum of a growth component g_t and a cyclical component c_t:

$y_t = g_t + c_t$ for t = 1, … T.

The idea they used is that c_t are deviations from g_t and that in a long run their average is near zero, which leads to following problem:

$$\underset{\{g_t\}_{t=-1}^{T}}{Min} \left\{ \sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \right\}$$

where $c_t = y_t - g_t$. The parameter λ is a number > 0 which penalizes variability in the growth component of the series. The higher the λ, the smoother is the final series. For quarterly data we applied $\lambda = 1600$.

4 Literature review

New classical economists have built their economic theories on the assumption that wages and prices are flexible. There was a dispute with the new Keynesian economists about how quickly wages and prices adjust. Neo classical economists believe that prices "clear" the markets and bring balance to supply and demand. New Keynesian economists, on the other hand, believe that market-clearing models cannot explain short-run economic fluctuations, and so they came with the models with sticky wages and prices.

Flexibility of the labor markets and their similar structure is one of the conditions of optimal currency area as stated by Angeloni, Flad and Mongeli (2007). If the countries give up exchange rate and monetary policy they lose an important tool to handle asymmetric shocks and that is why it is very important to have another adjustment mechanism – flexible labor market. Mankiw (2007) defines wage rigidity as a failure of the wage to adjust until labor supply equals labor demand. The problem with adjustment of wages is that they are normally upwards flexible but rigid downwards thanks to the factors that we will discuss further in this thesis. Generally, we distinguish between nominal and real wage rigidities.

4.1 Nominal and real wage rigidities

We refer to wages as rigid when they are unable to react to changes in economy. For clarity, nominal wages are measured only in terms of money, not by their purchasing power. Real wages, on the contrary, are adjusted for inflation or other equivalent; therefore express the amount of goods and services that can be bought.

Nominal wage rigidities are usually described by the speed with which nominal wages changes in reaction to economic shocks. Because real wages consist of nominal wages and price level, the real wage rigidity can be described as a consequence of two nominal rigidities: a nominal price rigidity and nominal wage rigidity as stated by Knell (2013). Real wage rigidity can have several definitions, however for the purpose of this thesis we will stick with the definition of Ball and Romer (1990) who define real wage rigidity as the speed with which the real wage gets to its equilibrium value after being hit by shocks.

It is a prevailing opinion that individuals mostly care about their nominal wage as stated by Tobin (1972). More recent models by Elsby (2005) provided

empirical evidence for this hypothesis and documents that nominal wage cuts are perceived as particularly unfair and can lead to lowered productivity.

4.2 Factors influencing the wage rigidities

There are several reasons why wages cannot clear the markets when the demand does not meet the supply. To understand the wage rigidity we now focus on some major factors influencing the wage rigidities:

- minimum wage laws,
- inflation,
- centralized labor unions,
- efficiency wages,
- menu costs,
- employee protection,
- long-term contracts,
- coordination failures,
- aggregate demand externalities.

4.2.1 Minimum wage laws

Minimum wage is set by the government at certain levels which are supposed to protect the employees from exploitation from the side of employers and provide them with life minimum. According to Mankiw (2007) the minimum wage has the biggest impact on teenage unemployment because teenagers are the least skilled and experienced labor force and minimum wage can be on higher than equilibrium level for them which cause unemployment.

Moreover, there are also some other negative effects of setting a minimum wage. According to Aghion (2011) the existence of minimum wage reduced the level of social dialog among workers and employers. The research has shown that the higher the percentage of minimum-wage workers is, the less frequently the firms negotiate about the wages. It also suggests that the absence of minimum wage laws would lead to bigger negotiation of wages and more fair distribution of wages.

However, setting a minimum wage is a sensitive case in a political way. Sobel (1999), who studied the empirical determinants of a minimum wage in the United

States, found out, that a minimum wage is not set according to normative causes or economic formulas but is the outcome of a political process.

4.2.2 Inflation

Inflation can be very strong factor influencing the wage rigidity. The inflation "greases" the market and helps the real wages to adjust while they stay "hidden" in price changes caused by inflation as said by Tobin (1972). In the markets with inflation close to zero (for example in the European Union during the crisis) it is very difficult to reduce real wages because the workers are more sensitive to changes as was reported by Beningo and Ricci (2010).

Therefore, Blanchard, DellAriccia, and Mauro (2010) are against the goal of European Central Bank to keep the inflation target bellow 2 % and suggest that it should be permanently raised in order to help deal with the crisis. The right value should be chosen for every country separately according to volatility in inflation and unemployment. Fagan and Messina (2009) modified existing DSGE model to be able to match the cross-section of individual wage changes in different environments and tested optimal inflation rate for Belgium, Finland, Germany, Portugal and the US. The results differ from 0 – 2 % inflation rate for Belgium and Finland, 2 % for Germany and Portugal and 5 % inflation rate for the US.

4.2.3 Centralized labor unions

Another cause of wage rigidity is the negotiating power of labor unions. Wages of the workers covered by labor unions are not determined by the market equilibrium but by the collective bargaining between the union and the management of the company. Usually the wages are set above the equilibrium level which brings the company to decision how many workers to employ.

Babecký and Dybczak (2012) studied the relation between the level of centralization of labor unions and the wage rigidities in twenty four EU countries. The results confirmed theoretical expectations that the higher is the percentage of employees covered by labor unions the higher is the wage flexibility. Results of the correlation can be seen in Figure 1. Similar results were reported by Dickens (2007) or by Holden and Wulfsberg (2009). Dickens also calculated that in the fifteen European countries 28 % of workers are covered by downward wage rigidity and their wages would have been cut if the wages were flexible.

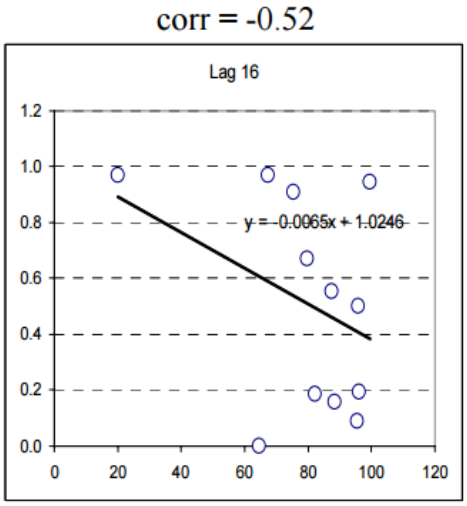

Figure 1 Correlation between wage flexibility on vertical axis (1 flexible, 0 rigid) and percentage of employees covered by labor unions, source: Babecký and Dybczak (2012)

Labor unions are also connected with the terms insiders and outsiders. Insiders are the employees covered by unions and outsiders are the potential workers outside the company. Workers inside the company are usually paid higher wages and unions continue to keep these wages high. This increases the costs to the employers and not allows them to hire more people that stay unemployed. Lindbeck and Snower (2001) brought evidence of higher persistence of unemployment in Europe compared to United States thanks to the higher employee coverage by unions.

4.2.4 Efficiency wages

Efficiency wage theory promoted by Salop (1979) or Shapiro and Stiglitz (1984), suggests that the higher wages make workers more productive. This could explain why the companies do not want to cut wages even in the period of bigger supply of labor because it could negatively influence the companies' profit. Mankiw and Romer (1991) say that the firm's aim is not to minimize labor cost per worker but rather minimize labor cost per efficiency unit.

Carter (2005) confirmed on the American labor market that companies keep higher wages than necessary in order to reduce fluctuation of employees which are also costly for the company.

4.2.5 Menu costs

Another reason why prices do not adjust immediately to the changes on the markets is that adjusting prices is costly. The evidence of influence of menu costs on a firm's behavior was described by Alexandrov (2014). The costs of price adjustment are called "menu costs" because the companies need to change menus, catalogues to customer and so on. In some cases it is more profitable for the company to keep the prices on the same level than to adjust prices. Therefore companies adjust prices in one time all together rather than continuously. The period between price changes causes rigidity in the short term.

4.2.6 Employee protection

Employee protection defined by law can be the crucial for the wage rigidities because it sets the limitation for employers to lower wages or dismiss workers. OECD brings the indicator of employment protection which measures the procedures and costs involved in dismissing individuals or groups of workers and the procedure of hiring workers. The index varies from 0 (least restrictions) to 6 (most restrictions). The data for the year 2013 are presented in Figure 2.

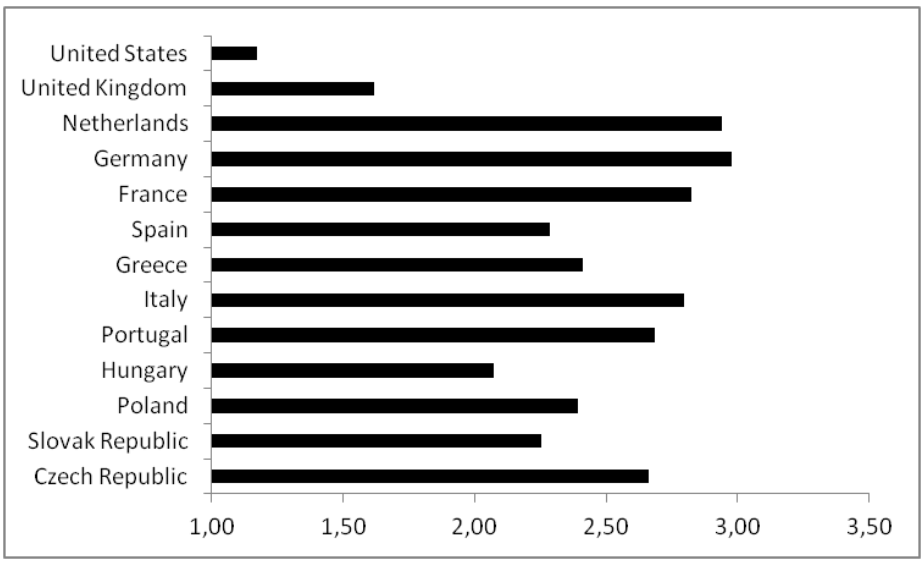

Figure 2 Indicator of employment protection, source: OECD (www.oecd.org)

Note: 0 – least restrictions, 6 - most restrictions

4.3 Implications of the wage rigidities

In this chapter we focus on how the wage rigidities influence the economy. We will focus on two main implications of wage rigidities: unemployment and reduced ability of an economy to adjust to asymmetric shock.

4.3.1 Unemployment

One of the important implications of wage rigidity is increased unemployment. Generally, rigidities and unemployment are the main focus of New Keynesian economics, Mankiw (2007) states that if the real wage is above the level that would be in case of equilibrium of supply and demand, the quantity of labor supplied is bigger than the quantity demanded, as it is shown in Figure 3. If the real wage is not able to decrease because of the rigidities we can see the amount of labor which stays unemployed.

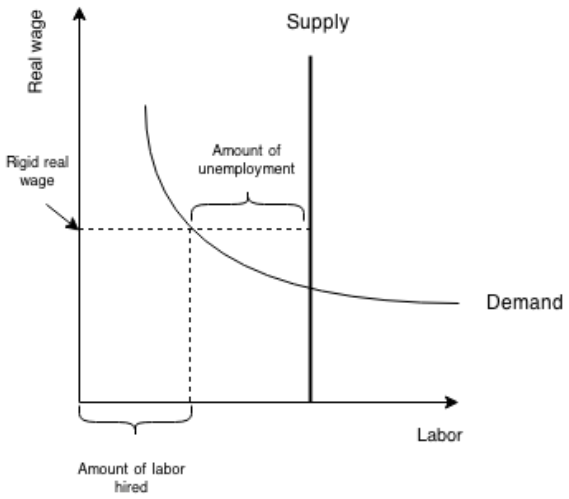

Figure 3 Wait unemployment caused by real wage rigidity, source: Mankiw (2007, p. 166), adjusted by author

Already Blanchard and Summers (1986) argued that nominal rigidities cannot fully explain unemployment because nominal prices adjust to shocks in some time. They shown evidence that the natural rate of unemployment in European countries changes when actual unemployment changes and that is why we cannot measure to which level the unemployment returns. On the other hand, they agreed that the nominal rigidities could be crucial for explaining the initial impulses of unemployment.

For better understanding of unemployment fluctuations we now focus on the transition process between employment and unemployment as explained by Mankiw (2007). For simplification let's assume the labor force size is fixed. The process of transition between employment and unemployment is illustrated in Figure 4.

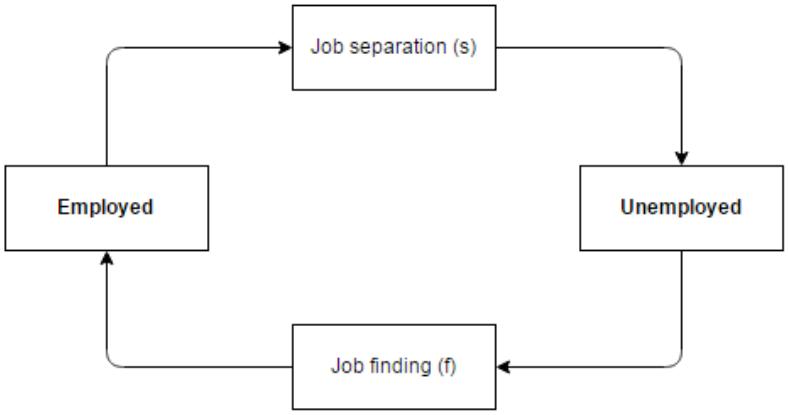

Figure 4 The transition process between employment and unemployment, source: Mankiw (2007, p. 181), adjusted by author

If the unemployment rate is stable, not falling or rising, we call that a steady state. It means that the number of people finding jobs is equal to people losing jobs. Mathematically written as:

$$f\ \mathrm{U} = s\ \mathrm{E}$$

Where f U is the number of people finding jobs and s E is the number of people losing jobs. If we rearrange this equation to find the steady-state employment, we can write that $E = L - U$. That means that number of employed people is equal to labor force minus the unemployed people. Now we can write this form of equation:

$$f\ \mathrm{U} = s\ (L - U)$$

If we divide the both sides by L and then solve for U/L we will get the following equation:

$$\frac{U}{L} = \frac{s}{s + f}$$

This equation shows that the rate of unemployment U/L depends on two things, the job separation and the job finding. If the separation rate rises the total unemployment rate rises as well. If there is higher rate of job finding the lower is the unemployment rate.

Mortensen and Pissarides (1994) expanded this simple model by external shocks and examined the volatility of job destruction processes and job creation processes. Tortorice (2013) expanded their work for wage rigidities and found out that the job-separation rate explains 70 % of the fluctuations in unemployment.

4.3.2 Ability to adjust to asymmetric shocks

When two countries create a monetary union they lose ability to control their monetary and exchange rate policies. If both countries are hit by asymmetric shock they have to use adjusting mechanisms to achieve equilibrium. According to Mundell's article (1961) about optimum currency areas, there are two main mechanisms that will bring automatically equilibrium in two countries that were hit by asymmetric shock: flexible labor market and the mobility of labor force. For the purpose of this thesis we now focus on flexible labor markets.

Flexible labor market

Let's assume that the first country was hit by negative shocks and the aggregate demand dropped while second country was hit by positive shocks and the demand rose as presented in Figure 5.

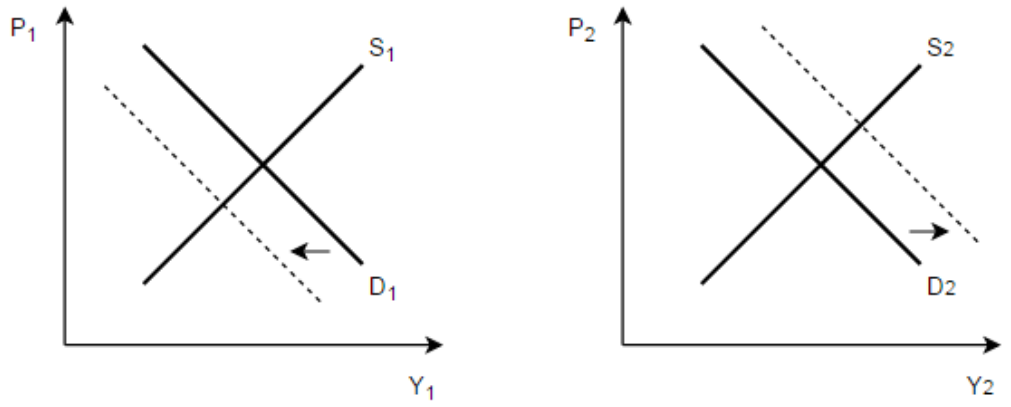

Figure 5 Changes in demand in economies hit by asymmetric shock, source: De Grauwe (2012), adjusted by author

When the wages in both countries are flexible, workers in the first country which was hit by negative shock are unemployed. They reduce their wage claims and that will shift the aggregate supply curve downwards reaching new equilibrium with the same output and lower prices. In the second country the situation is the opposite. The workers will want higher wages and the supply shift upwards. The new situation is shown in Figure 6.

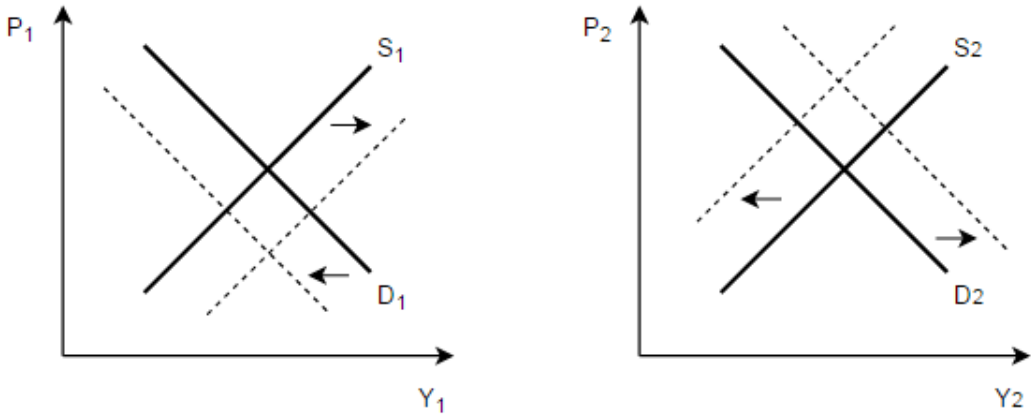

Figure 6 Automatic adjustment process, source: De Grauwe (2012), adjusted by author

There is a secondary effect after this adjustment. Now the prices of the goods and services of the first country are more competitive compared to the prices in the second country.

Andreea (2013) studied the factors influencing rigidity in the European Monetary Union and concluded that the criterion of optimum currency area: wage flexi-

bility, is not met and in the case of an asymmetric shock countries will face unemployment due to loss of competitiveness. On the contrary, because flexible labor markets are important in forming the monetary union Calmfors and Johansson (2006) asked the question, if the membership in a monetary union increases the wage flexibility. They found out that nominal wage flexibility is more probably larger within the EMU than outside the EMU.

In this moment it is difficult to say whether monetary union leads to bigger wage flexibility or not concerning the fact that the methods of how to measure wage flexibility are diversified as shown in the following chapter.

4.4 How to measure wage rigidity

There are many ways how to measure wage rigidity on microeconomic or macroeconomic basis. In the EU there is important influence of Wage Dynamics Network (WDN) which is a research network consisting of economists from European central bank and other national central banks from the EU. According to ECB (2014) its purpose is to study the depth of the features and sources of wage and labor cost dynamics and their implications for monetary policy in the Eurozone.

Research is organized around four research groups:

- **The macro group** – they explore the empirical characteristics of aggregate, country and sectoral wage and labor cost dynamics together with the structural analysis of their determinants and their interaction with inflation dynamics.
- **The micro group** – they focus on different responses of firms to shocks via employment, wages and prices. They also concentrate on determining the nature and magnitude of possible wage rigidities across countries.
- **The survey group** – prepares surveys on wages, labor costs and price setting behavior inside the firms.
- **The meta group** – that summarizes the overall WDN results.

Using the different approaches how to measure wage rigidity we can get different results. In the 1990's when there was the first interest about estimation of nominal wage rigidities there were very different results. McLaughlin (1994) found almost no evidence of downward wage rigidity, later proved by Smith (2000). Beissinger and Knoppik (2003) found out there are some degrees of rigidity, later confirmed

by Fehr and Goette (2005). And finally Altonji and Devereux (2000) found out the nominal wages are almost completely rigid.

According to the WDN survey from executive summary of the Wage Dynamics Network (2008) 60 % of more than 17 000 firms surveyed by the WDN reported that change base wages once a year, 25 % reported they change base wages less frequently than one year. For prices, the corresponding percentages are lower, 40 % of prices is changes once a year, 7.4 % is changed less frequently. The rest is changed in bigger frequency. The result is that the average estimated wage duration is 15 months while the estimated average price duration is 9.6 months which suggests slower wage adjustment to prices. They found no significant difference between the average frequency of wage changes in euro area countries and non-euro area countries. Interesting is the role of January, almost 30 % of all wage changes happen in January in almost all countries.

5 The analysis of wage rigidities across Europe

The goal of this chapter is to estimate and compare real wage rigidities using two different approaches, in particular using the multiple regression analysis on Phillips curve to see the reaction of real wages to changes in unemployment and then using the SVAR approach to find out the percentage of wage changes caused by real and nominal shocks.

This chapter is divided into three main parts. In the first one we examine closely the data entering the models, then the coefficients of Phillips curve are estimated and the third part is dedicated to the SVAR approach.

5.1 Data analysis

First of all we take a closer look at the data. We study the development in unemployment, nominal and real wages for the period from 2000Q1 to 2014Q2. Real wages will be obtained from nominal wages using the HICP deflator. Data are compared as a whole and then separately in smaller, more homogeneous groups for deeper understanding the differences among the chosen countries. Unemployment data and development in nominal and real wages will be used for the Phillips curve. For the SVAR modeling we will use nominal and real wages data.

5.1.1 Development of unemployment

First, we analyze the seasonally adjusted data of total unemployment with quarterly frequency from Eurostat visually in Figure 7 and then in the Table 1 according to the summary statistics.

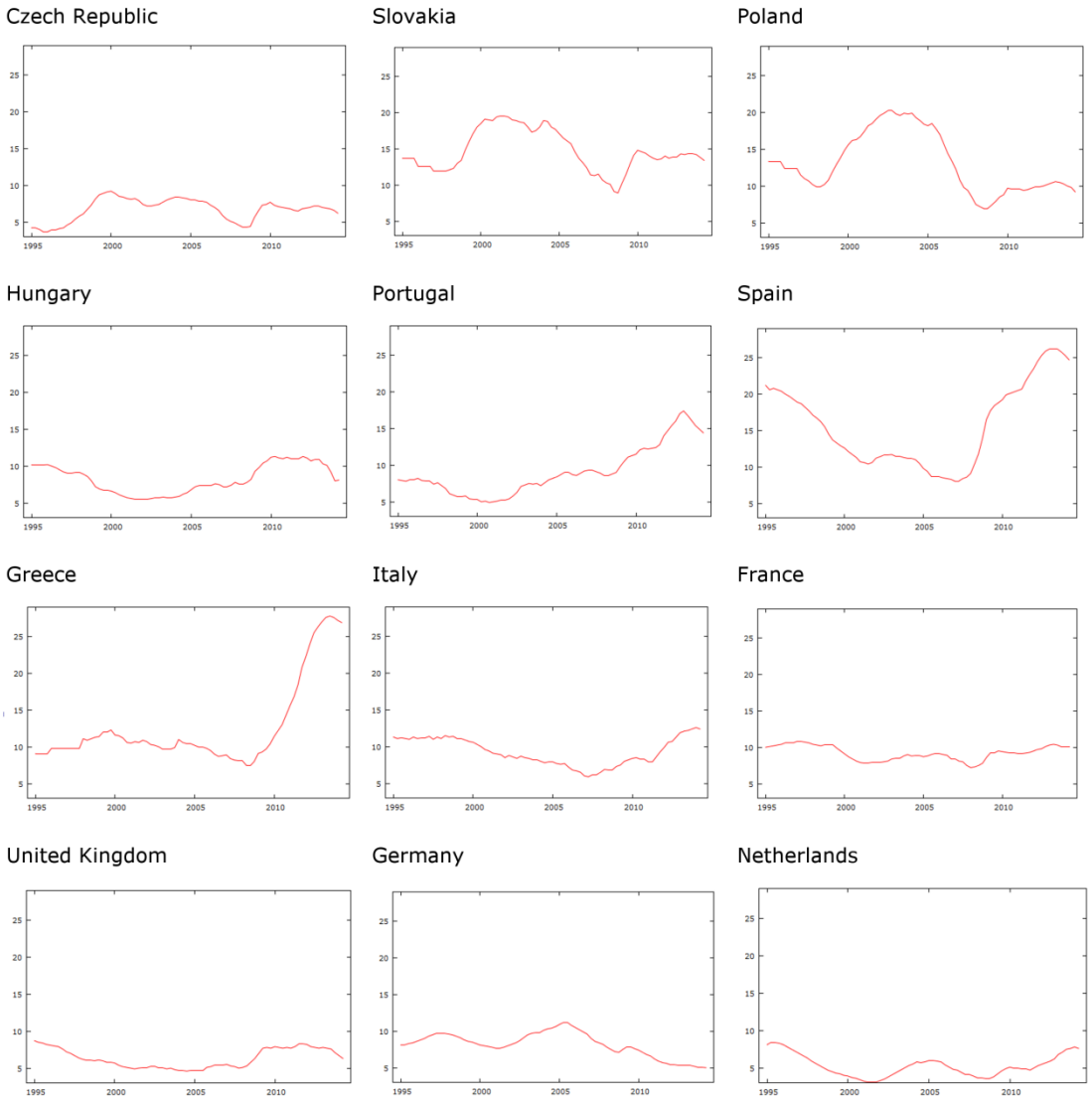

Figure 7 Development of unemployment rates [%], source: Eurostat

The Figure 7 shows unemployment rates of chosen EU countries. Horizontal axis shows examined time period. The vertical axis shows percentage rate of unemployment from 0 to 30 %. As we can see, all the countries experienced different development in unemployment during the monitored period. Almost every country was negatively hit by the start of the crisis in 2008. The most significant changes were observed in Greece and Spain with almost twenty percentage points rise of unemployment after the crisis. But it is also important to mention that Spain reacted much sooner than Greece in terms of unemployment.

Even in the first group of countries represented by Visegrad group we can see some differences. CZ, SK and PL had decreasing trend of unemployment before the

crisis and after the shock it follows the previous trend. Hungary on the other hand was experiencing slow growth in unemployment even before the economic crisis.

In the group of PIGS countries we can see very similar development connected with high unemployment. It is interesting that Portugal was not significantly hit by the crisis at the moment of its beginning but the situation gets slowly worse every year. Italy seems to be in the best shape according to unemployment in chosen group.

In the last group of core countries we can again see the very different development. Germany has after the crisis the best employment in the monitored period. United Kingdom experienced growth in unemployment by nearly 4 percentage points which seems to be decreasing again in the end of observing period. France and Netherlands keep the growing trend in unemployment with significant change during the beginning of the crisis.

To complete the analysis we can take a look at the data shown in the Table 1.

Table 1 Descriptive statistics of the unemployment data [%], 2000Q1 – 2014Q2

	Mean	Median	Minimum	Maximum	Std. Deviation
Czech Republic	7.90	7.20	4.30	9.20	1.14
Slovakia	15.19	14.30	8.90	19.50	3.40
Poland	13.42	10.70	6.90	20.30	4.67
Hungary	8.30	7.45	5.50	11.30	2.10
Portugal	9.80	8.95	4.90	17.40	3.55
Spain	14.97	11.60	8,00	26.20	6.24
Greece	13.34	10.45	7.50	27.80	6.43
Italy	8.63	8.35	5.90	12.60	1.73
France	8.80	8.90	7.20	10.40	0.80
United Kingdom	6.80	5.40	4.60	8.30	1.30
Germany	7.93	7.80	5.00	11.20	1.84
Netherlands	4.89	4.90	3.10	7.80	1.22

Source: Author's calculation based on Eurostat data

The table above shows the descriptive statistics of development of unemployment in percentage points. This data complete the results discussed in the previous paragraphs.

We can see that Netherlands kept the lowest average unemployment rate with low standard deviation. On the contrary, Spain has shown the worst results from the group.

In the Visegrad group the Czech Republic had the best results concerning unemployment. Hungary seemed to have worse results according to trend development but according to statistical description it has better results than Slovak Republic and Poland.

The rest of the results correspond with the visual explanation.

5.1.2 Development of long-term unemployment

Now we examine the long-term unemployment in chosen countries. The data are taken from Eurostat with annual frequency. Persons are identified as long-term unemployed when they are unemployed at least 12 months. Our hypothesis is that the countries with more rigid wages are experiencing higher rate of long-term unemployment.

In Figures 8, 9 and 10 we can see comparison of long term developments in chosen countries separately in our groups.

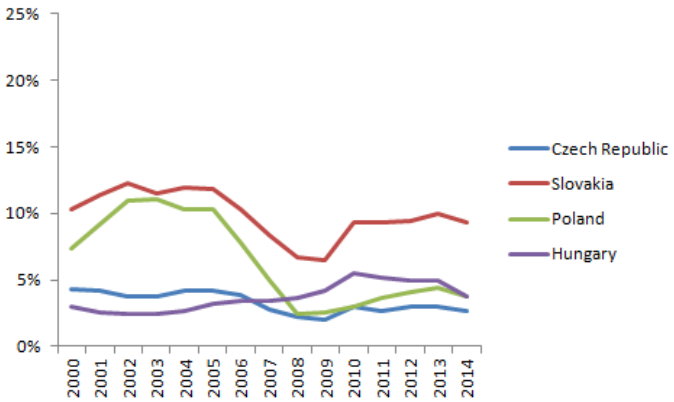

Figure 8 Development of long-term unemployment in chosen countries, source: author's interpretation of Eurostat data

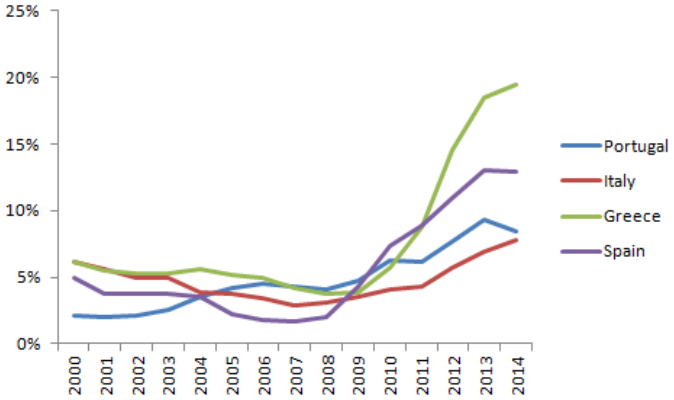

Figure 9 Development of long-term unemployment in chosen countries, source: author's interpretation of Eurostat data

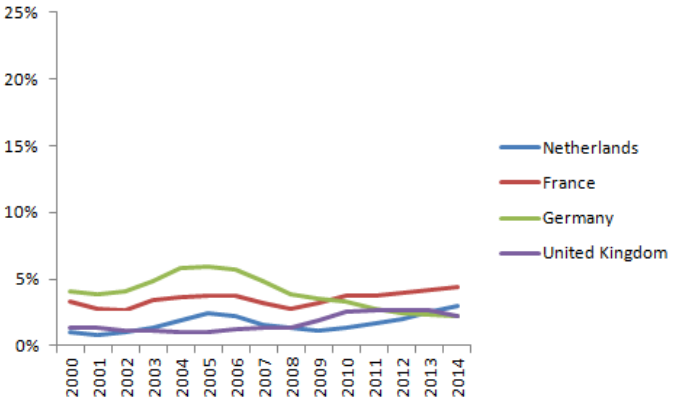

Figure 10 Development of long-term unemployment in chosen countries, source: author's interpretation of Eurostat data

Previous figures show the development on long term unemployment and according to the results we can see that the long-term unemployment reacted very similarly in chosen groups.

In the first group of Visegrad countries we can see that the long-term unemployment was not affected much by the crisis. The Czech Republic keeps the lowest rate of long-term unemployment in the long run from the chosen countries together with Hungary and Poland which improved its statistics from 2005 to 2008.

In the group of PIGS countries we can see the most significant change at Greece and Spain. If we compare total unemployment of Spain and Greece with long-term unemployment of these countries, we notice that even the both countries have almost the same rate of unemployment in 2014, in Greece there is most of the unemployment of a long-term character.

The last group of core EU countries keeps the long-term unemployment low for the whole observed period.

If we compare the average values of long-term unemployment in Figure 11 we can observe that the three countries with the lowest long-term unemployment are Netherlands, United Kingdom and Czech Republic.

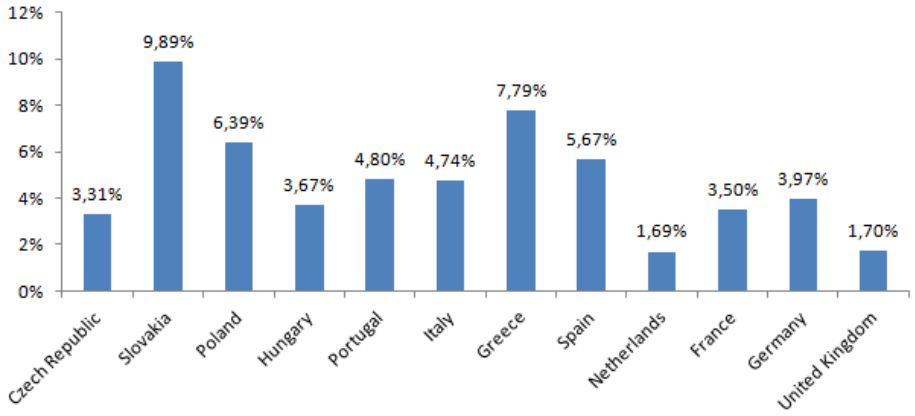

Figure 11 Comparison of average long-term unemployment rates, source: author's interpretation of Eurostat data

Other important aspect of unemployment is the ratio of long-term unemployment to total unemployment. In the Figures 12 and 13 we can observe the development of unemployment before and after the crisis.

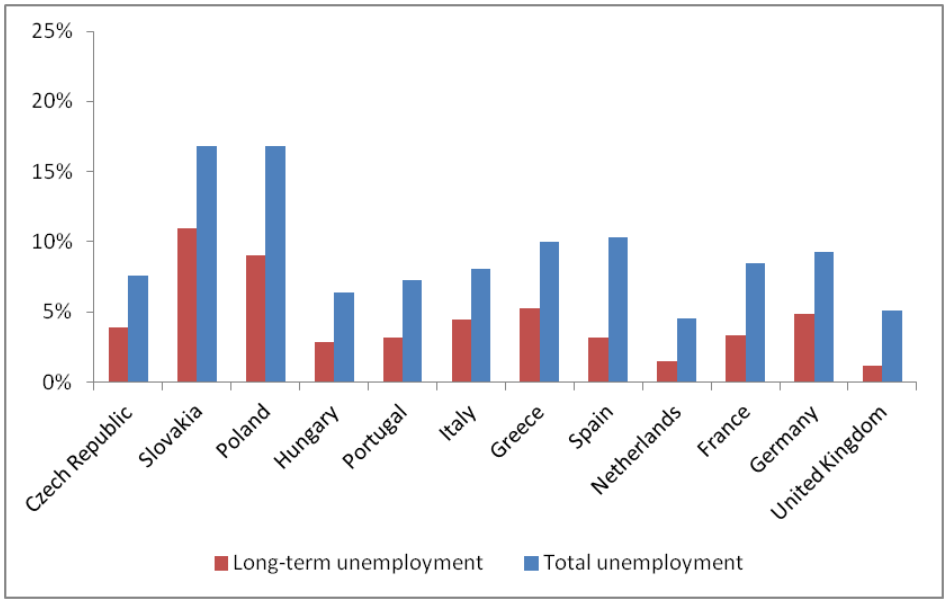

Figure 12 Comparison of the long-term unemployment to total unemployment ratio in the period 2000Q1 – 2007Q4, source: author's interpretation of Eurostat data

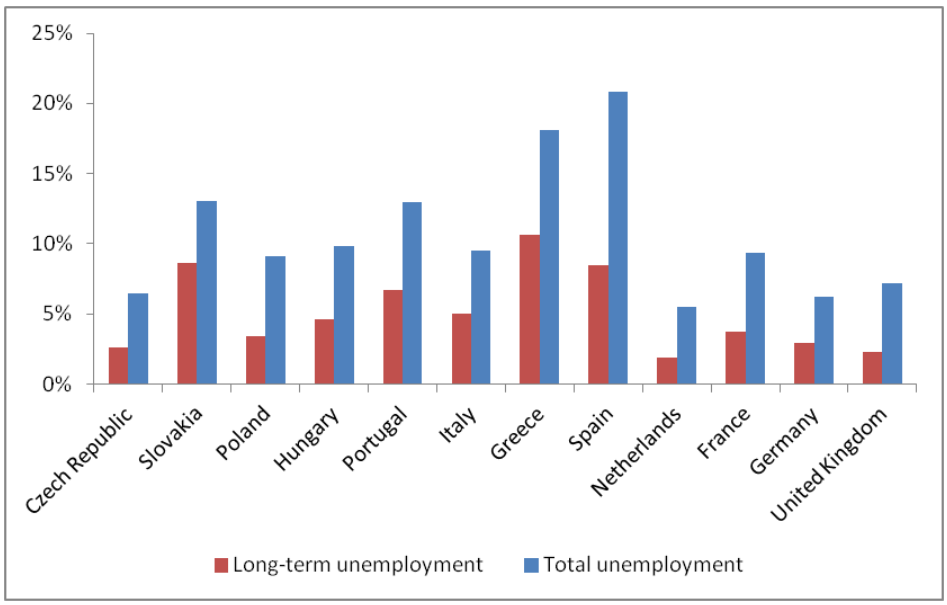

Figure 13 Comparison of the long-term unemployment to total unemployment ratio in the period 2008Q1 – 2014Q2, source: author's interpretation of Eurostat data

Figures 12 and 13 show that the total unemployment and long-term unemployment have changed in the same direction for all countries. If the total unemployment rose the long-term unemployment rose as well. The highest ration of long-term unemployment to total unemployment experienced Slovakia in both time periods with 65 % respectively 66 % in favor of long-term unemployment. For

comparison values for Spain are 31 %, respectively 40 % and for Greece 52 % to 58 %.

5.1.3 Development of nominal and real wages

Nominal and real wages are present in both models in order to quantify the wage flexibility. Term "wages" is used in the meaning of total labor cost data seasonally adjusted and adjusted by working days. Real wages are calculated from nominal wages using the HICP deflator. The country sample and the time period are the same as it is in the previous calculations.

First we take a look at the development of real wages in chosen countries in the Table 2.

Table 2 Real wage growth (%, y – o – y)

Country	2000Q1 -2007Q4	2008Q1 – 2014Q2	2000Q1 – 2014Q2
Czech Republic	5.4	1.3	3.4
Slovak Republic	3.8	1.2	2.6
Poland	4	1.6	2.9
Hungary	4	-0.1	2
Portugal	-0.1	-0.5	-0.4
Spain	1.2	0.4	0.8
Greece	0.4	-3.5	-1.4
Italy	0.6	0.7	0.7
France	1.3	0.4	0.8
United Kingdom	3.1	-1.2	1
Germany	0	0.5	0.3
Netherlands	0.6	0.3	0.5

Source: author's calculations based on Eurostat

Table 2 shows that in every country except of Italy the growth of real wages decreased during the period of the crisis. Only four countries in the sample experienced decrease of the real wage namely Hungary, Portugal, Greece and United Kingdom. It could mean that next to the countries which were hard hit by the recession like Greece or Portugal, the United Kingdom kept the flexible wages. In the rest of the countries the wages only slowed their growth during the crisis.

If we look closely to the data we can see some patterns in chosen groups. Countries of Visegrad experienced in total time period the highest growth of real wages (from 2 % for HU to 3.4 % for CZ) which could be explained by the convergence process.

The southern states experienced lower growth in wages or even decrease which reflects the economic situation in concerned countries. The core countries of the EU experienced only slow growth of wages (from 0.3 % DE to 1 % UK) during the sample period.

Development of the real and nominal wages can be seen in Figure 14. Data were calculated based on data provided by Eurostat and visually presented with Hedrick Prescott filter with $\lambda = 1600$.

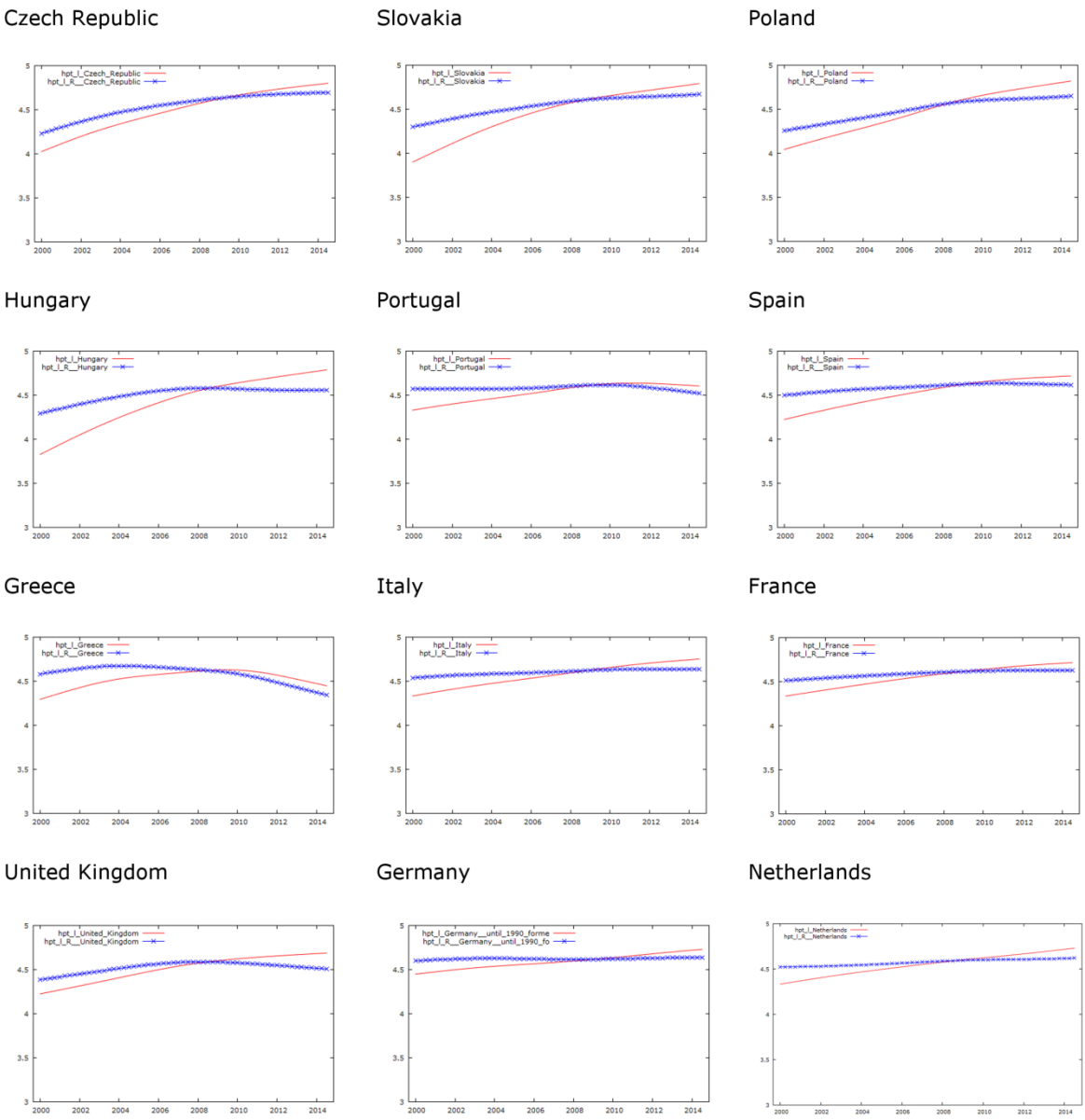

Figure 14 Logarithms of real (blue line) and nominal (red line) wages, source: author's calculations based on Eurostat

In the Figure 14 we can see the development of nominal and real wages that helps us understand the previous table. Now it is visible that countries like Hungary or United Kingdom experienced decrease in real wages while they experienced growth in nominal wages. On the contrary Greece and Portugal experienced during the crisis both, decrease in nominal and real wages. The rest of results from the graphs corresponds with the results in Table 2.

5.2 Estimation of wage rigidity 1/2: Multiple regression analysis

Reaction of wages to changes in demand for labor is one way of accommodation of economic shocks. If the wages are flexible they help keep the low unemployment rate. In this part of the thesis we measure accommodation of wages due to the changes in unemployment on Phillips curve using the multiple regression.

In this part of the thesis we use the data described in the chapter 5. 1. First, we estimate the model using the OLS method for the whole period from 2000Q1 to 2014Q2. For this example we will use the data for France as a representative for the core EU countries.

Dependent variable: wt_FR

	coefficient	std. error	t-ratio	p-value	
const	0.0438149	0.0119723	3.660	0.0006	***
l_U_France	-0.0179994	0.00544977	-3.303	0.0017	***
dPt1_FR	0.0286527	0.113573	0.2523	0.8018	

Mean dependent var	0.004857	S.D. dependent var	0.003987
Sum squared resid	0.000744	S.E. of regression	0.003677
R-squared	0.178904	Adjusted R-squared	0.149046
F(2, 55)	5.991816	P-value(F)	0.004424
Log-likelihood	244.3628	Akaike criterion	-482.7256
Schwarz criterion	-476.5443	Hannan-Quinn	-480.3179
rho	-0.040435	Durbin-Watson	2.065653

Figure 15 OLS results for France for total observed period, source: authors calculation

Figure 15 shows the results of regression for France. At this point we could say that the coefficient of wage elasticity is equal to – 0,018 and that is why the wages are flexible, but before the further interpretation of the results we have to check the data if there is no structural break. At this moment we use influential observations from model in Gretl to see some major disturbances. The results are shown in Figure 16.

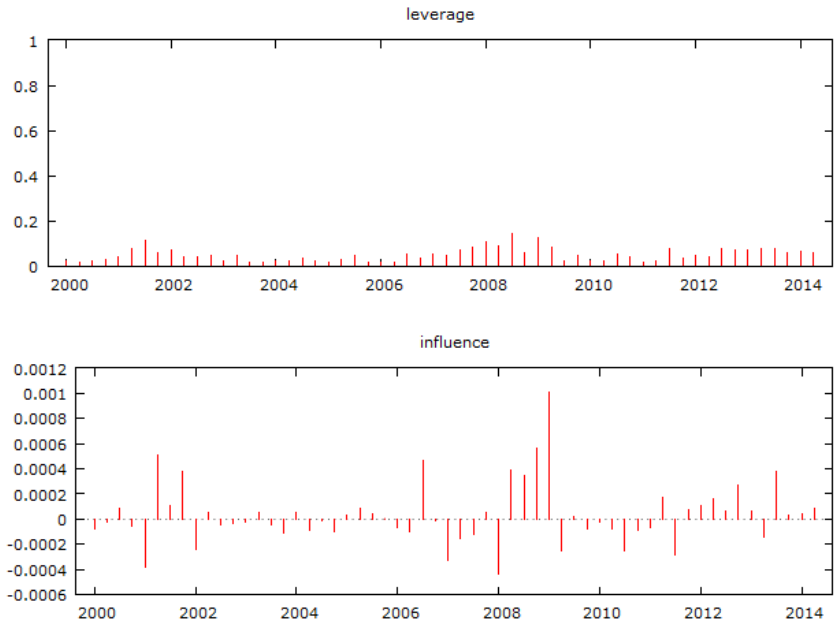

Figure 16 Influential observations for France for total period, source: authors calculation in Gretl

Figure 16 shows the influential observations from the time period for France; it says that there are some observations which could significantly change the overall results of the estimated model. The results suggest that there are some more significant changes starting in 2008 and ongoing to 2009. That is why we should do Chow test for the year 2008 and the first quarter in 2009 if there is no structural break which corresponds with beginning of the crisis period. The null hypothesis (H_0) of the Chow test is that there is no structural break. Testing against this hypothesis allows either rejects H_0 or not. Level of significance is 5 %. Results can be seen in Table 3.

Table 3 Results of Chow test

Tested period	Chow test p-value
2008Q1	0.12
2008Q2	0.06
2008Q3	0.10
2008Q4	0.10
2009Q1	0.37

Source: author's calculation

If the p-values are higher than 0.05 we do not reject the null hypothesis that there is no structural break for France with the 5% level of significance. The structural

break was not present at any chosen data as you can seen in the Table 12 in the appendix of this thesis. After the tests, we calculate the results for the two remaining sub periods and compare the results.

5.2.1 Results of multiple regression analysis

In the models we are interested in c_2 coefficient from the following equation:

$$\Delta w_t = c_1 + c_2 u_t + c_3 \Delta p_{t-1} + \varepsilon_t$$

The coefficient expresses the elasticity of the real wages on unemployment rate. Wage elasticity can acquire either negative or positive values. If the values are negative it means that the wages are flexible because growth in unemployment is compensated by decreasing wage. On the other hand very low or positive values can suggest rigid wages which can lead to the effect called hysteresis as explained by Lindbeck and Snower (2001) in the insider and outsider model. It says that if the wages are held above the equilibrium level because of negotiating power of labor unions it will increase unemployment.

The estimates were calculated using the method of Ordinary Least Squares (OLS) for two sub periods from 2000Q1 – 2007Q4 (32 observations) and 2008Q1-2014Q2 (26 observations) and total period (58 observations). The sub periods refer to the time period before and after the crisis.

First we create model for France for the period before the crisis. You can see the results in Figure 17.

```
Dependent variable: wt_FR

              coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const         0.0598521    0.0249453     2.399    0.0231  **
  l_U_France   -0.0263113    0.0117353    -2.242    0.0328  **
  dPt1_FR       0.233055     0.175623      1.327    0.1949

Mean dependent var    0.004871   S.D. dependent var    0.003917
Sum squared resid     0.000392   S.E. of regression    0.003679
R-squared             0.174972   Adjusted R-squared    0.118074
F(2, 29)              3.075163   P-value(F)            0.061489
Log-likelihood        135.5345   Akaike criterion     -265.0690
Schwarz criterion    -260.6718   Hannan-Quinn         -263.6115
rho                  -0.289975   Durbin-Watson         2.566758
```

Figure 17 OLS results for France for period before the crisis, source: authors calculation

Then we recreate the model for the period after the crisis as we can see in the Figure 18 and compare the results.

```
Model 4: OLS, using observations 2008:1-2014:2 (T = 26)
Dependent variable: wt_FR

              coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const         0.0627155    0.0161397     3.886    0.0007  ***
  l_U_France   -0.0258237    0.00715656   -3.608    0.0015  ***
  dPt1_FR      -0.136346     0.146158     -0.9329   0.3606

Mean dependent var    0.004839   S.D. dependent var    0.004148
Sum squared resid     0.000273   S.E. of regression    0.003444
R-squared             0.365920   Adjusted R-squared    0.310782
F(2, 23)              6.636499   P-value(F)            0.005305
Log-likelihood        112.1535   Akaike criterion     -218.3070
Schwarz criterion    -214.5327   Hannan-Quinn         -217.2201
rho                   0.076222   Durbin-Watson         1.745663
```

Figure 18 OLS results for France for period after the crisis, source: author's calculation

On the results from OLS method we can observe that the results after the crisis are more significant than before the crisis with higher level of adjusted R-squared and lower p-value. It can suggest that wages became more flexible in the period of crisis. With more observations covering the whole period and without a structural break in the data we can say that wages are flexible in France for the whole period.

Rest of the results we can see in the Table 4.

Table 4 Wage elasticity on unemployment rate

Country	2000Q1 -2007Q4	2008Q1 – 2014Q2	2000Q1 – 2014Q2
Czech Republic	−0.0010	−0.0256	−0.0058
Slovak Republic	0.0225	−0.0351	0.0017
Poland	−0.0064	−0.0380	−0.0093
Hungary	−0.0238	−0.0155	−0.0120
Portugal	-0.0036	−0.0110	−0.0075*
Spain	−0.0051	−0.0205**	−0.0131***
Greece	0.0314	−0.0801*	−0.0789**
Italy	−0.0011	−0.0074	−0.0072
France	−0.0263**	−0.0258***	−0.0180***
United Kingdom	0.0191	−0.0115	0.0010
Germany	−0.0154**	−0.0004	−0.0123***
Netherlands	−0.0236***	−0.0133	−0.0168***

Source: author's calculation
Note: Results in the table are accompanied with the t-test results. ***, ** or * mean 1%, 5% or 10% significance level.

Table 4 shows the coefficients which express the elasticity of the real wages on unemployment rate. If the coefficient is negative it means that the wages are flexible because growth in unemployment is compensated by decreasing wage. On the contrary, very low or positive values can suggest rigid wages. In the table, we can see that the chosen European countries react differently to changes in unemployment rates. Even in our chosen, more homogeneous groups.

In the first group of Czech Republic, Slovak Republic, Poland and Hungary we can see that the results are not significant. In every country from the group except the Hungary wage elasticity has improved during the period of crisis. This trend we can observe even at other countries. It can be caused by some institutional changes the local governments did to improve the situation on the market. It would be necessary to examine more deeply the relationship between institutional changes and wage elasticities to make conclusions.

In the second group we can find the PIGS countries, namely Portugal, Italy, Greece and Spain. It is interesting that at the countries hit the most by the recession like Spain and Greece we can see significant improvement of wage elasticities. It is probably connected with the austerity measures which were put on them in order to be able to receive bank loans.

Last group are the core countries of the EU, Germany, France, United Kingdom and Netherlands. Here we can observe very heterogenic results. Results of France are very slightly worse concerning wage flexibility but the results are more significant. It can be caused by lower volatility of the data sample. Germany and Netherlands got from significant values and elastic wages to more rigid wages. We can also observe small but insignificant improvement at United Kingdom.

To summarize the results we can observe improvement of wage elasticities at eight countries (CZ, SK, PL, PT, ES, GR, IT, UK) during the period of the crisis. At two of them, the improvements are significant (GR, ES). Four countries (DE, NL, HU and FR) experienced increase in wage rigidity but the results of France can be further discussed.

5.3 Estimation of wage rigidity 2/2: SVAR method

In the first part we measured wage flexibility as a reaction of wages to changes in unemployment. In this part of the analysis we will focus on a different way how to measure real wage rigidity in particular as a responsiveness of real wages to real (permanent) and nominal (temporary) shocks. First, we test the time series for stationarity, normality of residuals and SVAR stability. The second part is dedicated to the calculations of restrictions, impulse response functions and variance decompositions.

5.3.1 Preliminary tests

If we take a brief look at the data of the Czech Republic shown in Figure 19, it is obvious that the original time series is not stationary but the first differences could be stationary.

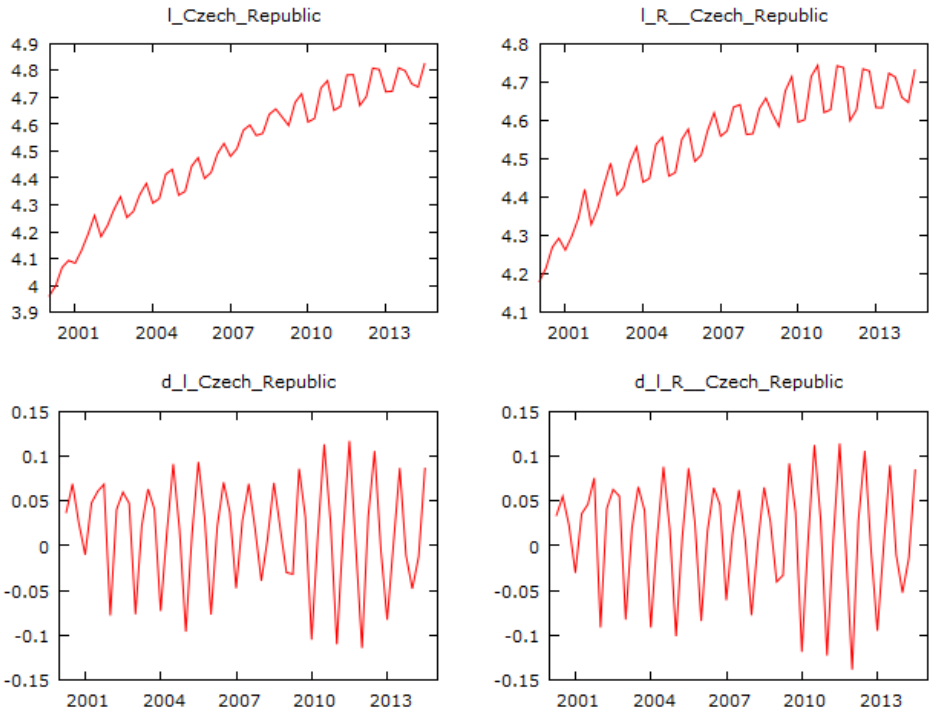

Figure 19 Time series before and after the first differences, source: Author's interpretation

Figure 19 depicts there is a possibility of first differences to be stationary. Prior to calculations of shocks we have to apply ADF test and KPSS test in order to find the unit root. Null hypothesis H_0 of ADF test is that the time series has unit root which means the time series is non-stationary. H_0 of KPSS is the opposite, thus that the time series is stationary. We test only the first differences because it is obvious from the previous graph that the time series are non-stationary. We apply tests without constant and trend.

The results of the tests are shown in the Table 5.

Table 5 P –values of Augmented Dickey Fuller tests and KPSS tests on the whole time period

	ADF test		KPSS test	
Country	Δwn	Δwr	Δwn	Δwr
Czech Rep.	0,04338	**0,06931**	> 0,1	> 0,1
Slovak Rep.	0,0652	5,261e-017	> 0,1	> 0,1
Poland	**0,1846**	**0,2428**	0,092	> 0,1
Hungary	**0,1085**	8,921e-015	0,073	> 0,1
Portugal	2,882e-040	4,837e-041	> 0,1	> 0,1
Spain	**0,2819**	0,03575	**< 0,01**	> 0,1
Greece	5,03e-013	4,671e-014	> 0,1	0,070
Italy	**0,2485**	2,399e-015	0,058	0,080
France	**0,2639**	**0,2639**	> 0,1	**0,045**
UK	**0,3563**	**0,2943**	0,060	**0,036**
Germany	**0,1749**	5,067e-011	> 0,1	> 0,1
Netherlands	2,174e-028	5.744e-029	> 0,1	> 0,1

Source: Author's calculations

Most of the times series seem to be integrated of order one according to at least one test. In some cases the time series could be integrated of order two but to preserve homogeneity and concerning short period of data we assume that all series are integrated of order one.

Before we can calculate the IRFs we must run series of tests to check whether the data can be used for VAR models and then we transform the VAR model into the SVAR model using the long term restrictions as proposed by Blanchard and Quah (1989).

First of all, we have to estimate the max lag length based on the information criteria using the software JMulti. The results can be seen in the Table 6.

Table 6 Estimated optimal number of lags for Czech Republic for period 2000Q1 – 2007Q4 and for period 2008Q1 – 20014Q2

Criterions	2000Q1 – 2007Q4	2008Q1 – 2014Q2
Akaike Info Criterion	3	2
Hannan-Quinn Criterion	3	2
Schwarz Criterion:	3	2
Final Prediction Error:	2	1

Source: author's calculation

Based on the results in Table 6, we choose the lag length of three for the period before the crisis and lag length of two for the period after the crisis. After that we test the SVAR model serial correlation, normality of residuals and for stability of the SVAR model.

Serial correlation is tested by Ljung-Box test with the null hypothesis that the data are independently distributed against the alternative hypothesis that the data are not independently distributed. According to the results in Table 7 we cannot reject the null hypothesis that the data are independently distributed. All time series passed the Ljung-Box test as you can see in the appendix of this thesis.

Table 7 P-values of Ljung-Box test for Czech Republic for period 2000Q1 – 2007Q4 and for period 2008Q1 – 20014Q2

Variable	2000Q1 – 2007Q4	2008Q1 – 2014Q2
e^{wr}	0.61	0.15
e^{w}	0.56	0.12

Source: Author's calculation

Normality of residuals is tested using the Jarque-Bera test. H_0 of the test is that the residuals have normal distribution against H_1 that the residuals have non-normal distribution. As you can see in the Table 8, we cannot reject the null hypothesis that all the residuals have normal distribution with the 95 % of significance and we can test model for stability. The rest of the test results can be found in the appendix of this thesis; all the time series passed the Jarque-Bera test.

Table 8 P-values of Jarque-Bera test for Czech Republic for period 2000Q1 – 2007Q4 and for period 2008Q1 – 20014Q2

Variable	2000Q1 – 2007Q4	2008Q1 – 2014Q2
e^{wr}	0.89	0.93
e^{w}	0.70	0.73

Source: Author's calculation

Stability of VAR model is tested by the CUSUM test. If the plotted line is out of the calculated lines of CUSUM test there is evidence against stability of the model. Results of CUSUM test can be seen in the Figures 20 and 21.

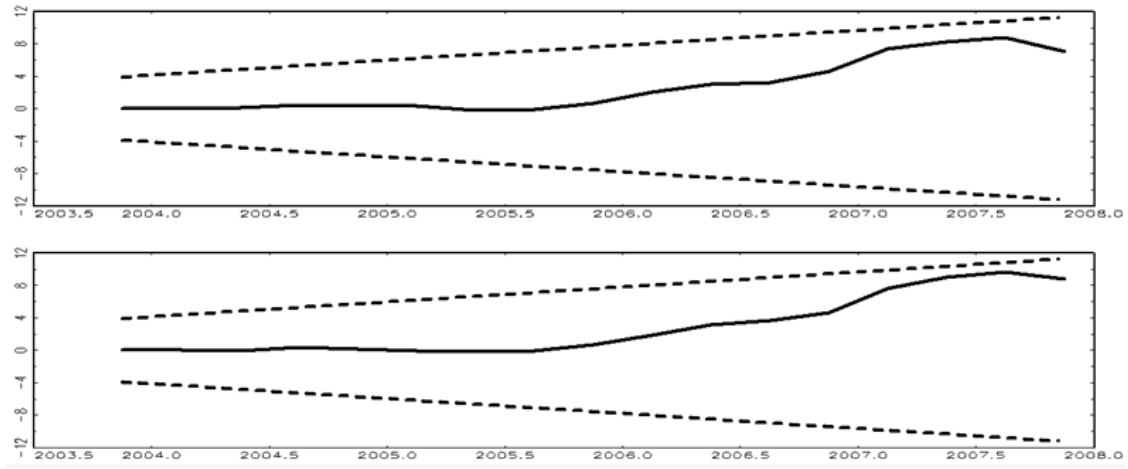

Figure 20 Results of CUSUM test for the Czech Republic for period 2000Q1 – 2007Q4, source: Author's calculation

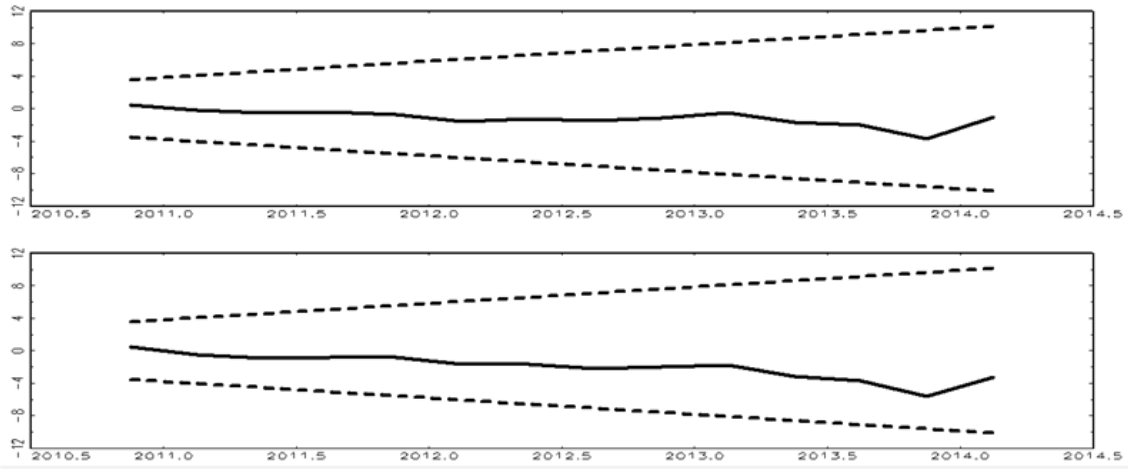

Figure 21 Results of CUSUM test for the Czech Republic for period 2008Q1 – 20014Q2, source: Author's calculation

5.3.2 Restrictions of the SVAR model

According to the test we have suitable data for VAR models. In the following part of the thesis we will use long term restrictions to switch from VAR models to SVAR models. The restrictions are as proposed by Moore and Pentecost (1996):

1. Variance of nominal shock is unity: $Var\ (\varepsilon^N) = 1$
2. Variance of real shock is unity: $Var\ (\varepsilon^R) = 1$
3. Nominal and real shocks are orthogonal: $Cov(\varepsilon^N, \varepsilon^R) = 0$
4. Nominal shocks have no long-term impact on real wages.

First three conditions are met in software JMulti by default. The fourth restriction influences the C matrix. C matrix enters the SVAR equation and influences the effects of shocks to variables.

$$\begin{bmatrix} 1 & B_{0;1,2} \\ B_{0;2,1} & 1 \end{bmatrix} \begin{bmatrix} wr_t \\ w_t \end{bmatrix} = \begin{bmatrix} C_{0;1} \\ C_{0;2} \end{bmatrix} + \begin{bmatrix} B_{1;1,1} & B_{1;1,2} \\ B_{1;2,1} & B_{1;2,2} \end{bmatrix} \begin{bmatrix} wr_{t-1} \\ w_{t-1} \end{bmatrix} + \begin{bmatrix} e_t^{wr} \\ e_t^{w} \end{bmatrix}$$

Coefficients of the C matrix are calculated in JMulti as you can see in Figures 22 and 23, where the zero represents no long term impact of nominal shocks on real variables.

$$C = \begin{pmatrix} 0{,}1000 & 0{,}000 \\ 0{,}0147 & 0{,}0133 \end{pmatrix}$$

Figure 22 C matrix for the Czech Republic for period 2000Q1 – 2007Q4, source: Author's calculation

$$C = \begin{pmatrix} 0{,}0119 & 0{,}000 \\ 0{,}0045 & 0{,}0067 \end{pmatrix}$$

Figure 23 C matrix for the Czech Republic for period 2008Q1 – 2014Q2, source: Author's calculation

Knowing all the restrictions we can identify shocks and then examine the IRF for the Czech Republic in the period before and after the crisis and compare the results.

5.3.3 Impulse responses of real wages

Once we tested the time series for stationarity, normality of residuals, serial correlation and stability, we can continue with Impulse Response Functions (IRFs) to see the reaction functions of variables to individual structural shocks. Calculations are divided into two time periods as in the previous calculations.

IRF represents the reaction function of endogenous variables on individual structural shocks. In other words it shows us how the variable behaved in time after being hit by shock. Reactions are studied on the forecast period of 20. In the following figures you can see the results.

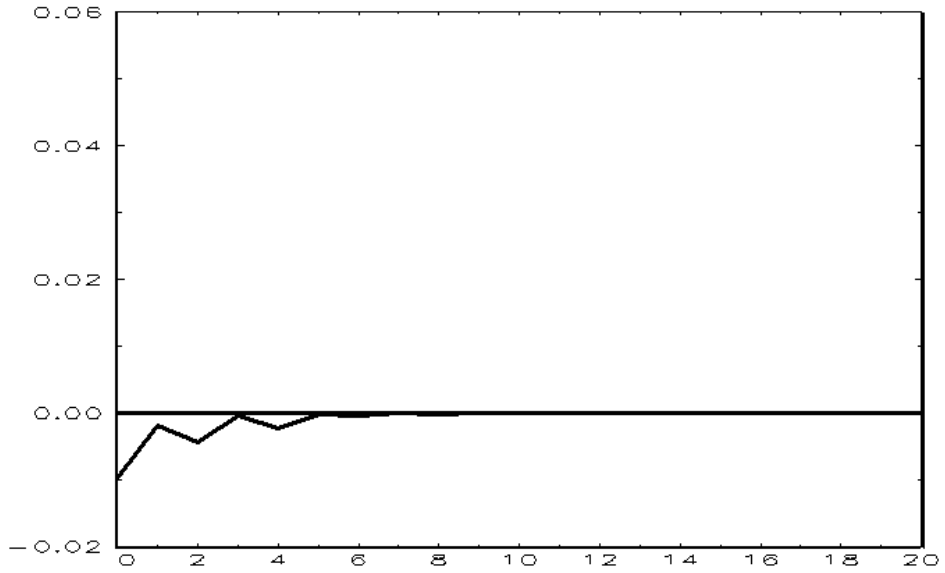

Figure 24 Accumulated reaction of real labor costs to nominal shocks for the Czech Republic for period 2000Q1 – 2007Q4, source: Author's calculation

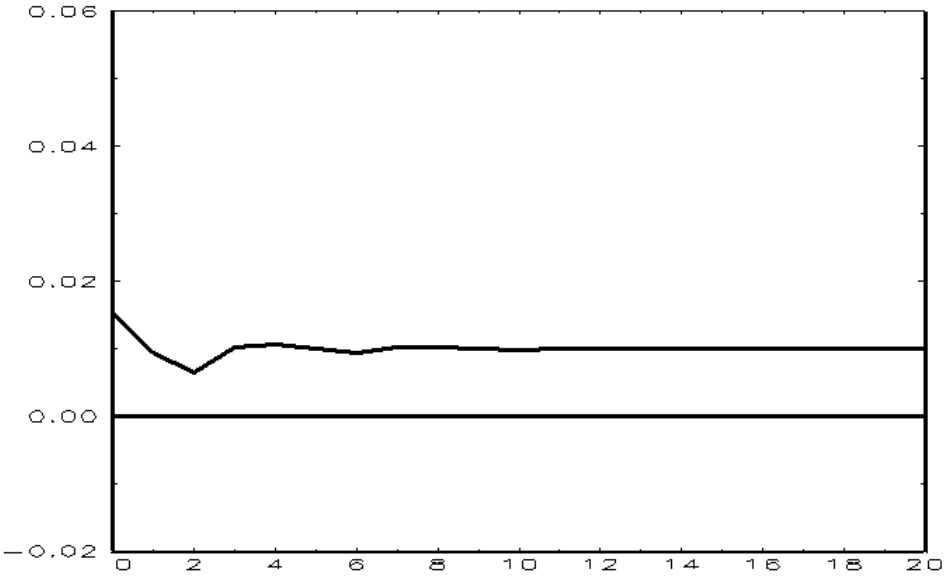

Figure 25 Accumulated reaction of real labor costs to real shocks for the Czech Republic for period 2000Q1 – 2007Q4, source: Author's calculation

Figures 24 and 25 shows the identified reactions of real wages to standard deviations in nominal (Figure 24) and real (Figure 25) shocks in the period before crisis. On the horizontal axis we can see the forecast horizon from one to twenty quarters. The vertical axis shows the volume of responses.

We can see that in the short run the real wages can be influenced by the nominal shocks. The effect of nominal shocks on real wages illustrates relative wage

stickiness. However, we can see that after about six periods it starts to oscillate very close to zero and the effect of nominal shock on real wages completely disappear after nine periods.

On the other hand, the real shocks influenced the real wages permanently and stop oscillating after twelve periods but the changes were minimal after four periods.

On the Figures 26 and 27 we can see the identified reactions of real wages to standard deviations in nominal and real shocks in the period after crisis.

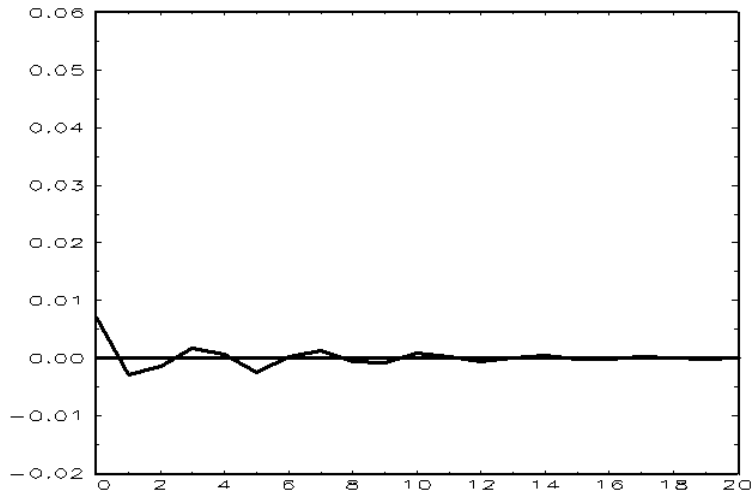

Figure 26 Accumulated reaction of real labor costs to nominal shocks for the Czech Republic for period 2008Q1 – 2014Q2, source: Author's calculation

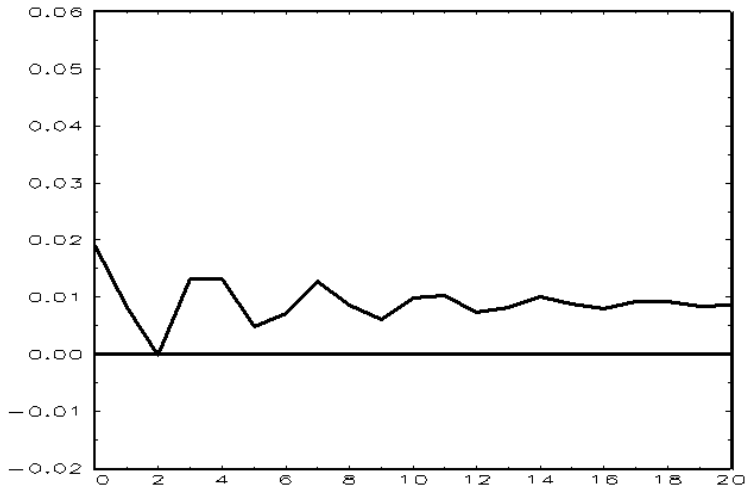

Figure 27 Accumulated reaction of real labor costs to nominal shocks for the Czech Republic for period 2008Q1 – 2014Q2, source: Author's calculation

From the previous figures we can observe that the wages reacted differently during the period of the crisis. It can be partly explained by the shorter observing period or shorter chosen lag.

For better comparison of the results we will merge the graphs together in Figure 28.

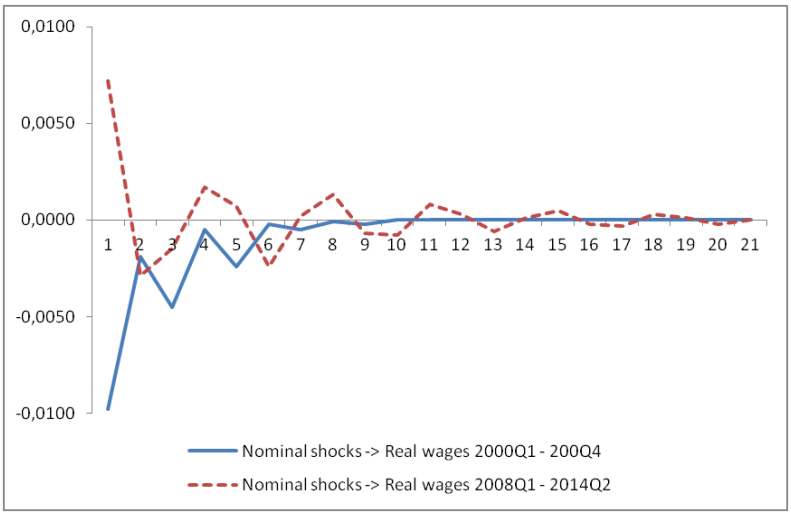

Figure 28 Comparison of IRFs before and after the crisis, source: author's calculations

According to the results it is obvious that it took longer time to accommodate nominal shocks in the crisis period compared to the previous period. Moreover, in the period of the crisis the wages reacted positively to the shock at first and then oscil-

lated around zero until disappeared. On the contrary both shocks had about the same power around 1 %.

Very similar results can be seen in the Figure 29, where the real wages react almost the same to the real shocks in both periods.

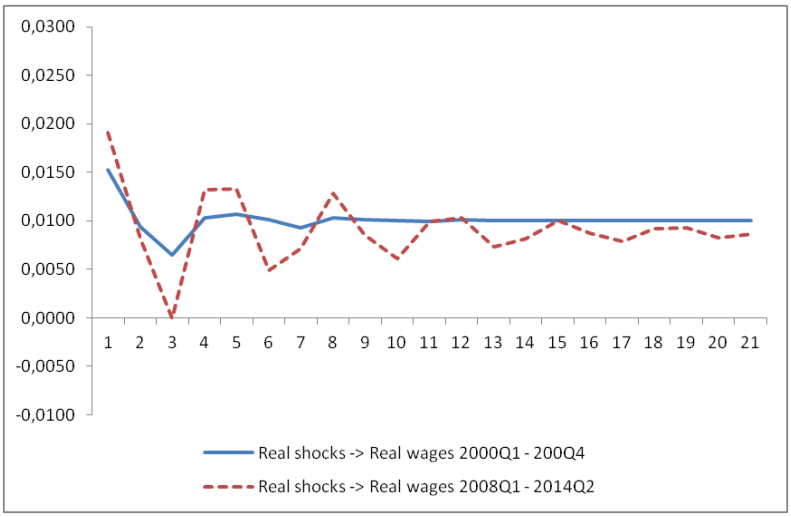

Figure 29 Comparison of IRFs before and after the crisis, source: Author's calculations in JMulti

5.3.4 Real wage flexibility - Variance decomposition

Once we discovered the dynamics of the shocks on real wages using the IRFs, we can measure the relative contribution of real and nominal shocks to fluctuation in real wages using the variance decomposition. In other to understand words how many percents of the real wage changes is explained by the real shocks. Real wages are called flexible when their variation is mainly because of the real shocks. The results will help to answer where the wages are flexible and where are not.

The Figure 30 shows that the variance in real wages in the Czech Republic in the period before crisis is explained from the 61 % by the real shocks. The rest is explained by nominal (temporary) shocks.

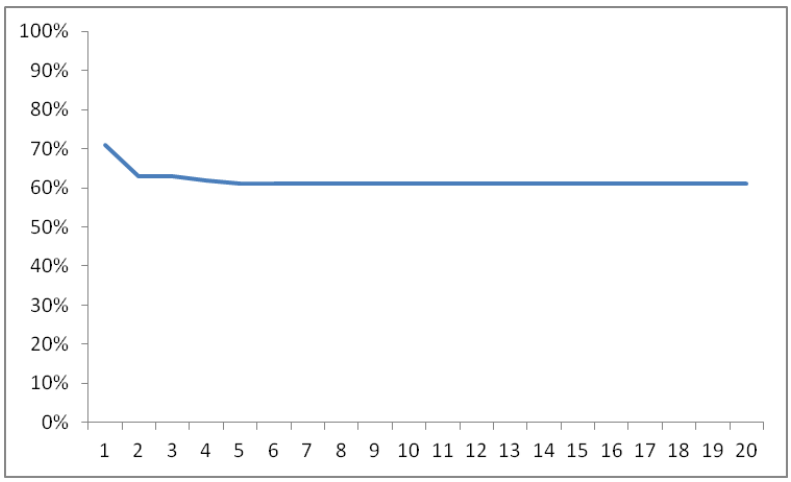

Figure 30 Variance decomposition for the Czech Republic for the period 2000Q1 – 2007Q4, source: author's calculation

Note: Forecast horizon is from one to twenty quarters. The horizontal axis represents the percentage of real wages explained by real shocks.

First, the variance started with the 71% level and after five quarters stayed at the value of 61 percent. The delay is explained by the effect of nominal shock to real wages which was first positive as we can see in Figure 28.

If we compare the results with the period after the crisis and before the crisis in the Figure 31, we can see that the percentage of real wage changes explained by real shocks is bigger in the period after the crisis which means that the wages became more flexible. This corresponds with the results obtained from multiple regression applied on Phillips curve. We compare all the results more in the end of this chapter.

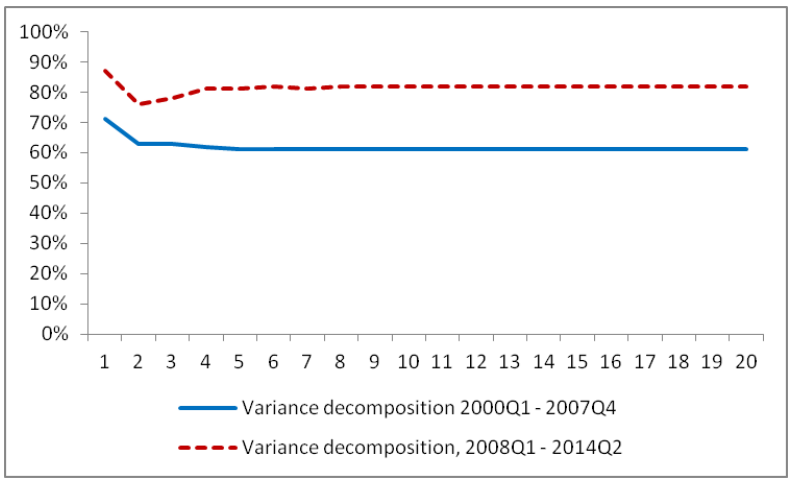

Figure 31 Variance decomposition for the Czech Republic for both periods, source: author's calculation

Note: Forecast horizon is from one to twenty quarters. The horizontal axis represents the percentage of real wages explained by real shocks.

5.3.5 Comparison of impulse response functions

In the following figure we compare IRFs for all the countries together. All the time series passed the test of normality of residuals and SVAR stability tests. Chosen lags and complete test results can be seen in the appendix of this thesis.

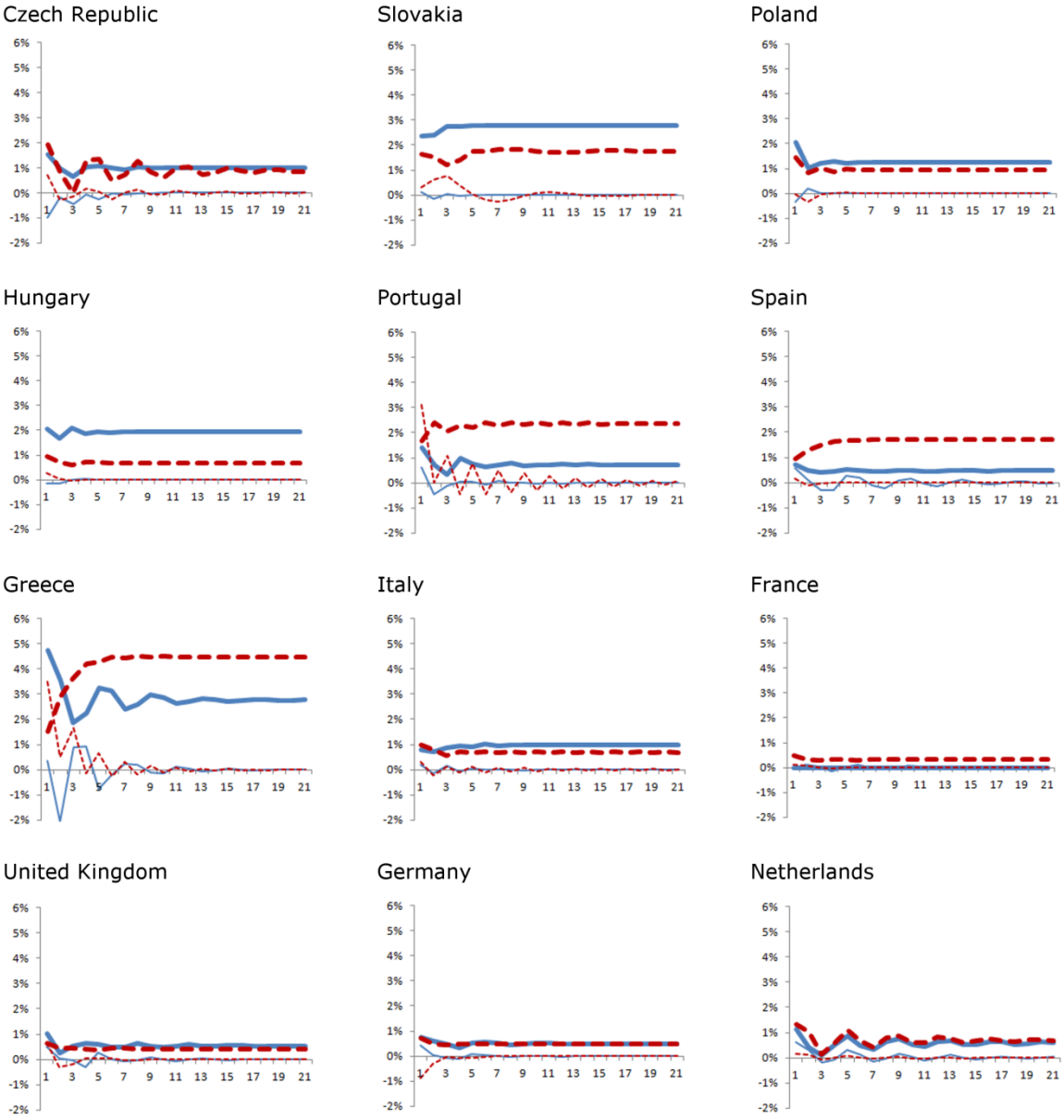

Figure 32 Reaction of real wages to nominal (——) and real (▬▬) shocks before (▬▬) and after (▬ ▬) the crisis.

Note: Accumulated IRFs from SVAR estimated over periods before and after the crisis. The horizontal axis shows the forecast period from one to twenty quarters. The vertical axis represents the volumes of the responses of real wages to nominal (transitory) and real (permanent) shocks.

In the Figure 32, we can see the identified reactions of real wages to one standard deviation in real and nominal shocks with the forecast horizon from one to twenty quarters. For a better cross country comparison we kept the range of the vertical axis from – 2 % to 6 %. The shape of the IRF curve shows the effect of shocks to

real wages, whether the reaction of wages was small (Germany) or significant (Greece).

If we would like to compare countries with the euro as a currency with the rest of the group, we can see that four of eight countries in our sample reacted very similarly and not significantly to the shocks, namely Germany, France, Italy and Netherlands. The four countries that reacted more to the shocks are Portugal, Spain, Greek and Slovakia. The countries without euro also did not react uniformly despite the fact there were some similarities. To conclude this, we cannot say that the common currency means the common reaction to shocks. Now we examine closely our countries by groups.

In the first group of Visegrad countries we can see some similar patterns of reactions. The power of nominal shocks does not exceed 1 % at any country and slowly disappears over the time. Real shocks keep the power of 1 % for the Czech Republic and Poland for both observing periods. If we compare Hungary and Slovakia we can again see some similarity. The wages reacted more strongly from 2 to 3 % in the time period before the crisis and then less by one percentage point in the period of crisis.

We can observe very different results in the PIGS countries. According to these results Italy reacts more like other core countries, than countries in its group. Portugal, Spain and Greece experienced bigger reaction of real wages to real shocks in the period of crisis compared to the previous one. This is a big difference compared to the first group. Moreover, Portugal and Greece experience more significant reaction of real wages to nominal shocks compared to all other chosen EU countries which illustrates relative wage stickiness. The reaction of real wages to nominal shocks became more significant in the period of the crisis as well.

The last group of the core countries has very similar results of reactions which can be described as low because they are under 1 %. The only country differentiating from others is Netherlands for it took longer time to accommodate shocks by wages.

5.3.6 Comparison of real wage flexibility

Once we identified shocks we can continue to estimate variance decomposition which is crucial for assessing the wage flexibility. Variance decomposition measures the relative contributions of real and nominal shocks to fluctuations in real wages in other words how many percents of wage changes is explained by real

shocks. We will consider wages flexible when most of the variation will be influenced by real (permanent) shocks. The total results can be seen in Figure 33.

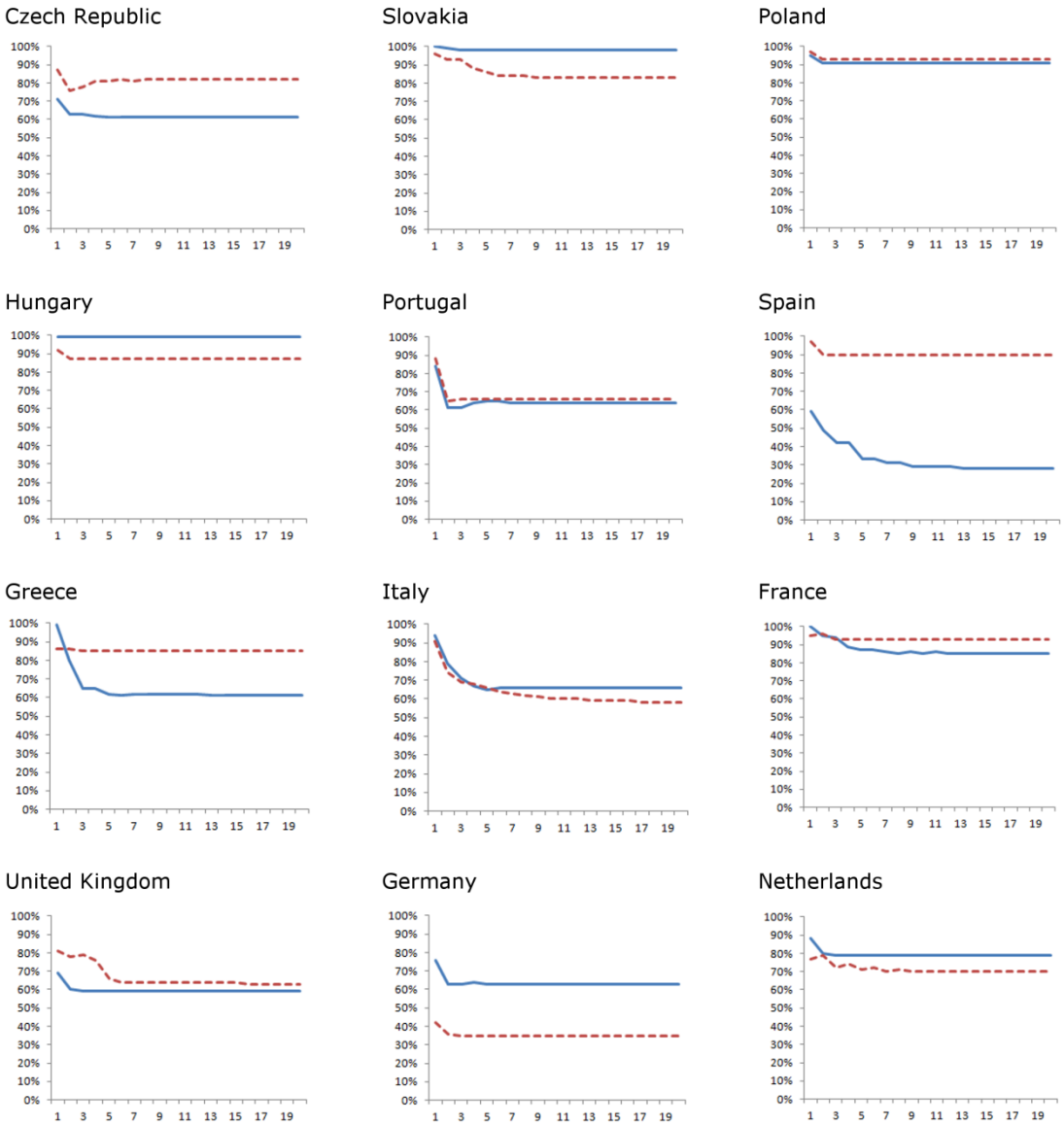

Figure 33 Real wage flexibility before ( ) and after ( ) the crisis.

Note: The horizontal axis shows the forecast period from one to twenty quarters. The vertical axis represents the percentage of variance in real wages explained by real shocks.

The number of percents shows the wage flexibility. The higher the percentage of variance explained by the real shocks, the more flexible the wages are. First, we can see the chosen countries have very different results concerning wage flexibility of changes of flexibility during the crisis. The results vary from almost 30 % to al-

most 100 %. Second, the contribution of shocks to variance depends on the forecast horizon as well. For example, changes in real wages are explained from almost 100 % at first quarter in Italy, but it significantly drops after four periods to nearly 70 %. These delays are explained by the effects of nominal shocks to real wages examined in Figure 32. If the nominal shock has a long lasting effect before it disappears, it takes the variance decomposition curve more time periods to keep one value. For example, at Slovakia we can see longer lasting response of real wages to nominal shocks in the period after the crisis in the Figure 32 and that is why it takes longer time for variance decomposition curve to stabilize at single value in Figure 33.

If we would like to compare Eurozone countries with the rest of the chosen countries we can see that the results are not uniform again. Therefore we compare the countries in our chosen groups.

In the Visegrad group we can say the wages are flexible. The interesting fact is that the wage flexibility improved at the Czech Republic and Poland while it got worse at Hungary and Slovakia during the period of crisis. However, we can describe wages as a whole in this group as flexible.

Big changes happened in the group of PIGS countries. Wage flexibility improved significantly in Greece and Spain and slightly got worse in Italy. At Greece and Spain there is also evident that the time of accommodation of nominal shocks got shorter. On the other hand, in Italy the accommodation of nominal shocks take a longer time during the crisis period.

The most significant change in the last group of countries is at Germany. Its wage flexibility got significantly worse during the period of the crisis. Another small degradation can be seen at Netherlands. On the contrary, the France and United Kingdom improved their wage flexibility. However, while France decreased the time of accommodating nominal shocks, the United Kingdom increased that time.

The facts which could influence the results of the wage flexibility estimates will be discussed further in this thesis.

5.4 Comparison of the results

In this part of the thesis we will compare the results of estimates of wage flexibilities that we got by applying two different methods, namely by multiple regression applied on Phillips curve and using the SVAR approach. The result can be seen in

Table 9. In the table there is a column named "Relation" which shows the relation between values estimated using the Phillips curve and values estimated using the SVAR approach. We look for negative relation because the lesser is the estimated coefficient from Phillips curve, the more flexible the wages are. On the contrary, the higher is the variance from SVAR, the more flexible wages are.

Table 9 Comparison of results of wage rigidity estimates

	Phillips, P1	Phillips, P2	SVAR, P1	SVAR, P2	Correlation
Czech Rep.	-0.001	-0.0256	0.61	0.81	-
Slovakia	0.0225	-0.0351	0.98	0.86	+
Poland	-0.0064	-0.038	0.91	0.93	-
Hungary	-0.0238	-0.0155	0.99	0.87	-
Portugal	-0.0036	-0.011	0.65	0.66	-
Spain	-0.0051	-0.0205**	0.33	0.9	-
Greece	0.0314	-0.0801*	0.62	0.85	-
Italy	-0.0011	-0.0074	0.65	0.66	-
France	-0.0263**	-0.0258***	0.87	0.93	+
Germany	-0.0154**	-0.0004	0.63	0.35	-
Netherlands	-0.0236**	-0.0133	0.79	0.71	-
United Kingdom	0.0191	-0.0115	0.59	0.66	-

Source: Author's calculation
Note: Phillips refers to the method of multiple regression applied on Phillips curve, SVAR refers to the estimates gained using the SVAR approach. P1 refers to period before the crisis; P2 refers to period after the crisis. Correlation shows the relation between results from multiple regression compared to results from SVAR.

The table shows the coefficients obtained from the multiple regression as well as the wage flexibility explained by the SVAR. If the coefficients from multiple regression are negative it means that the wages react negatively to increase in unemployment thus they are flexible. Positive or values close to zero indicate rigid wages. The numbers obtained using SVAR method shows percentage of variance in real wages explained by real shocks. The higher is the percentage, the more flexible wages are. In the Table 9, we can observe that changes in wage flexibility developed the same over the period of crisis according both methods almost in every case. One of the cases where the development was not the same is France. However, the changes of results are insignificant and can be overlooked. Moreover, it could explain the increased significance of the t-test in the second period. The oth-

er case is Slovakia, where the difference in the direction of change is very noticeable. We might say that the coefficients in the Phillips curve are not significant for Slovakia or we can say that the wages in Slovakia reacted more to changes in unemployment compared to other shocks.

5.5 Wage flexibility and long-term unemployment

Since we compared both methods and found out that both methods bring similar results, we can now focus on the hypothesis that rigid wages increase the long term unemployment. For comparison of influence of wage rigidities to long-term unemployment we chose estimated coefficients from the Phillips curve which we compare to the data of long-term unemployment. The data can be seen in Table 10.

Table 10 Results of multiple regression applied on Phillips curve compared to long-term unemployment rates

	Phill., P1	Phill., P2	Phill., P12	Avg LTU,1	Avg LTU,2	AVG LTU
Czech Rep.	-0.0010	-0.0256	-0.0058	3.89%	2.66%	3.31%
Slovakia	0.0225	-0.0351	0.0017	10.98%	8.64%	9.89%
Poland	-0.0064	-0.0380	-0.0093	9.00%	3.40%	6.39%
Hungary	-0.0238	-0.0155	-0.012	2.88%	4.59%	3.67%
Portugal	-0.0036	-0.0110	-0.0075	3.16%	6.67%	4.80%
Spain	-0.0051	-0.0205	-0.0131	3.20%	8.49%	5.67%
Greece	0.0314	-0.0801	-0.0789	5.28%	10.66%	7.79%
Italy	-0.0011	-0.0074	-0.0072	4.46%	5.06%	4.74%
France	-0.0263	-0.0258	-0.018	3.30%	3.73%	3.50%
Germany	-0.0154	-0.0004	-0.0123	4.89%	2.91%	1.69%
Netherlands	-0.0236	-0.0133	-0.0168	1.53%	1.87%	3.97%
United Kingdom	0.0191	-0.0115	0.001	1.18%	2.30%	1.70%

Source: Author's calculation
Note: Phill. refers to the coefficients from multiple regression applied on Phillips curve. P1 refers to period before the crisis; P2 refers to period after the crisis, P12 refers to both periods. AVG LTU refers to average unemployment rate.

Now we are more interested in correlations between these values. If there is a positive correlation it means that we cannot reject our hypothesis, in particular that

the more flexible the wages are, the lower is the long-term unemployment. The results can be seen in Table 11.

Table 11 Correlation between estimates from Phillips curve and long-term unemployment rates

Correlation P1	0,38
Correlation P2	-0,62
Correlation P12	-0,28
Correlation P12 without PIGS countries	0,43

Source: Author's calculation
Note: Correlation is measured between coefficients estimated using the multiple regression on Phillip curve and the long-term unemployment rates. Positive correlation means that the flexible wages bring low long-term unemployment. P1 refers to period before the crisis; P2 refers to period after the crisis, P12 refers to both periods.

If we take a look at the results it is obvious that in the period before the crisis the hypothesis was right, the more flexible wages were connected with lower long-term unemployment rates. However, in the period of the crisis the situation dramatically changes. In the countries like Spain or Greece the wage flexibility significantly rose but the long-term unemployment rates rose as well which brings us the high negative correlation in the second period which influences correlation for total period as negative.

If we don't take into account the PIGS countries where the high long-term unemployment can be connected with other serious economic problems, we can see that there is a positive correlation between the flexible wages and long-term unemployment which would suggest that we cannot reject our hypothesis, in particular that more flexible wages are connected with low long-term unemployment rates.

6 Discussion and conclusion

As we found out in literature review, there are several ways how to estimate wage rigidity and every method can bring different results. In this thesis we focused on two approaches, namely applying multiple regression on Phillips curve in order to get the wage elasticities and SVAR approach to see the responsiveness of real wages to real shocks. We studied the period from the first quarter of the year 2000 until the second quarter of 2014. We divided this period into two sub periods for better understanding the development in wage flexibility during the crisis.

The goal of this thesis was to examine real wage rigidities as a potential adjustment mechanism under conditions of current ongoing economic and monetary integration process in Europe. Findings of this thesis were supposed to help answer the following research question:

- *What is the relation between the wage rigidity and the long-term unemployment?*

The hypothesis was that: *"the higher is the real wage rigidity, the higher is the long-term unemployment rate."*

In order to be able to answer this question we estimated the coefficients using the multiple regression applied on Phillips curve following the methodology of Alogoskoufis and Smith (1991) which is used by the Czech Central Bank for assessing the convergence of Czech economy with other EU countries. The other methodology used in this thesis is methodology proposed by Moore and Pentecost (2006) for estimating the variance of real wages explained by real shocks using the SVAR methods with long-term restrictions as proposed by Blanchard and Quah (1989).

The results have shown that both methods described the changes in wage flexibility during the crisis almost in the same direction and that is why we can expect that the wage rigidity really changed that way. However, the results were not identical across the country sample. Once we had the estimates we compared them with the long-term unemployment rates in order to evaluate our hypothesis using the correlation analysis.

The results of the correlation analysis were not uniform but once we excluded the PIGS countries for extreme results during the period of the crisis we could not reject the hypothesis that the higher is the wage flexibility the lower are the long-

term unemployment rates. We also focused on whether the countries that accepted euro have more flexible wages since they cannot use the monetary and exchange rate policy. The results varied from country to country very much; therefore we are not able to conclude whether the presence of common currency has an influence on wage flexibility.

However, we should also be aware of the limitations which are connected with our chosen methods. In the first method of multiple regression we used lagged inflation for two quarters and change in wages lagged for one quarter. We expected that the wages will adjust to inflation in one time period. If we would choose different lag we could get different results. The other results could be obtained if we would have chosen the different deflators to get real labor cost data. We used Harmonized Index of Consumer Prices but using the different deflator we would get different real labor cost data and hence different wage rigidities estimates as proposed by Messina (2010).

There are some other limitations which were not mentioned in the model. According to the WDN survey, at the beginning of the crisis the low pays workers were fired first which could even statistically increase the aggregated total labor costs for a short time period. Moreover, if the firms are limited by contracts to lower the wages they could use some alternative methods to cut costs in order to protect worker's job positions, for example cut the working hours for employees. If the working hours are cut, the employer can employ the same amount of people with lower costs while producing lower output. And because our measures are based on hourly labor costs, the real situation of wage flexibility does not have to be reflected. Another indicator that could influence the results is the governments measures established to promote employment like direct transfer to the employers or employees which also are not part of the total labor cost data.

Considering the results of this thesis, the further research could focus on development of other institutional features e.g. minimum wage, negotiating power of labor unions, inflation or price rigidity and their influence on wage rigidities. The influence could be measured for example by correlation analysis or these variables could be part of other regression analysis where they would explain rigidity. Other research could focus on how big is the role of the wage rigidities in long term unemployment.

In this thesis we tried to answer the question: "What is the relation between the wage rigidity and the long-term unemployment?" In further research we could study how big is the influence of the wage rigidities on long-term employment

compared to other market variables or how the ration of long-term unemployment in total unemployment influences the real wage rigidity.

Flexible wages are important for common monetary union in case of asymmetric shocks that is why they should be the concern of policy makers. Wage cuts are of course worse to promote than interventions by central banks but there are also other ways how to improve wage flexibility. One way how to achieve that goal could be lesser employee protection as shows the results from the US which would help the employers in the time of the bad economic development to save the companies. Another way could be increasing the ration of part time jobs which would allow some groups to have job which would not be that binding as a full time job. Policy makers should also be very careful setting the minimum wage which should be more result of an economic discussion than way how to be reelected.

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Appendix

A Tests for multiple regression method

Table 12 P-values of Chow test for whole period

	2008Q1	2008Q2	2008Q3	2008Q4
Czech Republic	0,39	0,18	0,4	0,27
Slovak Republic	0,22	0,53	0,51	0,6
Poland	0,52	0,32	0,29	0,36
Hungary	0,22	0,17	0,19	0,18
Portugal	0,19	0,17	0,16	0,13
Spain	0,31	0,84	0,97	0,97
Greece	0,94	0,92	0,95	0,95
Italy	0,78	0,82	0,79	0,75
France	0,12	0,06	0,1	0,1
United Kingdom	0,53	0,6	0,46	0,31
Germany	0,54	0,54	0,63	0,54
Netherlands	0,65	0,63	0,62	0,63

Source: Author's calculation

B Tests for SVAR method

Table 13 P-values of Jarque-Bera test

	2000Q1 - 2007Q4		2008Q1 - 2014Q2	
	u1	u2	u1	u2
Slovakia	0,88	0,69	0,16	0,38
Poland	0,11	0,052	0,54	0,55
Hungary	0,054	0,5	0,24	0,33
Portugal	0,49	0,37	0,76	0,84
Italy	0,66	0,65	0,83	0,76
Greece	0,99	0,96	0,74	0,82
Spain	0,53	0,69	0,89	0,56
France	0,98	0,7	0,28	0,17
Germany	0,99	0,49	0,49	0,63
Netherlands	0,6	0,36	0,76	0,98
United Kingdom	0,53	0,53	0,41	0,51

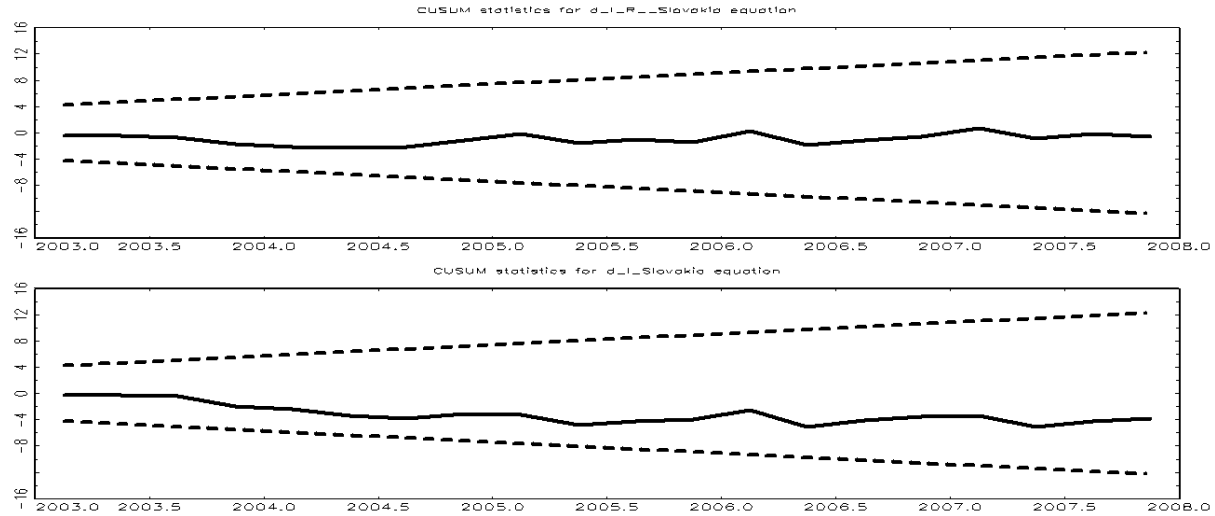
Source: Author's calculation

Table 14 P-values of Ljung-Box test

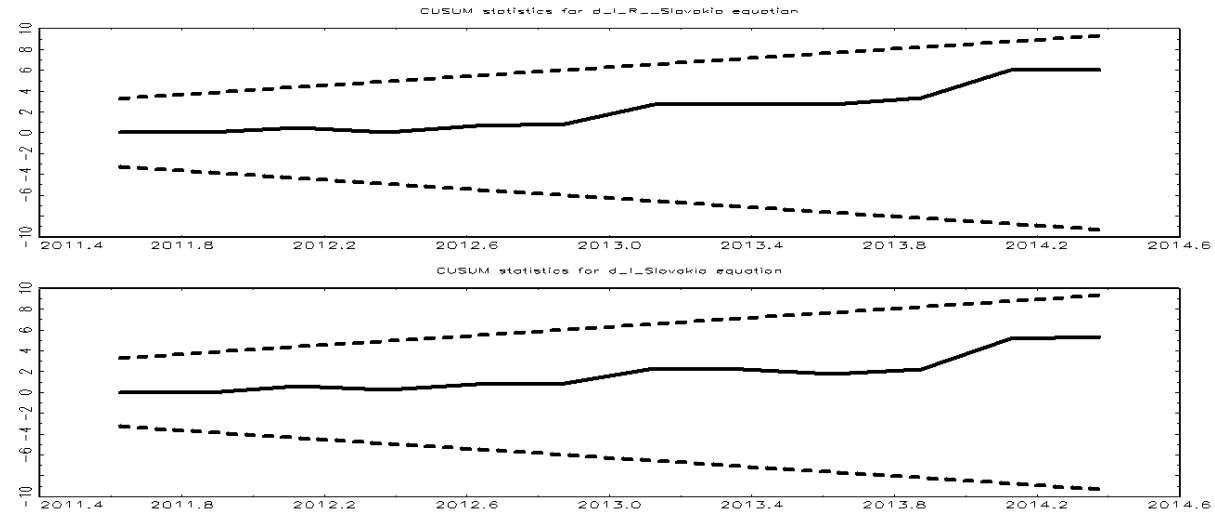
	2000Q1 - 2007Q4		2008Q1 - 2014Q2	
	u1	u2	u1	u2
Slovakia	0.65	0.19	0.78	0.38
Poland	0.42	0.39	0.63	0.58
Hungary	0.25	0.49	0.50	0.73
Portugal	0.57	0.34	0.63	0.45
Italy	0.15	0.35	0.57	0.32
Greece	0.96	0.95	0.08	0.11
Spain	0.34	0.06	0.11	0.12
France	0.42	0.39	0.29	0.14
Germany	0.66	0.52	0.70	0.49
Netherlands	0.73	0.45	0.23	0.54
UK	0.74	0.42	0.21	0.38

Source: Author's calculation

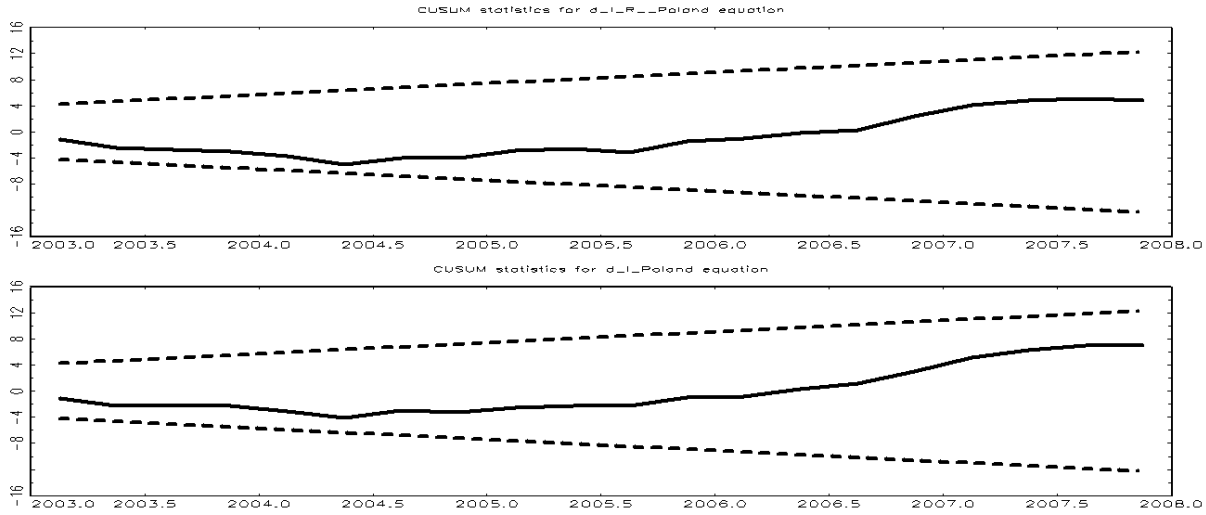
Cusum test results:



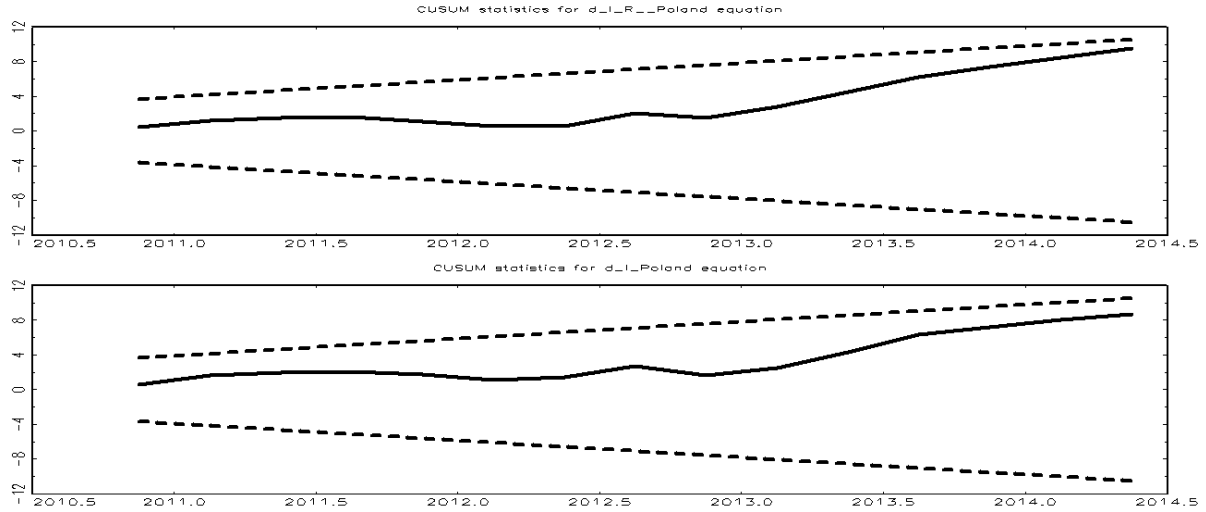
SK, 1st period



SK, 2nd period



PL, 1st period



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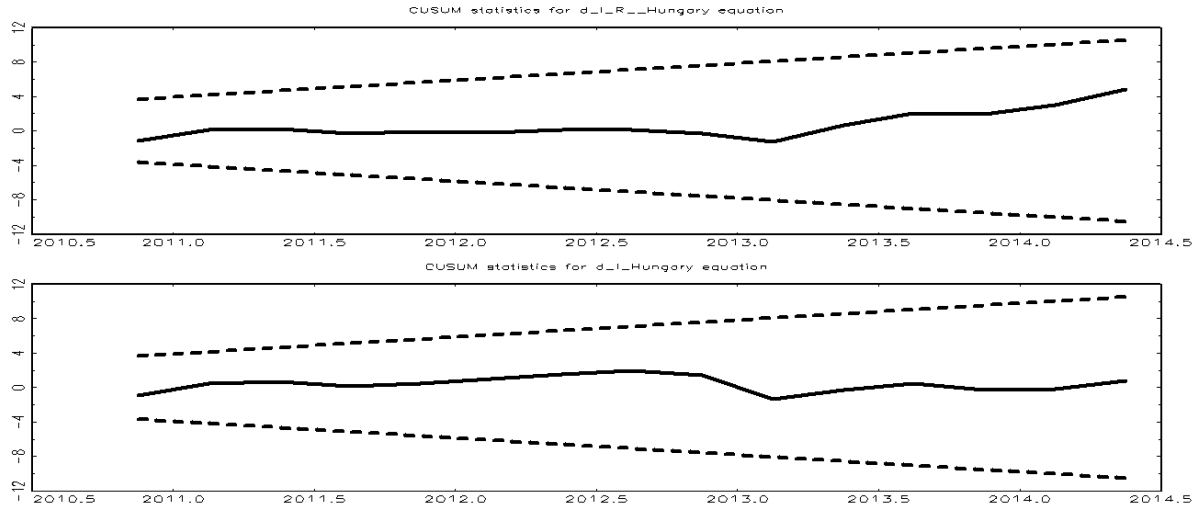

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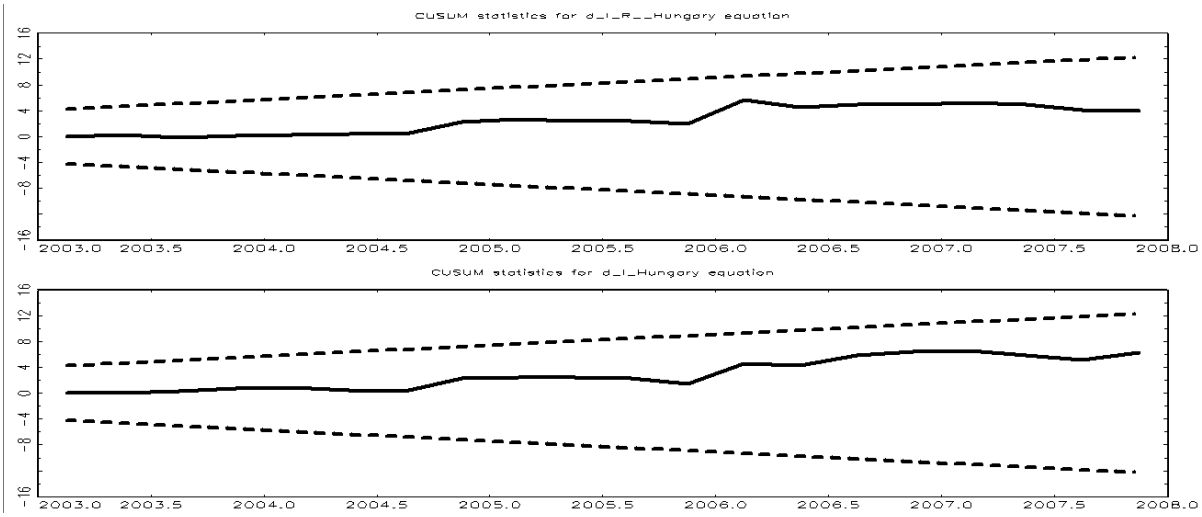

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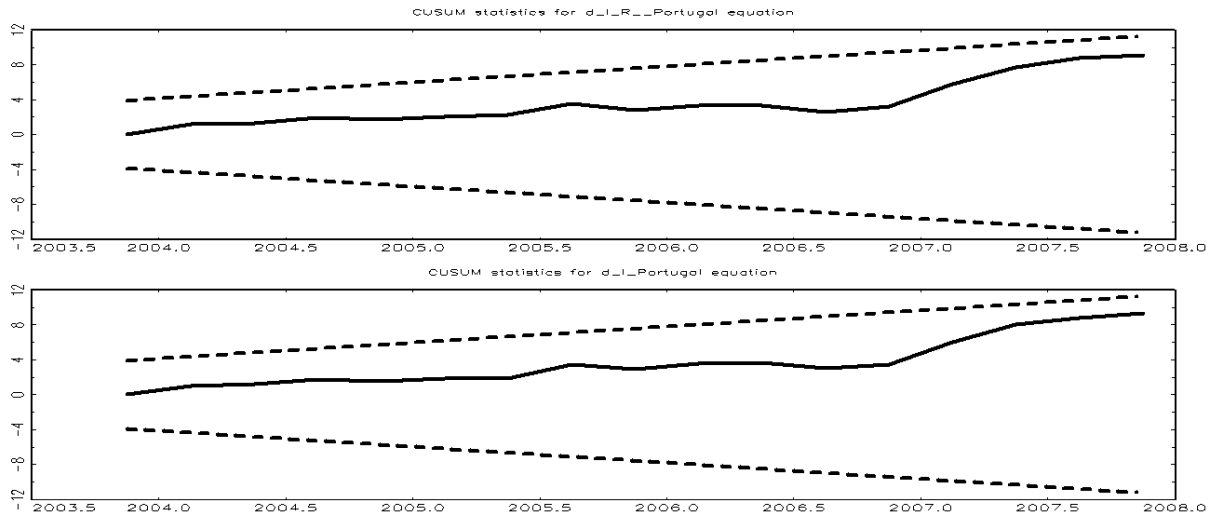

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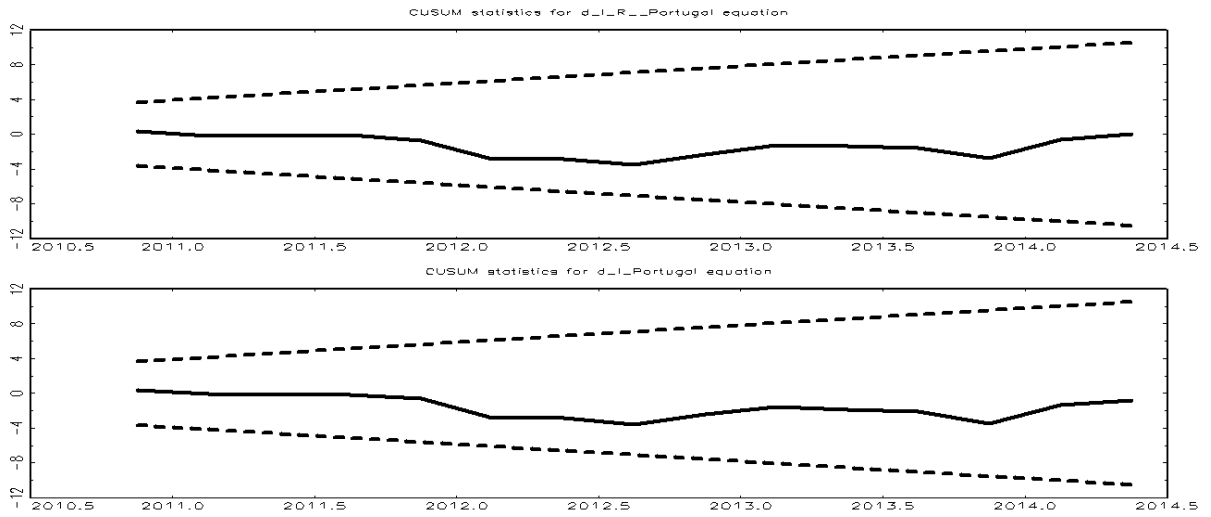

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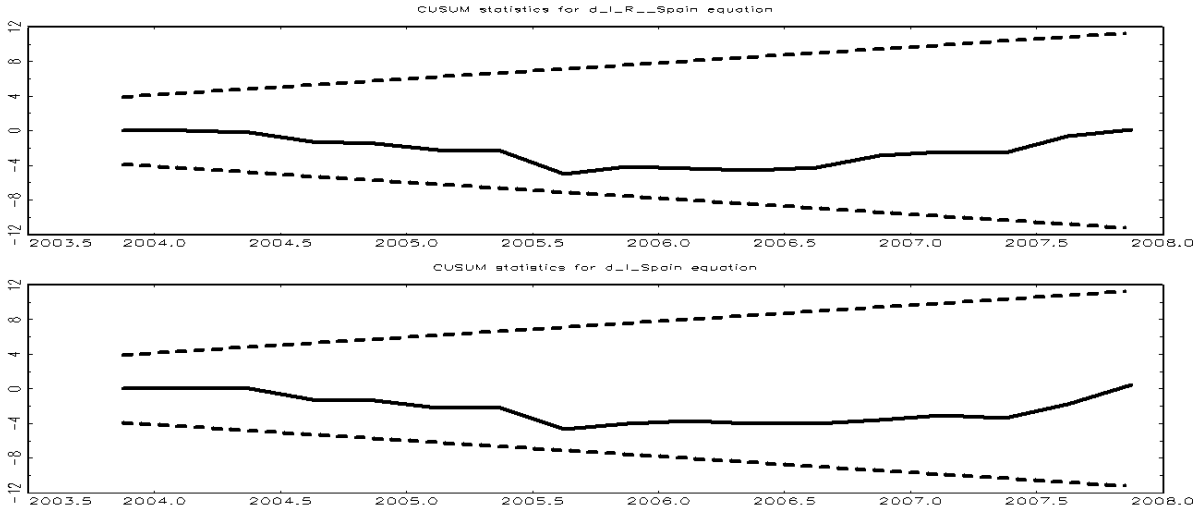

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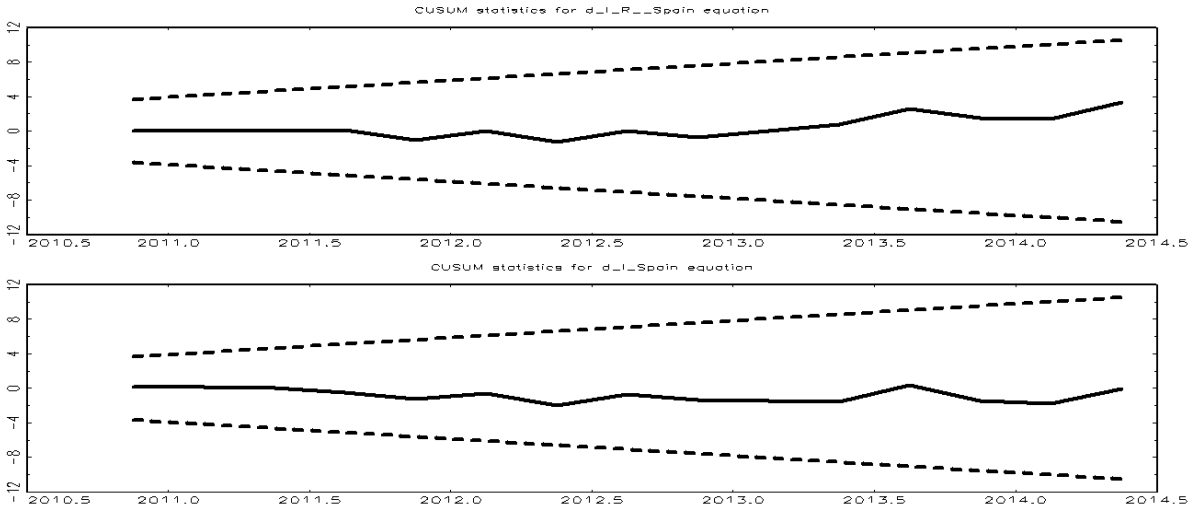

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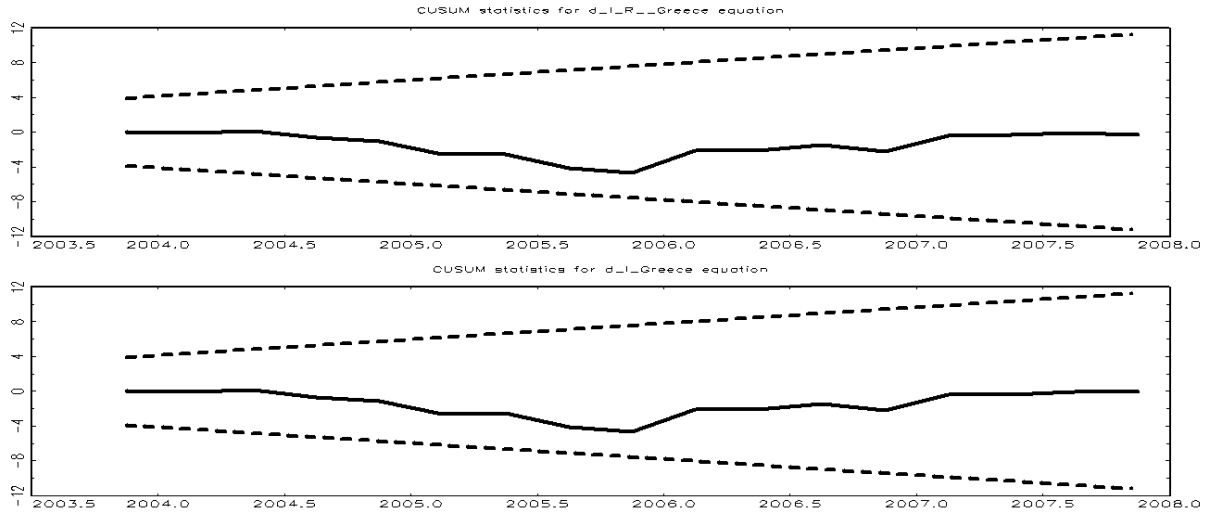

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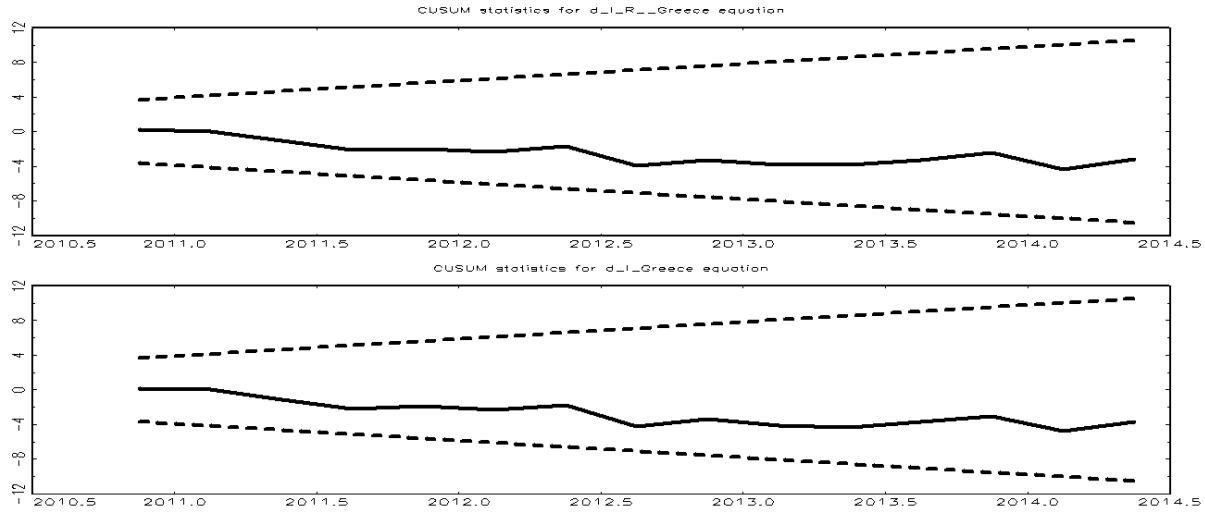

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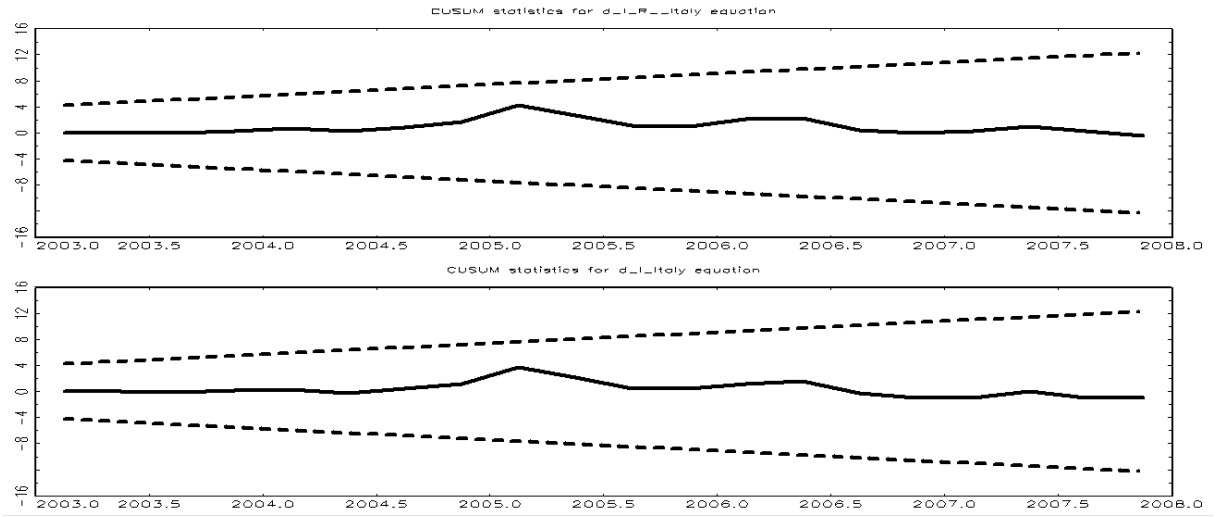

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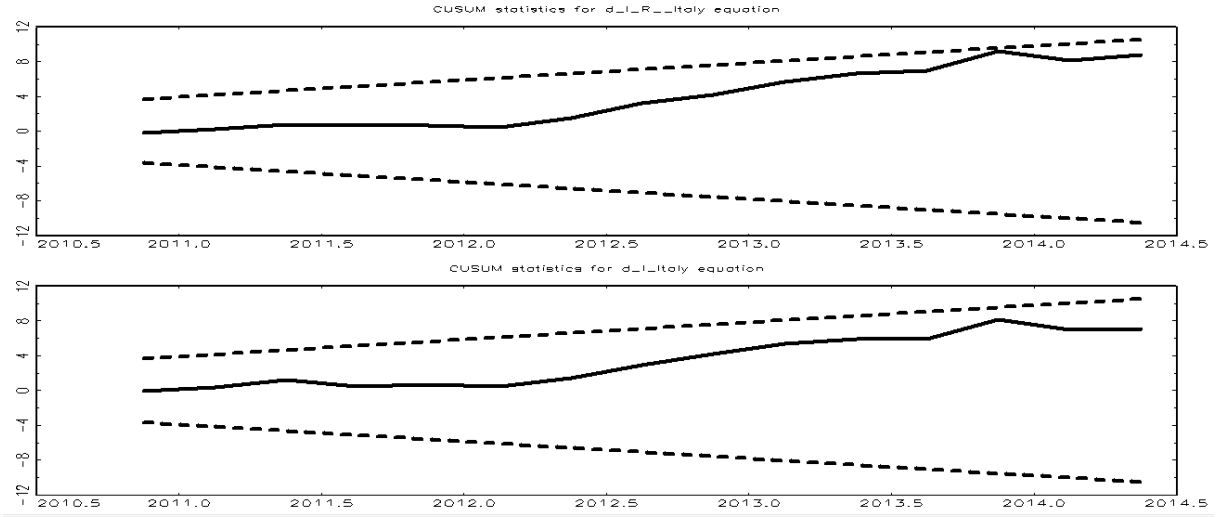

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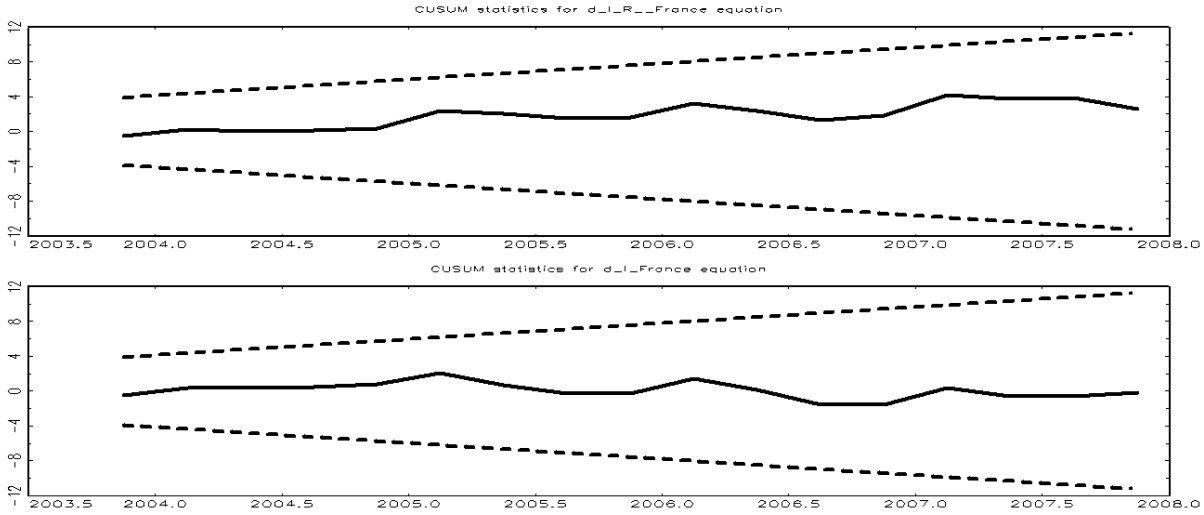

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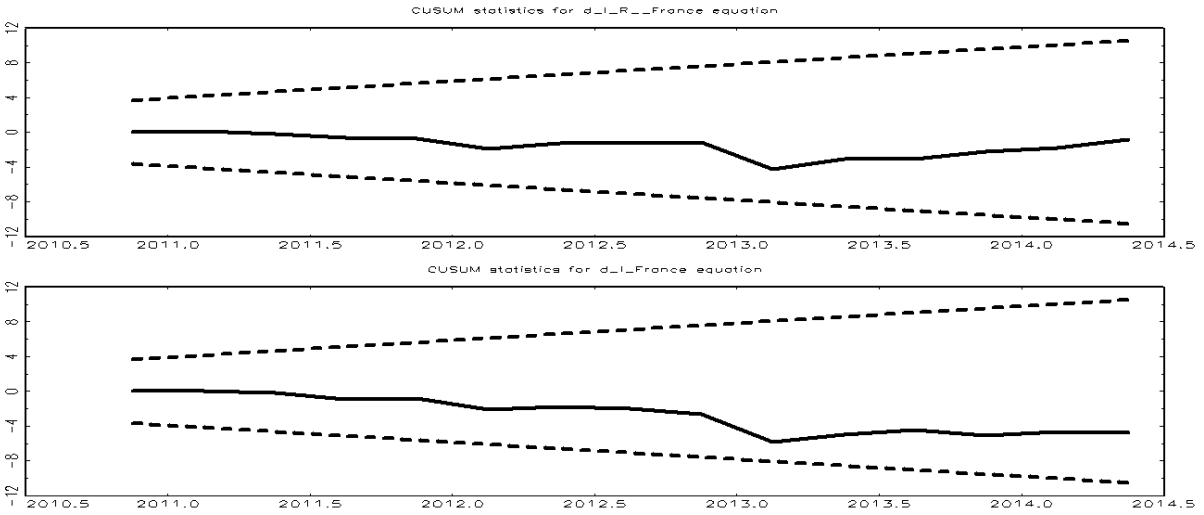

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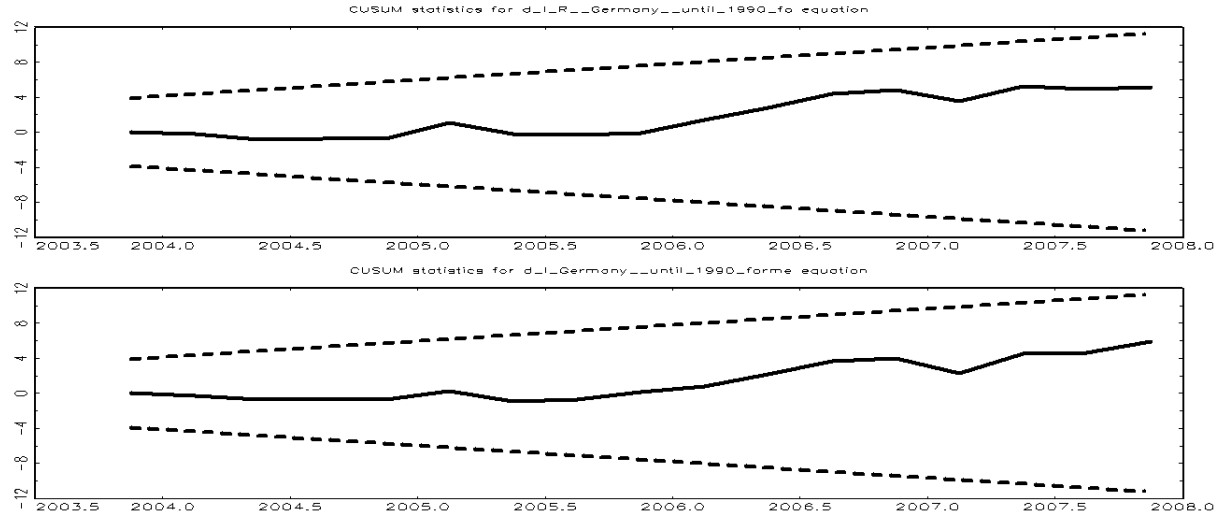

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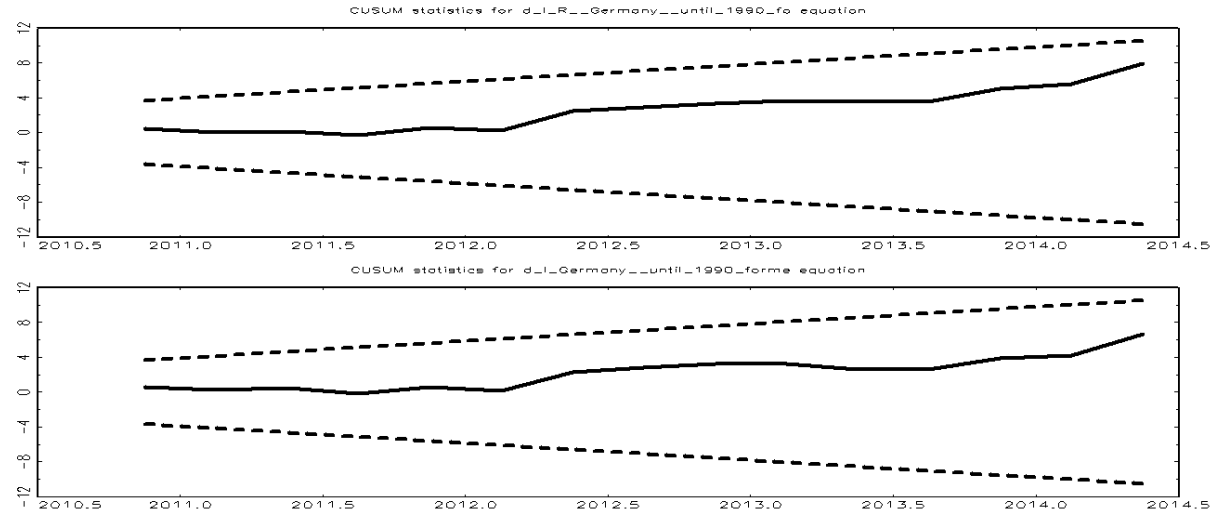

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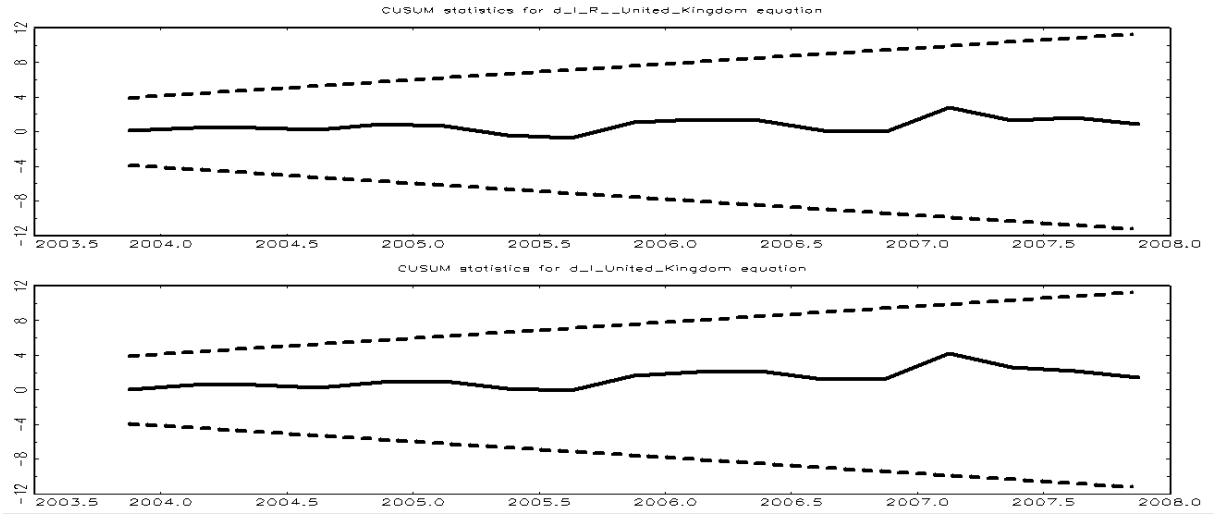

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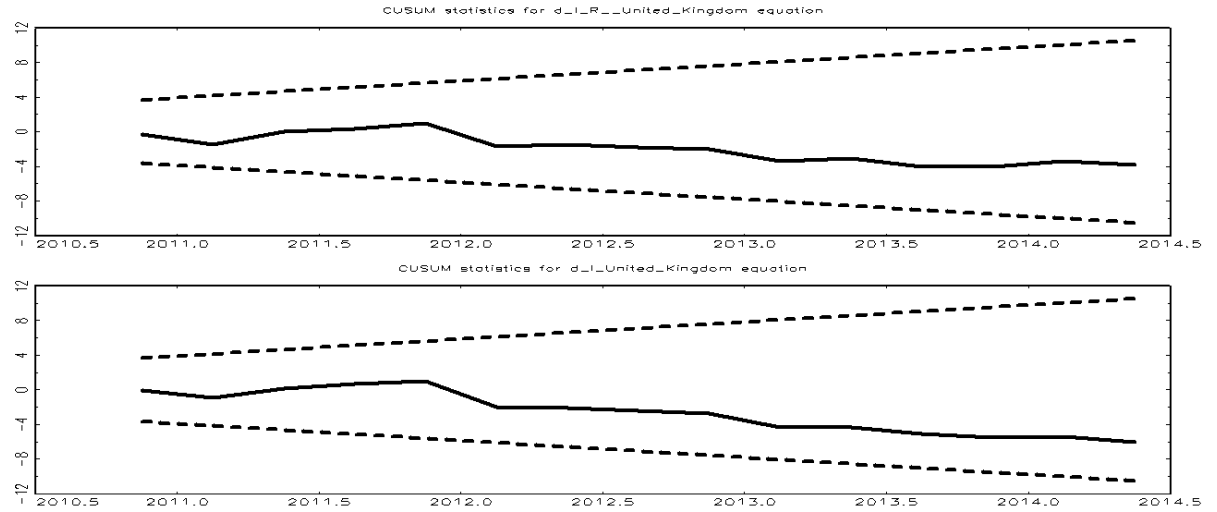

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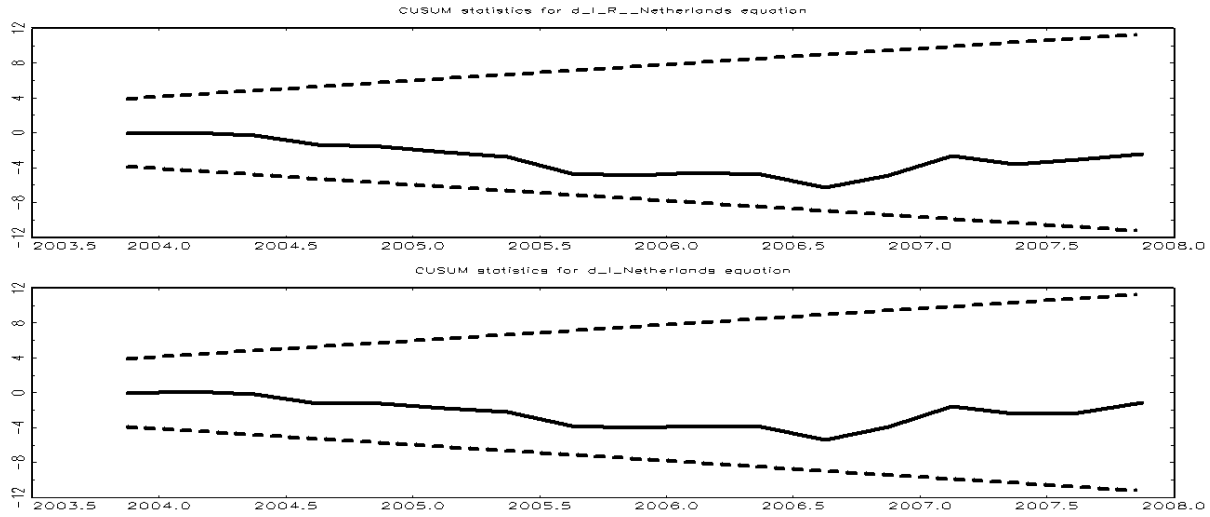

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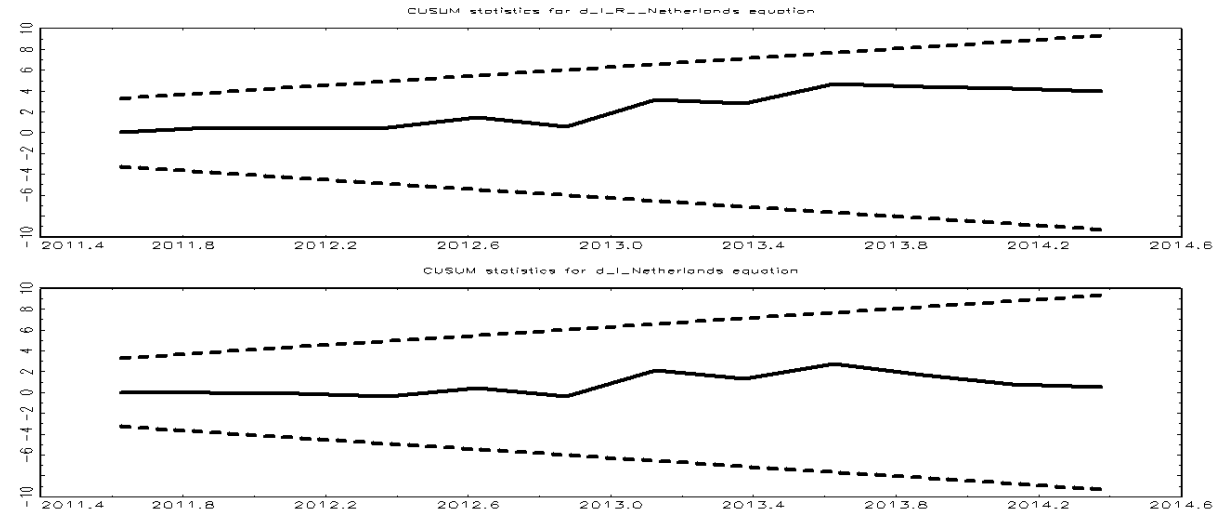

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