ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
ECONOMIC STUDIES

ГОДИНА XXI, 2012, 4

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COMPARING NAIRU AND ECONOMIC CYCLE FROM THE PERSPECTIVE OF LABOUR MARKET IN THE COUNTRIES OF THE VISEGRAD GROUP

This paper is aimed to map the development of the NAIRU and the business cycle in the labour market in selected transition economies. The article is focused on methods able to capture the fragile environment in the labour market and in the economy. Sources of instability, changes in development of NAIRU and estimation of changes in the labour market in the near future are the main issues discussed in this paper.

The results of our analysis show that in case of economies in transition the labour market is best described by NAIRU estimated by Kalman filter and HP filter. Kalman filter succeeded in capturing the non stable environment in the labour market. Sources of instability and eventual changes in labour market can be for example the restructuring of the economy, change in nature of trade off between unemployment rate and households´ consumption deflator caused by factors exogenous to the labour market or by the global financial and economic crisis. Findings about non stable environment in past (in the Czech Republic for example years 1999-2000) can be used, under condition of anticipated expectations environment, to the support of hypothesis that the non stable environment is present in the labour market at the end of the examined period (1-3Q 2008). Kalman filter can be used also for testing of time leading between labour market development in various countries and consequently for short term prediction making.

HP filter results support, according to our analysis, the hypothesis resulting from Kalman filter. Gradual reduction in unemployment gap derived by HP filter indicated a forthcoming change in business cycle phases. In one case the HP filter succeeded in predicting the business cycle phases change even sooner than the Kalman filter did.

JEL: E24; E32; E37

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1. Introduction

Basic indicator explaining the labour market behavior and the relationship between unemployment rate and inflation is the natural rate of unemployment (Richardson, Boone, Giorno, Meacci, Rae, Turner, 2000). Natural rate of unemployment indicates such a level of unemployment at which the inflation rate is constant (Estrada, Hernando a López-Salido, 2000). This concept, according to the authors mentioned, is called Non-Accelerating Inflation Rate of Unemployment (NAIRU).

NAIRU is an unobservable variable and indicates the "equilibrium" or "expected" values of parameters to be estimated (Boone, 2000). Estrada, Hernando a López-Salido (2000) found that alternative measurement instruments provide different point estimates of the NAIRU. Differences in estimates of structural or non-accelerating inflation unemployment resulting from the application of different estimation techniques are admitted also by Boone (2000). Fabiani a Mestre (2000) presented not only the simple univariate filters but also complex multivariate methods based on Phillips curve (PC) principles.

The high degree of uncertainty associated with the NAIRU estimates caused that the use of NAIRU in macroeconomic policy discussions started to be very limited (Estrada, Hernando a López-Salido, 2000). The relatively low credibility and therefore somewhat lower application possibilities in macroeconomic context is mentioned also by Mc Adam a Mc Morrow (1999). The koncept of NAIRU is anyway a very useful theoretical concept. Some authors recommend the use of NAIRU as a structural indicator for comparing the flexibility in labour markets accross countries. More to that, the NAIRU is applied when evaluating the extent of non-functioning of labour market and for structural reforms adjustment in a given economy.

This paper is aimed to map the development of the NAIRU and the business cycle in the labour market in selected transition economies through a number of methods which have been ordered in terms of temporal logic. The article is focused on methods able to capture the fragile environment in the labour market and in the economy. Sources of instability, changes in development of NAIRU and estimation of changes in the labour market in the near future are the main issues discussed in this article. Selected methods were one by one applied to the economic data of selected member economies of the Visegrad Group (V4).

2. Development of the NAIRU Concept

Humphrey (1985) states that the trade off in PC should be regarded as misleading and incomplete, and that Phillips and his successors inherited the concept of PC, so their work should be regarded as an extension of previous analysis. He further names three factors that attracted attention of economists and promoted the success of Phillips's formulation. These were mainly about finding a hundred year run empirical stability in the PC relationship, about convincing interpretation of his

work by the most important economists and about presentation of the PC in the right moment. Humphrey also points out that despite some critics tried to reject the PC, the relationship between inflation and unemployment remains an essential part of macroeconomic models. He also recalls that after Phillips formulated the relationship between inflation and unemployment many further versions with greater explanatory power and theoretical content, higher political relevance and better matching the real data have been developed.

According to Humperly (in Humphrey, 1985) we can count economists such as Law, Thornton, Attwood, Mill, Fischer, Tinbergen, Klein and Goldberger, Brown, Sultan, and others among the predecessors of Phillips. Law pointed to stimulating role of money for the real economic activity and at the same time he linked the decrease of unemployment to the decline in prices. These arguments suggest that Law tended to support the absence of the relationship between inflation and unemployment as presented in the PC. Thorton states that monetary expansion can stimulate employment under condition of rising prices and he therefore admits the existence of trade-off between price growth and decline of unemployment. Attwood admits the existence of a long term trade-off between unemployment level and inflation, Mill, on the other hand, mentions a trade-off which is only temporary, arises during unexpected price changes and disappears with adaptation to reality. Fischer presents the first statistical evidence of the unemployment-inflation relationship. He understands this causality going from inflation towards unemployment, while Tinbergen sees a reverse causality that is from unemployment towards inflation. The Klein´s and Goldberger´s wage reaction function suggests a change in money wage depending on an excessive labour demand. Brown mentions an inverse connection between yearly inflation rate and unemployment rate and a non-linear relationship between them (wages change faster at low unemployment rates than at higher unemployment rates. Sultan was the first to draw the PC, we can consider his chart the first schematic presentation of the PC in form of a stable trade off relationship p=f(U) between inflation and unemployment.

Phillips (1958) by his statistical results supported the hypothesis bases on the fact that the rate of nominal wage change can be explained by the level of unemployment and by the rate of unemployment change. He formulated his hypothesis in the introduction to his paper as follows:

When the demand for labour is high and there are very few unemployed we should expect employers to bid wage rates up quite rapidly, each firm and each industry being continually tempted to offer a little above the prevailing rates to attract the most suitable labour from other firms and industries." (Phillips, 1958, p. 283)

Among the successors of Phillips we can count Samuelson and Solow (1960). These authors formulated the relationship between the rate of price inflation and the rate of unemployment and they considered this relationship unstable in the long run. Phelps (1967) believes that there is a dynamic trade off relationship between unemployment and inflation. Friedman (1968) suggests that in every moment in time there is a level of unemployment which is consistent with the equilibrium in structure of real wage rates. According to him there is only a temporary trade off between inflation and

unemployment. Modigliani a Papademos (1975) define the NIRU – non inflation rate of unemployment – as such a rate of unemployment when a decline of inflation can be expected. According to Tobin (1997) the NAIRU is a result of macroeconomic settlement of pressures on the inflation growth from markets with an excessive demand and pressures on the inflation decrease from markets with an excessive supply. Akerlof, Dickens a Perry (Akerlof, Dickens a Perry (1996) call LSRU (the Lowest Sustainable Rate of Unemployment) the level of unemployment when there is an equilibrium between unemployment and real wages in the economy. In case of absence of the downwards rigidity of real wages, this would be, according to the authors, the NAIRU level of unemployment. Ball a Moffitt (2001) proposed a model with a slow adjustment of wage growht to changes in labour productivity. The authors use a new variable within the PC model that is the gap between the labour productivity growth and the growth of average past real wage.

3. Selected Approaches to NAIRU Estimation

Richardson, Boone, Giorno, Meacci, Rae a Turner (2000) in their papers remind that the unobservable NAIRU has to be quantified before beeing used by the authorities. They classify the methods from the perspective of their technical nature to the following groups: structural methods, purely statistical methods and so called reduced form approach. In our analysis we divide the methods according to the time logic of the estimated NAIRU. Based on experience from our previous research on economies in transition we will give priority to the methods that estimate the NAIRU varying during the examined period of time, namely the Kalman filter and the Hodrick-Prescott (HP) filter.

Kalman filter belongs to the group of methods called Reduced form approach (Richardson, Boone, Giorno, Meacci, Rae a Turner, 2000). These methods use to estimate the NAIRU through behavioral equations explaining inflation (PC with expectations) and solving identification restrictions for the NAIRU estimated and the gap of unemployment. Among the advantages of this methods belongs, according to the authors, the direct connection of the NAIRU estimate with inflation. To the contrary the main disadvantage of this method is considered to be the absence of identification of basic structural relationships. Nevertheless, the filtration methods inside the system of these methods improve the NAIRU estimates comparing with other methods.

Kalman filter is used by Fabiani a Mestre (2000). They added the assumption of changeability of NAIRU to the basic model of inflation equation. This assumption ensures that the NAIRU will move not far from the real unemployment. NAIRU is specified as a random walk. The authors add to the basic model of time variable NAIRU by the reduced form of the Phillips curve according to the equation in which the dependent variable is the inflation increase and the independent variables are the unemployment gap and the supply side factors. Their statistical significance decided the inclusion of the independent variables into the model.

HP filter belongs to the group of methods called purely statistical methods (Richardson, Boone, Giorno, Meacci, Rae a Turner, 2000). The authors regard this approach as methodology that divide the proper rate of unemployment to its trend (NAIRU) and its cyclical component. According to them there is no long term trade off between inflation and unemployment and the average inflation fluctuates around the NAIRU. The authors discuss as a disadvantage of this approach the issue of decomposition that is dependent on arbitrary and often unprobable assumptions.

Fabiani a Mestre (2000) use HP filter to identify the trend and the cycle. Boone (2000) states that the simple HP filter is able to estimate unobservable variables by solving the minimalizing problem. The filtered dataset is moving average of the observed data series. The author uses λ_1 for ensuring equilibrium between smoothness of the trend and the amplitude of cyclical fluctuations.

With the aim of making our analysis of NAIRU development in economies in transition as complete as possible we will also use a method that divides the NAIRU development into several time intervals. In the context of this group of methods called Reduced form approach Fabiani a Mestre (2000) discuss the Break model. The NAIRU obtained by this model acquires different values in time. The breakpoint can be determined or estimated in advance. In case of extimation we can use the sequential algorithm where the first estimated breakpoint is considered fix and then follows estimation of the next breakpoint. In this work, according to the definition given by the model creators there is applied the limitation that no breakpoint can be detected within the period of eight quarters from the beginning to the end of the monitored period. Breakpoints fell on the periods in which the minimalization of the sum of the squares of the residua was the least. After this decomposition of the time series there were estimated straight lines by the method of least squares for all periods and calculated values of NAIRU (their statistical significance again decided the inclusion of the variables into the model).

The less suitable approach in the context of economies in transition is from our point of view the so called group of Structural methods. These methods estimate NAIRU by means of a system of equations that describe the wage and price negotiation (Richardson, Boone, Giorno, Meacci, Rae a Turner, 2000). This group of methods explatins the impact of macroeconomic shocks and policies on structural unemployment. The estimated NAIRU is unfortunatelly not very precise.

According to Mc Adam a Mc Morrow (1999) the NAIRU estimation can be performed by the so called Gordon's Triangle Model, where the inflation rate depends on inflation expectations, on demand conditions such as unemployment gap, and on supply shocks. For means of our analysis we will call the Gordon's Triangle Model One-equation model. Using this model only one value of NAIRU for the whole examined period can be estimated.

4. Empirical Testing of Data for Countries of the Visegrad Group – V4

When selecting countries for our analysis we, have considered the following: the level of similarity of administrative measures in the moment of transition from centrally planned economy to market economy, the level of structural similarity of the economies and the level of openess of the economies.

We have chosen the households´ consumption deflator as indicator of development of price levels in the examined economies that is the Czech Republic, Slovakia, Hungary and Poland. The data series is transformed in such a way that it can show the adaptive formation of expectations (year on year change in time t - year on year change in time t-1). For describing situation on labour market we use unemployment rate as defined by International Labour Organization – ILO in %. As explanatory variables we use values for year on year changes in exchange rate of domestic currencies of examined economies to EUR in %, oil prices (Brent) and import prices. Time series for unemployment rate are supplied to the model after seasonal adjustment by moving multiplicative average[3]. The time series were tested by Augmented Dickey – Fuller test which has confirmed stationarity of all above mentioned time series.

As the aim of our analysis is to map the development of NAIRU from time logic point of view, we decided to apply four different ways of estimating NAIRU. First we use **One-equation model** which will give us one value of NAIRU for the whole examined period. Next, by using the **Break model**, we will divide the time series into intervals and we will estimate separate values of NAIRU. Crucial importance for economies in transition should have those methods which estimate NAIRU varying in time. For this reason we use also **Kalman filter** and **HP filter**.

4.1. NAIRU Estimated by One-Equation Model (Constant NAIRU Everover the Empire Period)

We start our analysis by application of **One-equation model,** which will provide for the whole period only one long-term NAIRU, which will not make possible the capturing of development in the labour market during unstable and transition periods (eg.the transition environment and recession period or let us say, conjuncture). Year on year change of the household consumption deflator (in %) is our dependent variable, fix regressors are values for unemployment rate in % (with and without lag), lagged values for year on year changes in households´ consumption deflator in %, values for year on year changes in exchange rates of domestic currencies of examined economies to EUR in % (with and without lag),

[3] Seasonally adjusted time series (marked eg. z_t) was calculated as follows: $z_t=y_t/s_t$, where s_t stands for seasonal factor for quarter i (Qi) which is calculated as average from values y_t/x_t for the given Q (normated by geometrical average), and where x_t is calculated as $x_t=(0{,}5y_{t+2}+y_{t+1}+y_t+y_{t-+}+0{,}5y_{t-2})$ and y_t stands for the original non adjusted series.
Source: Eviews (1998).

year on year changes in oil price (Brent) and import prices without lag. The one-equation model provides a constant value of NAIRU in time.

Table 1

Equations of Curves Obtained from One-Equation Model

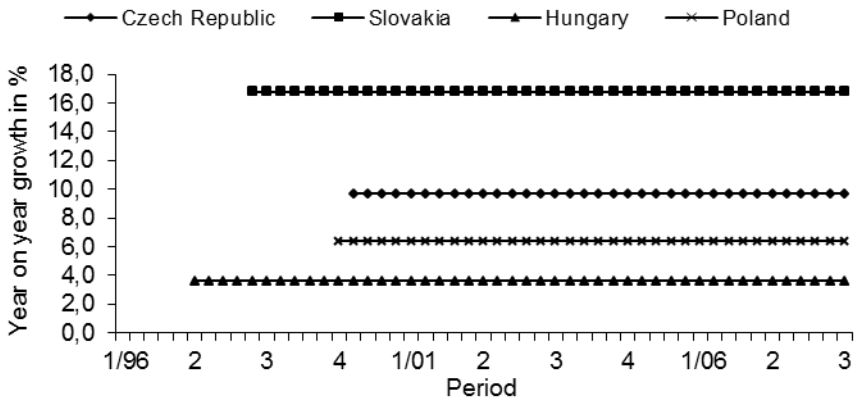
Country	Equations of curves - method of least squares
Czech Republic	$\Delta\pi_t = 10{,}529 - 1{,}085u_{t-1} + 0{,}428\Delta\pi_{t-1} + 0{,}205x_t^{CZK/EUR} + 0{,}228x_{t-3}^{CZK/EUR} + e_t$
Slovakia	$\Delta\pi_t = 4{,}984 - 0{,}296u_t + 0{,}608\Delta\pi_{t-1} + 0{,}163x_{t-1}^{SKK/EUR} + e_t$
Hungary	$\Delta\pi_t = 1{,}248 - 0{,}348u_{t-9} + 0{,}419\Delta\pi_{t-1} + 0{,}024x_t^{Oil\ p} + e_t$
Poland	$\Delta\pi_t = 0{,}922 - 0{,}144u_t + 0{,}494\Delta\pi_{t-1} + 0{,}016x_t^{Oil\ p} + 0{,}239x_t^{Import\ p} + e_t$

Source: Authors´ calculation of parameters based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.
http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls,
http://www.czso.cz/csu/csu.nsf/i/tab_v/$File/tab_v_2q09.xls,
http://www.cnb.cz/cs/financni_trhy/devizovy_trh/kurzy_devizoveho_trhu/denni_kurz.jsp,
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

Where π_t is the year on year change in households´ consumption deflator in %, u_t stands for the rate of unemployment in %, X_t stands for the year on year change in exchange rate to EUR in %, year on year change in oil price (Brent) and year on year change in import prices in %.

Chart 1

NAIRU development obtained from the One-equation model in countries of V4



Source: Authors´ calculation based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.
http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls,
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http://www.cnb.cz/cs/financni_trhy/devizovy_trh/kurzy_devizoveho_trhu/denni_kurz.jsp,
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

The estimated NAIRU value in the **Czech Republic** was found equal to 9.7%. Regarding the fact that NAIRU is a long-term average of real rates of unemployment, and the real rate of unemployment in the previous period was higher

than in the monitored period, the NAIRU was far above the real rate of unemployment in the whole examined period. Parameters are in harmony with the theoretical expectation and express a substitution relation. In **Slovakia** we found the value of NAIRU at 16.8% and it differed significantly from the real rate of unemployment only at the end of the examined period. For the case of **Hungary** the model estimated the NAIRU at 3.6% in the whole period of timeThe NAIRU lied far below the real rate of unemployment in the whole period of time. Due to high level of heterogeneity of macroeconomic environment, no exogenous variable succeeded in approximating the NAIRU to the real rate of unemployment, which in the period examined (2Q 1997 – 3Q 2008) amounted to an average of 7.2%. In **Poland** the NAIRU found amounted to 6.4%. This method estimated unrealistically high gap of unemployment with desinflation impulses until the 2Q 2007. In the following period the difference between the NAIRU and the real rate of unemployment amounts to an average of 1.1 p.p.

4.2. NAIRU Obtained from the Break Model (Different Discrete NAIRUs Over Time)

In this part we estimate the NAIRU in selected time periods through the **Break model**. Since this method in the monitored period separates out some time intervals, the estimated NAIRU better reflects the real situation in the labour market. Year on year change of the households´ consumption deflator (in %) is our dependent variable, significant fix regressors are values for unemployment rate in % (with and without lag), lagged values for year on year changes in households´ consumption deflator in %, values for year on year changes in exchange rate of domestic currencies of examined economies to EUR in % (with and without lag), year on year changes in oil prices (Brent) and import prices with and without lag. The Break model method provides variable values of NAIRU in different time periods.

Where πt is the year on year change in households´ consumption deflator in %, ut stands for the rate of unemployment in %, Xt stands for the year on year change in exchange rate to EUR in %, year on year change in oil price (Brent) and year on year change in import prices in %.

Breakpoints fell within periods in which the minimization of the sum of squares of residua was the least. After this decomposition of the time series there were estimated straight lines by the method of the least squares for all periods and calculated values of NAIRU. By the minimization of the sum of squares of the residua, the whole period of time in the case of the **Czech Republic** was divided into four intervals (there were thus estimated two breakpoints). The first interval starts in 2Q 1996 and ends in 4Q 1999. The second one lasts from 1Q 2000 until 2Q 2003, the third interval covers the period between 3Q 2003 and 4Q 2004 and the last one between 1Q 2005 and 3Q 2008. The break model estimated four values of NAIRU (3.6, 9.3, 8.9 and 8%). The estimated values of NAIRU responded sensitively to the development of the real rate of unemployment. Parameters for the whole period of time are in harmony with the theoretical expectation and express the substitution relation.

Table 2

Equations of Curves Obtained from the Break Model

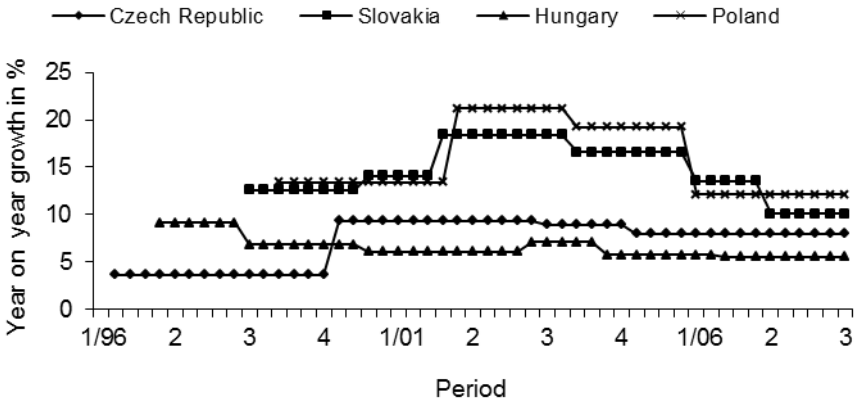
Country	Equations of curves – method of least squares
Czech Republic	
1. interval	$\Delta\pi_t = 3{,}222 - 0{,}896u_{t-1} + 0{,}557\Delta\pi_{t-1} + 0{,}297x_t^{CZK/EUR} + e_t$
2. interval	$\Delta\pi_t = 13{,}801 - 1{,}481u_{t-1} + 0{,}251\Delta\pi_{t-1} + 0{,}266x_t^{CZK/EUR} + 0{,}300x_{t-3}^{CZK/EUR} + e_t$
3. interval	$\Delta\pi_t = 43{,}763 - 4{,}899u_{t-1} + 0{,}811\Delta\pi_{t-1} + 0{,}368x_t^{CZK/EUR} + 0{,}507x_{t-3}^{CZK/EUR} + e_t$
4. interval	$\Delta\pi_t = 17{,}054 - 2{,}119u_{t-1} + 0{,}619x_{t-1}^{Import\ p} + e_t$
Slovakia	
1. interval	$\Delta\pi_t = 12{,}294 - 0{,}972u_{t-1} + 0{,}619x_{t-2}^{SKK/EUR} + 0{,}031x_t^{Oil\ p} + e_t$
2. interval	$\Delta\pi_t = 16{,}551 - 1{,}178u_t + 0{,}643x_{t-2}^{SKK/EUR} + 0{,}222x_{t-5}^{Import\ p} + e_t$
3. interval	$\Delta\pi_t = 34{,}880 - 1{,}898u_{t-1} + 0{,}049x_{t-2}^{Oil\ p} + e_t$
4. interval	$\Delta\pi_t = 19{,}969 - 1{,}200u_{t-3} + 0{,}708\Delta\pi_{t-1} + e_t$
5. interval	$\Delta\pi_t = -21{,}258 + 1{,}570u_{t-2} + e_t$
6. interval	$\Delta\pi_t = 42{,}477 - 4{,}220u_t + 0{,}298x_{t-3}^{Import\ p} + e_t$
Hungary	
1. interval	$\Delta\pi_t = 49{,}368 - 5{,}434u_{t-7} + 0{,}114x_t^{HUF/EUR} + 0{,}046x_t^{Oil\ p} + e_t$
2. interval	$\Delta\pi_t = 36{,}572 - 5{,}391u_{t-1} + 0{,}122x_t^{HUF/EUR} + e_t$
3. interval	$\Delta\pi_t = 29{,}578 - 4{,}864u_{t-8} + 0{,}074x_{t-2}^{Oil\ p} + e_t$
4. interval	$\Delta\pi_t = 43{,}018 - 6{,}081u_{t-3} + 1{,}555x_{t-6}^{HUF/EUR} + e_t$
5. interval	$\Delta\pi_t = 23{,}494 - 4{,}118u_{t-8} + e_t$
6. interval	$\Delta\pi_t = 30{,}278 - 4{,}018u_{t-2} + 0{,}391x_{t-4}^{HUF/EUR} + e_t$
Poland	
1. interval	$\Delta\pi_t = -22{,}364 + 1{,}673u_{t-6} + 0{,}051x_{t-1}^{Oil\ p} + e_t$
2. interval	$\Delta\pi_t = -30{,}328 + 1{,}432u_{t-1} + e_t$
3. interval	$\Delta\pi_t = -79{,}421 + 4{,}135u_{t-5} + e_t$
4. interval	$\Delta\pi_t = 4{,}127 - 0{,}340u_t + e_t$

Source: Authors´ calculation of parameters based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.
http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls,
http://www.czso.cz/csu/csu.nsf/i/tab_v/$File/tab_v_2q09.xls,
http://www.czso.cz/csu/redakce.nsf/i/ceny_vd_ekon
http://www.cnb.cz/cs/financni_trhy/devizovy_trh/kurzy_devizoveho_trhu/denni_kurz.jsp,
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

In case of **Slovakia** the Break model estimated three breakpoints in NAIRU development (six time periods. Trade off between unemployment and deflator was divided into six time intervals as follows: 3Q 1998 – 2Q 2000, 3Q 2000 – 3Q 2001, 4Q 2001 – 4Q 2003 and so on. The Break model estimated in total six intervals in which the NAIRU amounted to the following values (in time order): 12.6, 14.1, 18.4, 16.6, 13.5 and 10.1%. According to this methodology the Slovak economy was in a boom phase from the 1Q 2008 until the end of the estimated period. Parameters in the whole period of time except the fifth one are in harmony with the theoretical expectation and express the substitution relation.

Chart 2

NAIRU Development Obtained from the Break Model in Countries of V4



Source: Authors´ calculation based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.
http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls,
http://www.czso.cz/csu/csu.nsf/i/tab_v/$File/tab_v_2q09.xls,
http://www.czso.cz/csu/redakce.nsf/i/ceny_vd_ekon
http://www.cnb.cz/cs/financni_trhy/devizovy_trh/kurzy_devizoveho_trhu/denni_kurz.jsp,
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

In **Hungary** the model detected three breakpoints (2Q 1998, 1Q 2003 and 2Q 2006) and six time intervals. In the first interval the value of NAIRU was 9,1 %, in the second period it was 6.8%, in the third one 6.1%, then 7.1, 5.7 and finally 7.5% in the sixth period. The deducted NAIRU was below the real rate of unemployment between 1Q 2001 and 3Q 2008. Parameters in the whole period of time are in harmony with the theoretical expectation and express the substitution relation. In **Poland** the Break model estimated two breakpoints (4Q 2000 and 4Q 2005) and four time intervals. The NAIRU estimated was as follows: 13.4, 21.2, 19.2 and 12.1%. Values of NAIRU copy the development of the real rate of unemployment until 2Q 2007. In the following period the NAIRU was found significantly above the real rate of unemployment. The peak of the economic boom phase was identified in 2008. Only the parameters in the last period of time are in harmony with the theoretical expectation and express the substitution relation.

4.3. NAIRU Obtained from Kalman Filter and HP Filter (the Time-Varying NAIRU)

These methods provide variable values of NAIRU in each time interval. In this part we first apply the **Kalman filter**. NAIRU is specified as a random walk in the reaction to shocks. The approach in this analysis comes out of the presentation of a series of alternative NAIRU which differ by value, which gives the smoothing level of the estimated NAIRU. As the Czech Republic, Slovakia, Hungary and Poland are small open economies in transition, we have used smoothing at the level of 0.6 and 1

instead of standardly recommended value of 0.2. In the literature there is preferred the choice 0.2 (in the conditions of the Czech Republic it has been used by the authors Fukač, 2003 and Beneš and N´Diaye, 2004), which allows small fluctuations in the estimates of NAIRU, and thus avoids big jumps in the smoothened estimate of NAIRU. This analysis, to the contrary, in the effort to ensure sufficiently smooth transitions among individual stages of NAIRU development in the transition economy and for the description of unstable periods uses expertly selected higher values, by which, according to our opinion, there is ensured the capturing of the variable development of unemployment.

The Kalman filter (for both smoothings) used year on year change of the household consumption deflator (in %) as dependent variable, fix regressors were lagged values for unemployment rate in %, values for year on year changes in households´ consumption deflator in %, values for year on year changes in exchange rate of domestic currencies to EUR in %, and oil prices (Brent). Year on year changes in import prices were significant without lag.

Table 3

Equations of curves obtained from Kalman filter

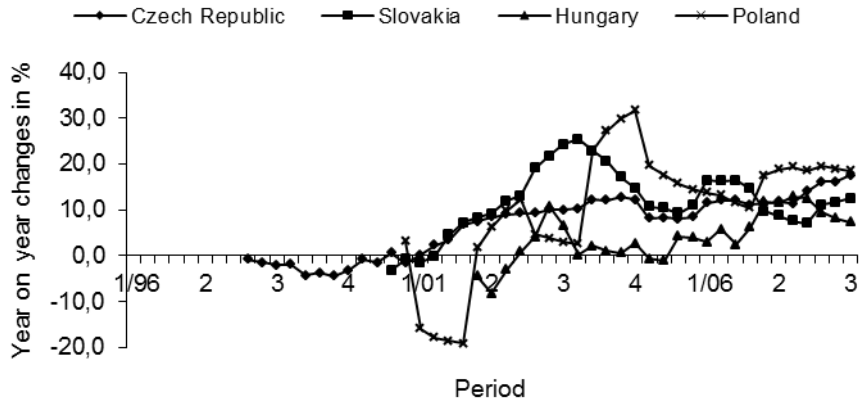
Country	Equations of curves – method of least squares
Czech Republic	
Smoothing 0,6	$\Delta\pi_t = SV1 - 0{,}713u_{t-2} + 0{,}306\Delta\pi_{t-2} + 0{,}316x_{t-2}^{CZK/EUR} + 0{,}292x_t^{Import\ p} + e_t$
Smoothing 1,0	$\Delta\pi_t = SV1 - 0{,}750u_{t-1} + 0{,}325x_{t-2}^{CZK/EUR} + 0{,}183x_t^{Import\ p} + e_t$
Slovakia	
Smoothing 0,6	$\Delta\pi_t = SV1 - 0{,}307u_{t-4} + 0{,}483\Delta\pi_{t-1} + 0{,}026x_{t-6}^{Oil\ p} + e_t$
Smoothing 1,0	$\Delta\pi_t = SV1 - 0{,}377u_{t-4} + 0{,}418\Delta\pi_{t-1} + 0{,}029x_{t-6}^{Oil\ p} + e_t$
Hungary	
Smoothing 0,6	$\Delta\pi_t = SV1 - 0{,}206u_{t-11} + 0{,}303\Delta\pi_{t-1} + e_t$
Smoothing 1,0	$\Delta\pi_t = SV1 - 0{,}317u_{t-8} + 0{,}256\Delta\pi_{t-1} + e_t$
Poland	
Smoothing 0,6	$\Delta\pi_t = SV1 - 0{,}090u_{t-2} + 0{,}443\Delta\pi_{t-1} + e_t$
Smoothing 1,0	$\Delta\pi_t = SV1 - 0{,}340u_{t-3} + 0{,}293x_t^{Import\ p} + e_t$

Source: Authors´ calculation of parameters based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.
http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls,
http://www.czso.cz/csu/csu.nsf/i/tab_v/$File/tab_v_2q09.xls,
http://www.czso.cz/csu/redakce.nsf/i/ceny_vd_ekon
http://www.cnb.cz/cs/financni_trhy/devizovy_trh/kurzy_devizoveho_trhu/denni_kurz.jsp,
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

Where πt is the year on year change in households´ consumption deflator in %, ut stands for the rate of unemployment in %, Xt stands for the year on year change in exchange rate to EUR in %, year on year change in oil price (Brent) and year on year change in import prices in %.

Chart 3

NAIRU development obtained from Kalman filter in countries of V4



Source: Authors´ calculation based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.
http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls,
http://www.czso.cz/csu/csu.nsf/i/tab_v/$File/tab_v_2q09.xls,
http://www.czso.cz/csu/redakce.nsf/i/ceny_vd_ekon
http://www.cnb.cz/cs/financni_trhy/devizovy_trh/kurzy_devizoveho_trhu/denni_kurz.jsp,
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

In case of the **Czech Republic** the values of NAIRU after smoothing by 0,6 were lying between – 1.1 and +13.4% and after smoothing by 1 the values were lying between – 1.9 and +13.9%. In time interval from 1Q 1999 until 4Q 1999 the NAIRU acquired negative values both when smoothing by 0.6 and by 1. The model with higher smoothing (ie. with negative NAIRU values) in this way reacted to sharp changes in the impact of restructuring of the domestic economy) which caused unstability in trade off between unemployment and households´ consumption deflator. Apart from the restructuring of the economy, we can name some other important factors, such as fluctuations in oil prices (year to year decline by 21.1% in the first quarter and, on the other hand, 130.1% rise in the fourth quarter), exchange rate fluctuations (from appreciation in the first quarter to depreciation in the fourth quarter). There was a 6.8% decline in year to year import prices in the 1Q but a 11.1% growth in the 4Q. Regulated prices grew first by 11.9% on the year to year basis, but at the end of the 1999 the growth decelerated only to 4.2%.

The highest value of NAIRU was estimated for 3Q 2008. In case of smoothing by 0.6 we obtained value of 13.4% and for τ 1 the value estimated was 13.9%. In this interval the declining rate of unemployment (from 5.9% in the 1Q 2008 to 5.3% in the 3Q 2008) was accompanied by a decceleration in growth of households´ consumption deflator (from 6.9 to 5.9%) and by consumers´ price index (from 7.4 to 6.7%). The change in trade off between unemployment and inflation was caused primarily by development of oil price (decline in year to year growth by 12.3 pp during the examined period), by development of import prices (deepening of year to

year decline by 1.1 pp) and by development of exchange rate CZK/EUR (higher appreciation pressures).

Absence of trade off between unemployment and households´ consumption deflator is demostrated by high gap (8.1 pp for smoothing by 0.6 and 8.6 pp for smoothing by 1). In the environment of anticipated expectations this absence of trade off is similar to the development in 1999 when the NAIRU highly above the real rate of unemployment (caused by a lower rate of unemployment in the current period than in the previous period and mapped thanks to the applying of a higher coefficient of smoothing than is the commonly recommended value) signaled the presence of non stable environment and structural changes in the economy leading to increase of NAIRU value in the near future. Increased values of NAIRU in 1999 were related to acceleration in restructuring of the Czech economy and in 2008 it can be a consequence of spreding of global financial and economic crisis to the Czech labour market and to the real economy in general. Possible changes in labour market were signaled already by HP filter when the HP filter estimated unemployment gap for 3Q 2008 at 0,5 pp and therefore showed possible shift from boom phase of economic cycle towards recession in labour market.

In case of **Slovakia** the values of NAIRU after smoothing by 0,6 were lying between -3.3 and +25.3% and after smoothing by 1,0 the values were lying between -2.9 and + 25.8%. Negative values of NAIRU estimated by Kalman filter with a higher smoothing coefficient signaled a non stable environment with structural shifts in the Slovak labour market in the interval between 3Q 2000 and 2Q 2001. The restructuring of the Slovak economy from 1999 can be considered decisive factor for the described development. Apart from it, in this period there were high fluctuations in oil prices (year to year increase by 73.5% in 2000 and, on the other hand, 13.2% decline in 2001), exchange rate fluctuations (depreciation was followed by appreciation). There was also a decline in growth dynamics of import prices.

Due to instability in trade off between 2Q 2003 ane 2Q 2004 the values of NAIRU increased significantly. Simultaneous increase of unemployment rate and households´ consumption deflator in 2004 comparing with 2003 was due to factors exogenous to labour market, such as significant increase in year to year dynamics of oil price growth. The instability of economic environment was reflected in an increase of excess of NAIRU above the real rate of unemployment which in the 4Q 2003 acqiured value of 7.9 pp after smoothing by 0.6 and 8.4 pp for smoothing by 1.

Real economy variables development in 3Q 2008 did not signal unstable environment nor structural shifts which could increase the NAIRU value in the next period. Unemployment gap values (average between 1Q and 3Q 2008 was 2.1 pp resp. 2.6 pp) are similar to the values in other intervals of the examined period. Only increase in dynamics of quarter to quarter growth in unemployment gaps can be considered a significant signal in labour market. Possible changes in labour market were signaled also by HP filter when the HP filter confirmed excess of real rate of unemployment above NAIRU in 3Q 2008 and therefore showed possible shift from boom phase of economic cycle towards recession in labour market.

In case of **Hungary** the values of NAIRU after smoothing by 0,6 were lying between -8.3 and +12.9% and after smoothing by 1 between -6.3 and +12.4%. Kalman filter estimated negative values of NAIRU between 1Q and 3Q 2002. During this interval the characteristics of trade off between unemployment and households´ consumption deflator changed. Main factors influencing this change were exchange rate HUF/EUR, oil price and import prices. Unemployment rate (real unemployment rate exceeded NAIRU) was lying between 8.9 pp (smoothing by 0.6) or 6.8 pp (smoothing by 1) and 13.9 pp or 11.9 pp respectively.

Highest values of NAIRU from the whole examined period were found between 1Q and 4Q 2007. Average value of NAIRU after smoothing by 0.6 amounted to 12.2% and after smoothing by 1 amounted to 11.8%. The rate of unemployment stagnated more or less at the level of 2006 (7.5% in 2006 and 7.4% in 2007), but was accompanied by a significant increase in growth dynamics of households´ consumption deflator (from 3.4 to 6.4%). The change in trade off between unemployment and households´ consumption deflator was caused mainly by oil price (Brent) development. Also the gap of unemployment (excess of NAIRU above the real rate of unemployment) increased in this period up to its average value of 4.7 pp (smoothing by 0.6) or to 4.4 pp (smoothing by 1) and signaled the presence of an unstable environment in the labour market and probable future structural shifts. During 3Q 2008 the NAIRU really decreased under the level of real rate of unemployment. In the labour market was therefore evident the impact of the global financial and economic crisis. The hypothesis telling that the gap of only 0.09 pp signaled possible depletion of boom pfase and start of recession phase in 4Q 2008 or at the beginning of 2009 from HP filter analysis was confirmed.

In case of **Poland** the values of NAIRU estimated by Kalman filter after smoothing by 0,6 were lying between -19.2 and +31.7% and after smoothing by 1 between -2.8 and +22.4%. Kalman filter signaled for Poland a non stable environment with structural shifts for the period between 1Q and 4Q 2001. Negative values of NAIRU were result of domestic economy restructuring (GDP growth in 2001 decreased by 3.2 pp comparing with the growth dynamics in 2000) and of oil price fluctuations (year on year increase of 73.5% in 2000 was followed by a year on year decrease of 13.2%) and import prices fluctuations (year on year increase of 7.9% in 2000 was followed by a year on year decrease to 1.3% in 2001).

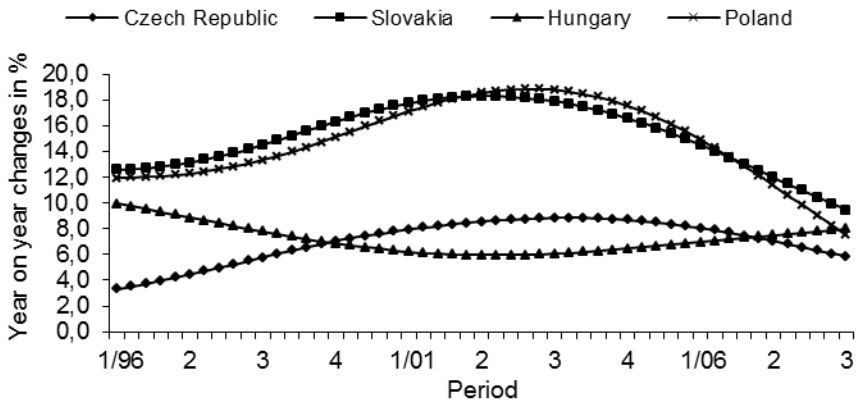
Highest values of NAIRU from the whole examined period were found between 1Q and 4Q 2004. These values were higly influenced by the implemented restructuring of the domestic economy in the previous period, oil price fluctuations (significant acceleration of year on year growth) and exchange rate PLN/EUR development (year on year decrease of depreciation intensity). The instability of economic environment was represented by a sharp shift from long lasting recession towards a short boom phase in the labour market. The NAIRU exceeded the real rate of unemployment in the 4Q by up to 12.7 pp (smoothing by 0.6).

Similarly high values of unemployment gap and related signals of possible structural shifts in the labour market in next periods (this time caused by global financial and economic crisis) can be observed also from 2Q 2007 till the end of the examined

period, that is 3Q 2008. During this interval the NAIRU exceeded the real rate of unemployment on average by 11.1 pp (for smoothing by 0.6) and by 6.9 pp (for smoothing by 1). Deduction of structural shifts in the economy on basis of anticipated expectations is in conformity with conclusions of HP filter, which predicted labour market shift into the recession phase at the end of 2008 or at the beginning of the following year on basis of gradual depletion of excesson NAIRU over the real rate of unemployment.

Chart 4

NAIRU Development Obtained from HP Filter in Countries of V4



Source: Authors´ calculation based on data obtained from the Czech Statistical Authority and from OECD.
http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls,
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

In the last part of our analysis we estimate the NAIRU varying in time by means of **HP filter**. λ value was set at standardly recommended value for quaterly data (e.g. in the conditions of the Czech Republic this smoothing was also used by Hájek and Bezděk, 2000), which is 1600. The beginning of time series for unemployment rate was set in 1993. Real values were completed by authors´ own prediction of unemployment rate for 2010.

In case of the **Czech Republic** the values of estimated NAIRU were lying between 2 and 8.8%. Real rate of unemployment was below the NAIRU in the following periods: 2Q 1995 – 3Q 1998, 2Q 2001 – 2Q 2003 and finally from 4Q 2006 till 3Q 2008. In 3Q 2008 the excess of NAIRU above the real rate of unemployment amounted to only 0.5 pp.

In Slovakia the HP filter estimated the NAIRU in the interval between 9.4 and 18.3%. From 2Q 2006 till 2Q 2008 the real rate of unemployment decreased below the NAIRU and the labour market was in the boom phase. In 3Q 2008 the real rate of unemployment exceeded the NAIRU and the labour market shifted into the recession phase (the gap of unemployment amounted to 0.28 pp).

The NAIRU in **Hungary** was estimated by means of this methodology between 5.9 and 10.8%. From 1Q 2005 starts the recession phase, from 2Q 2007 comes the phase of soft boom with growing inflation pressures in the economy. The peak of this phase is in 4Q 2007 (gap of unemployment amounted to 0.29 pp). In 3Q 2008 the gap amounted to only 0.09 pp and signaled gradual depletion of this positive phase and shift into recession phase caused by global financial and economic crisis in 4Q 2008 or at the beginning of 2009.

In case of **Poland** the HP filter estimated NAIRU in the interval between 7.5 and 18.8%. From 1Q 2001 till 1Q 2007 the real rate of unemployment was exceeding the NAIRU and resulted in desinflationary pressures. In the last part of the examined period the economy was in the boom phase with peak in 4Q 2007 and weakening afterwards. Given that the gap in 3Q 2008 amounted to only 0.29 pp, it is possible to expect a shift to recession phase in the labour market in the near future.

5. Summary of Findings

Our analysis of NAIRU can be a variant of ways of looking at the labour market. From the used methods this problem is best described by the Kalman filter and the HP filter.

Kalman filter (with a higher coefficient of smoothing than is the commonly recommended value) in our analysis succeeded in capturing the non stable environment in the labour market and in the whole economy. Sources of instability and eventual changes in labour market can include for example the restructuring of the economy (case of the Czech Republic, Slovakia and Poland), change in nature of trade off between unemployment rate and households´ consumption deflator caused by factors exogenous to the labour market (impact of exchange rate HUF/EUR, oil price and import prices in Hungary) or by the global financial and economic crisis (case of the Czech Republic or Hungary). The instability of economic environment is represented, for example, by negative values of NAIRU (case of the Czech Republic in 1999 and 2008, Slovakia in 2003 and 2004, Hungary in 2007 and Poland in 2004 and turn of 2007 and 2008).

On basis of our analysis we can also draw conclusion that findings about non stable environment in past can be used, under condition of anticipated expectations environment, to the support of hypothesis that the non stable environment is present in the labour market at the end of the examined period. We can, for example, observe a parallel between high gap of unemployment in 1999 (result of the restructuring of the economy) and between 1Q and 3Q 2008 in the Czech Republic (result of global financial and economic crisis spreading into the Czech labour market and into the Czech real economy). In case of Poland we can use experience from years 2001 and 2004 for estimation of development in 2007 and 2008. While in 2001 and 2004 the unemployment gap can be explained by the restructuring of the economy and by factors exogenous to the labour market (mainly oil price), in turn of 2007 and 2008 it could signal the spreading of global financial and economic crisis to the labour market.

Kalman filter can be used also for testing of time leading between labour market development in various countries and consequently for short term prediction making. As an example of such a leading indicator we can name the development of gap at the end of examined period in the Czech Republic and Hungary. While the last boom phase in the Czech Republic started already in 1Q 2006, in Hungary and in Poland the start was delayed by one year to 1Q 2007. On the other hand the impact of global financial and economic crisis was estimated by Kalman filter only in case of Hungary. Kalman filter estimated the start of recession phase in 2Q 2008 using smoothing by 1,0 or in 3Q 2008 using smoothing by 0,6. In other countries Kalman filter did not succeed in predicting the start of recession phase at the end of examined period.

HP filter results support, according to our labour market analysis, the hypothesis resulting from Kalman filter. Gradual reduction in unemployment gap derived by HP filter indicates a forthcoming change in business cycle phases. This is the case of the Czech Republic and Poland where in 3Q 2008 the gap of unemployment decreased up to 0.5 pp and up to 0,3 pp. In one case the HP filter succeeded in predicting the business cycle phases change even sooner than the Kalman filter did. This is the case of Slovakia in 3Q 2008. HP filter predicted for this period the start of the recession phase, but Kalman filter with neither smoothing succeeded to predict the impact of global financial and economic crisis at the end of the examined period.

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http://www.czso.cz/csu/csu.nsf/i/tab_zam/$File/czam070211cr.xls
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http://www.czso.cz/csu/redakce.nsf/i/ceny_vd_ekon
Czech National Bank
Exchange rates
http://www.cnb.cz/cs/financni_trhy/devizovy_trh/kurzy_devizoveho_trhu/denni_kurz.jsp
OECD
Economic Outlook NO. 85 Annex Tables – Table of Contens
http://www.oecd.org/document/61/0,3343,en_2649_34573_2483901_1_1_1_1,00.html

Annex 1

Survey of Parameters, P-Values and Selected Characteristics of Models in Part 4.1 (One-Equation Model)

Name of the method	Parameter of the model	Value	P-value	Selected charact. of the model		
				R-squared	Durbin-Watson stat.	Prob (F-stat)
Czech Republic						
	Constant	10,53	0,00			
	Rate of unemployment (t-1)	-1,09	0,00			
	Consumption deflator (t-1)	0,43	0,00			
	Exchange rate (t)	0,21	0,00			
	Exchange rate (t-3)	0,23	0,01			
	Characteristics of the model			0,73	1,52	0,00
Slovakia						
	Constant	4,98	0,06			
	Rate of unemployment (t)	-0,30	0,07			
	Consumption deflator (t-1)	0,61	0,00			
	Exchange rate (t-1)	0,16	0,03			
	Characteristics of the model			0,56	1,67	0,00
Hungary						
	Constant	1,25	0,10			
	Rate of unemployment (t-9)	-0,35	0,10			
	Consumption deflator (t-1)	0,42	0,02			
	Oil price (t)	0,02	0,01			
	Characteristics of the model			0,50	2,00	0,00
Poland						
	Constant	0,92	0,10			
	Rate of unemployment (t)	-0,14	0,10			
	Consumption deflator (t-1)	0,49	0,00			
	Oil price (t)	0,02	0,10			
	Import prices (t)	0,24	0,05			
	Characteristics of the model			0,51	1,73	0,00

Source: Authors´ calculation of parameters based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.

Annex 2

Survey of Parameters, P-Values and Selected Characteristics of Models in Part 4.2 (Break Model)

Name of the method	Parameter of the model	Value	P-value	Selected charact. of the model		
				R-squared	Durbin-Watson stat.	Prob (F-stat)
Czech Republic						
1. interval	Constant	3,22	0,10			
	Rate of unemployment (t-1)	-0,90	0,06			
	Consumption deflator (t-1)	0,56	0,01			
	Exchange rate (t)	0,30	0,02			
	Characteristics of the model			0,81	1,67	0,00
2. interval	Constant	13,80	0,07			
	Rate of unemployment (t-1)	-1,48	0,10			
	Consumption deflator (t-1)	0,25	0,10			
	Exchange rate (t)	0,27	0,01			
	Exchange rate (t-3)	0,30	0,00			
	Characteristics of the model			0,85	2,00	0,00
3. interval	Constant	43,76	0,03			
	Rate of unemployment (t-1)	-4,90	0,03			
	Consumption deflator (t-1)	0,81	0,05			
	Exchange rate (t)	0,37	0,06			
	Exchange rate (t-3)	0,51	0,02			
	Characteristics of the model			0,99	2,00	0,02
4. interval	Constant	17,05	0,00			
	Rate of unemployment (t-1)	-2,12	0,00			
	Import prices (t-1)	0,62	0,05			
	Characteristics of the model			0,75	1,98	0,00
Slovakia						
1. interval	Constant	12,29	0,10			
	Rate of unemployment (t-1)	-0,97	0,10			
	Exchange rate (t-2)	0,62	0,09			
	Oil price (t)	0,03	0,07			
	Characteristics of the model			0,88	1,56	0,03
2. interval	Constant	16,55	0,10			
	Rate of unemployment (t)	-1,18	0,10			
	Exchange rate (t-2)	0,64	0,04			
	Import prices (t-5)	0,22	0,05			
	Characteristics of the model			0,90	1,99	0,05
3. interval	Constant	34,88	0,05			
	Rate of unemployment (t-1)	-1,90	0,05			
	Oil price (t-2)	0,05	0,09			
	Characteristics of the model			0,82	1,96	0,01
4. interval	Constant	19,97	0,10			
	Rate of unemployment (t-3)	-1,20	0,10			
	Consumption deflator (t-1)	0,71	0,01			
	Characteristics of the model			0,84	2,00	0,01
5. interval	Constant	-21,26	0,06			
	Rate of unemployment (t-2)	1,57	0,05			
	Characteristics of the model			0,76	1,95	0,05
6. interval	Constant	42,48	0,01			
	Rate of unemployment (t)	-4,22	0,01			
	Import prices (t-3)	0,30	0,10			
	Characteristics of the model			0,90	2,00	0,00
Hungary						
1. interval	Constant	49,37	0,10			
	Rate of unemployment (t-7)	-5,43	0,09			
	Exchange rate (t)	0,11	0,03			
	Oil price (t)	0,05	0,10			

	Characteristics of the model			0,96	1,81	0,07
2. interval	Constant	36,57	0,00			
	Rate of unemployment (t-1)	-5,39	0,00			
	Exchange rate (t)	0,12	0,02			
	Characteristics of the model			0,94	2,00	0,00
3. interval	Constant	29,58	0,03			
	Rate of unemployment (t-8)	-4,86	0,02			
	Oil price (t-2)	0,07	0,01			
	Characteristics of the model			0,62	1,98	0,02
4. interval	Constant	43,02	0,08			
	Rate of unemployment (t-3)	-6,08	0,10			
	Exchange rate (t-6)	1,56	0,03			
	Characteristics of the model			0,96	2,00	0,05
5. interval	Constant	23,49	0,10			
	Rate of unemployment (t-8)	-4,12	0,10			
	Characteristics of the model			0,59	1,95	0,09
6. interval	Constant	30,28	0,10			
	Rate of unemployment (t-2)	-4,02	0,10			
	Exchange rate (t-4)	0,39	0,01			
	Characteristics of the model			0,73	2,00	0,02
Poland						
1. interval	Constant	-22,36	0,01			
	Rate of unemployment (t-6)	1,67	0,02			
	Oil price (t-1)	0,05	0,01			
	Characteristics of the model			0,86	2,00	0,01
2. interval	Constant	-30,33	0,01			
	Rate of unemployment (t-1)	1,43	0,01			
	Characteristics of the model			0,51	1,56	0,01
3. interval	Constant	-79,42	0,02			
	Rate of unemployment (t-5)	4,14	0,02			
	Characteristics of the model			0,62	2,00	0,02
4. interval	Constant	4,13	0,00			
	Rate of unemployment (t)	-0,34	0,00			
	Characteristics of the model			0,80	1,83	0,00

Source: Authors´ calculation of parameters based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.

Annex 3

Survey of Parameters, P-Values and Selected Characteristics of Models in Part 4.3 (Kalman Filter)

Name of the method	Parameter of the model	P-value	P-hodnota	Selected charact. of the model	
				R-squared	Durbin-Watson stat.
Czech Republic					
Smoothing (0,6)	Constant	9,52	0,00		
	Rate of unemployment (t-2)	-0,71	0,00		
	Consumption deflator (t-2)	0,31	0,00		
	Exchange rate (t-2)	0,32	0,00		
	Import prices (t)	0,29	0,00		
	Characteristics of the model			0,90	2,00
Smoothing (1,0)	Constant	10,41	0,00		
	Rate of unemployment (t-1)	-0,75	0,03		
	Exchange rate (t-2)	0,33	0,00		
	Import prices (t)	0,18	0,05		
	Characteristics of the model			0,92	1,98
Slovakia					
Smoothing (0,6)	Constant	3,81	0,01		
	Rate of unemployment (t-4)	-0,31	0,00		
	Consumption deflator (t-1)	0,48	0,00		
	Oil price (t-6)	0,03	0,01		
	Characteristics of the model			0,80	1,58
Smoothing (1,0)	Constant	4,85	0,00		
	Rate of unemployment (t-4)	-0,38	0,00		
	Consumption deflator (t-1)	0,42	0,00		
	Oil price (t-6)	0,03	0,00		
	Characteristics of the model			0,89	1,55
Hungary					
Smoothing (0,6)	Constant	1,51	0,10		
	Rate of unemployment (t-11)	-0,21	0,10		
	Consumption deflator (t-1)	0,30	0,10		
	Characteristics of the model			0,51	1,99
Smoothing (1,0)	Constant	2,28	0,10		
	Rate of unemployment (t-8)	-0,32	0,10		
	Consumption deflator (t-1)	0,26	0,10		
	Characteristics of the model			0,51	2,00
Poland					
Smoothing (0,6)	Constant	1,67	0,10		
	Rate of unemployment (t-2)	-0,09	0,10		
	Consumption deflator (t-1)	0,44	0,10		
	Characteristics of the model			0,63	1,95
Smoothing (1,0)	Constant	4,29	0,00		
	Rate of unemployment (t-3)	-0,34	0,01		
	Import prices (t)	0,29	0,01		
	Characteristics of the model			0,93	2,01

Source: Authors´ calculation of parameters based on data obtained from the Czech National Bank, Czech Statistical Authority and from OECD.