Lajos Tamás Szabó

Estimates of the Non-accelerating Inflation Rate of Unemployment (NAIRU) for Hungary

MNB Working Papers 5

2015

Lajos Tamás Szabó

Estimates of the Non-accelerating Inflation Rate of Unemployment (NAIRU) for Hungary

MNB Working Papers 5

2015

MNB Working Papers 5

Estimates of the Non-accelerating Inflation Rate of Unemployment (NAIRU) for Hungary*

(Az inflációt nem gyorsító munkanélküliségi ráta (NAIRU) becslése Magyarországra)

Written by Lajos Tamás Szabó

Budapest, December 2015

Published by the Magyar Nemzeti Bank

Publisher in charge: Eszter Hergár

Szabadság tér 9., H-1054 Budapest

www.mnb.hu

ISSN 1585-5600 (online)

*I am indebted to Gábor Pellényi and István Kónya for their helpful comments and suggestions. I am also grateful to Balázs Kertész for his useful comments on programming. Any remaining errors are my own.

”their days on a gloomy string,

on the endless rope they swing

as torn shirts in the smoky wind,

once they were out on a pin,

will never again be taken in.”

Weöres: Unemployed[1] (excerpt)

[1] This is a rough translation of the poem, not made by a literary translator.

Contents

Abstract

Labour market tightness, that is the ratio of jobs to the unemployed, has an impact on wage setting, which also affects inflation. Among other things, the unemployment gap, which is the difference between unemployment rate and non-accelerating inflation rate of unemployment (NAIRU), is used to measure inflationary pressure from the labour market. This paper examines which of the NAIRU estimation methods described in the literature can be applied to Hungary. In evaluating the results, the revisional property of the NAIRU is also examined, as well as the forecast capacity of the unemployment gap with regard to wages. Based on these, the model containing the tightness indicator performs the best. This is notable from a forecasting perspective, because the vast majority of estimates in the literature use wages to provide an estimate of the unemployment gap. Therefore, an indicator which does not use wages at all to estimate the unemployment gap performs the best in forecasting wage growth. Based on the estimation the NAIRU has decreased in recent years. Of the factors affecting the NAIRU, the variables describing the general macro environment (total factor productivity, long-term unemployed, number of persons employed in construction, risk premium) have considerablely contributed to the decrease in the NAIRU, which may have been complemented by changes in labour market institutions. Based on the literature, the latter may be useful when explaining the differences between countries. For the estimation of these factors' effects (e.g. decrease in the tax wedge, transformation of the unemployment benefit system etc.) further research is necessary. Within the framework of the sensitivity analysis, if the groups which are loosely linked to the labour market (e.g. discouraged workers) are also regarded as part of the free labour force capacity, the view of the tightness of the labour market (the unemployment gap) does not change. However, the results are sensitive to the assumption made about the labour market status of fostered workers.

JEL: E24, J21, J69.

Keywords: NAIRU, unemployment, wages, vacancies.

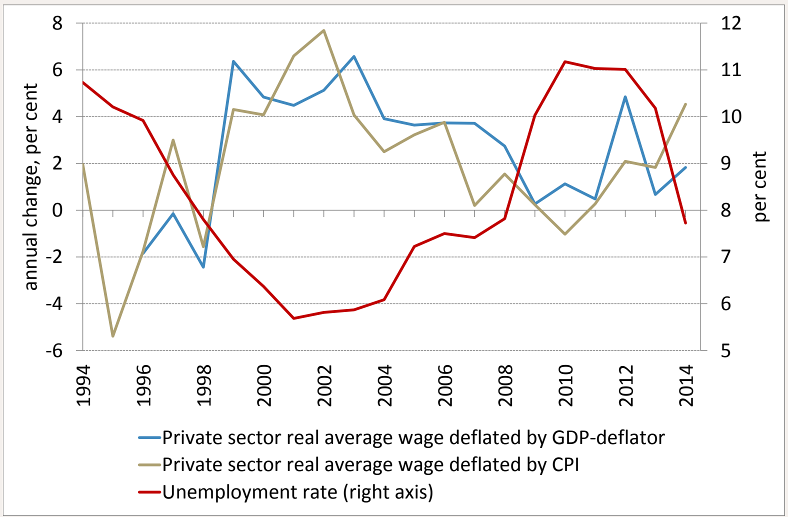
Összefoglaló

A munkapiaci feszesség, vagyis az álláshelyek és a munkanélküliek aránya hatással van a bérezésre, ami az inflációt is befolyásolja. A munkapiac felől érkező inflációs nyomás mérésére szolgál többek között a munkanélküliségi rés, ami a munkanélküliségi ráta és az inflációt nem gyorsító munkanélküliségi ráta (NAIRU) különbsége. Tanulmányomban megvizsgálom, hogy az irodalomban található NAIRU becslési eljárások közül melyek alkalmazhatók Magyarországra. A kapott eredmények kiértékelése során a NAIRU revíziós tulajdonságát és a munkanélküliségi rés bérekre vonatkozó előrejelzési képességét is vizsgálom. Ezek alapján a feszességi mutatót tartalmazó modell teljesít a legjobban. Előrejelzési szempontból ez azért is figyelemre méltó, mert az irodalomban található becslések nagy többsége valamilyen formában felhasználja a béreket a munkanélküliségi rés becsléséhez. Így egy olyan mutató teljesít a legjobban a bérek előrejelzését tekintve, ami a béreket egyáltalán nem használja fel a munkanélküliségi rés becsléséhez. A becslés alapján a NAIRU csökkent az utóbbi években. A NAIRU-t befolyásoló tényezők közül hazánkban az általános makrokörnyezetet (teljes tényező termelékenység, hosszú távú munkanélküliek, építőiparban foglalkoztatottak száma, kockázati prémium) leíró változók érdemben hozzájárulhattak a NAIRU csökkenéséhez, amit egyes munkapiaci intézményi változások kiegészíthettek. Az irodalom alapján ez utóbbiak hasznosnak bizonyulnak az országok közötti eltérések magyarázatában. Az egyes tényezők (pl. adóék csökkenése, munkanélküli segélyezés átalakítása) pontos hatásának becsléséhez további vizsgálatok szükségesek. Érzékenységi vizsgálat keretében, ha a munkapiachoz lazán kötődő csoportokat (pl. reményvesztett munkanélküliek) is a szabad munkaerő-kapacitás részének tekintem, nem változik a munkapiac feszességéről (a munkanélküliségi rés) alkotott kép. Azonban az eredmények érzékenyek arra, hogy milyen feltevéssel élünk a közfoglalkoztatottak munkapiaci státuszáról.

1 Introduction

In Hungary, unemployment and the growth rate of real wages in the private sector moved in opposite directions since the 1990s. From the mid-90s until the millennium, the unemployment rate decreased considerably and in parallel with that the real wage growth rate accelerated. The unemployment rate stagnated for a couple of years after the millennium and then gradually increased, while the wage growth rate slowed. After the crisis of 2008, the unemployment rate increased significantly, rising from its pre-crisis level of around 8 per cent to above 11 per cent. Starting from 2013, there was a massive decrease in the unemployment rate, which fell to close to 7 per cent by the end of 2014 (Figure 1). The growth rate of real wages in the private sector decelerated after 2008 compared to the previous years. One exception to this was the temporary acceleration due to the minimum wage increase in 2012. Thus, unemployment came close to the pre-crisis level, while the real wage growth rate has not yet reached it. According to economic theory, there is a level of unemployment that is accompanied by stable price and wage dynamics; this is what we refer to as the non-accelerating inflation rate of unemployment (NAIRU) or the non-accelerating wage rate of unemployment (NAWRU). However, the level of this may change over time. For the purpose of central bank decisions, it is important to understand the magnitude of such change and the factors influencing it.

Figure 1
Unemployment rate and annual index of the private sector real gross average wage



In the New Keynesian Model, inflation is determined by the nominal (price and wage) rigidities present in the economy. The NAIRU is the level of unemployment that is determined by real economy factors – in the absence of nominal rigidities this would be the level of unemployment. The concept of the NAIRU determined by the real factors comes, amongst others, from Friedman (1968). Consequently, according to the New Keynesian Model, the difference between current unemployment and the NAIRU is influenced by nominal rigidities, primarily wage rigidity. For example, during an economic downturn, due to the downward rigidity of wages, companies are not able to reduce wages at the rate that would be justified by their declining profitability; therefore they are compelled to reduce the number of employees. Then unemployment increases, and thus the unemployment gap may become positive. With declining demand for workforce, the competition among companies for potential employees will lessen, which results in lower wages for new entrants.

Based on the above train of thought the unemployment gap (the difference between actual unemployment and NAIRU) may help forecast the future development of wages and thus support the monetary policy decision-making. Ball and Mankiw (2002) also point this out and believe that the most fundamental objective of the NAIRU estimate is to provide decision-makers with a forecasting tool. If the unemployment rate exceeds the NAIRU, i.e. the unemployment gap is positive, there is no inflationary pressure or it is negligible. If the unemployment gap is negative, the labour market may exert inflationary pressure.

In Section 2 of this paper, the various conceptual definitions of the NAIRU and the most widely-used estimation methods are briefly reviewed, and estimates of the Hungarian NAIRU are also described. In Section 3, the results based on the evolution of revision and their ability to help forecast wages are compared. Section 4 presents an examination of how the results are affected if the free labour force capacity is expanded to include groups which are loosely tied to the labour market. A review of the factors explaining the change of the NAIRU in Hungary is found in Section 5. Section 6 summarises the results.

The NAIRU derived by the model using the labour market tightness provides a good identification of the labour market processes during the period under review. This NAIRU also performed the best on the basis of its revisional property evaluated on the whole sample and its out-of-sample forecast capacity of wages. Of the factors mentioned in the literature, the variables related to economic activity may influence the development of the Hungarian NAIRU.

2 Concept and measurement of NAIRU

NAIRU, NAWRU (non-accelerating wage rate of unemployment) and the structural unemployment rate are all concepts which are close to each other, but the definition of the concepts is not always accurate. These concepts help explain the labour market processes and the link between unemployment and inflation. However, none of these rates can be observed directly; the development of such may be identified with the assistance of estimates ensuing from the economic hypothesis. In the following, these concepts and the link between them are defined, based on the literature.

Friedman (1968) discusses the unemployment rate which is determined by the structural factors of the commodity and labour market, and at which the growth rate of real wages is in equilibrium. Gordon (1997) identifies this with the NAIRU, deduced from the triangle model of inflation. In that model, the explanatory variables are the lag of inflation (persistence of the model), the demand (variables: output and unemployment gap) and the supply. The purpose of the model is to forecast inflation relying on the unemployment gap. The approach of Gordon (1997) is also used by Driver et al. (2006). According to Orlandi (2012), the structural unemployment rate is the level of the unemployment rate that characterises the economy in the long run, without shocks. Richardson et al. (2000) add to this that it is the rate that has already fully adjusted to all supply and decision-making impacts, including also those that have long-term effects. The structural unemployment rate is determined by those institutional and fiscal factors that affect the reservation wage. There is no consensus in the literature as to the degree of institutional factors' impact on the structural unemployment rate (the key factors are included in Section 5, the development of which is also examined for Hungary).

Richardson et al. (2000) draw a distinction between the NAIRU and the short-term NAIRU. The NAIRU is the rate towards which unemployment converges in the absence of short-term shocks. The short-term NAIRU is the unemployment rate at which the inflation rate stabilises at the current level in the next period. The short-term NAIRU is dependent on the NAIRU specified above, but is more volatile as it is influenced by all supply effects (short-term ones as well). Several authors (e.g. Daly et al. (2012), Guichard and Rusticelli (2011), Irac (2000), etc.) do not differentiate these latter two concepts so distinctly; they only state that the NAIRU is the unemployment rate at which inflation remains constant. In this paper, this latter approach is used.

Orlandi (2012) links the structural unemployment to wage inflation rather than to inflation. Accordingly, he explains the development of the NAWRU, i.e. the non-accelerating wage rate of unemployment, estimated by the European Commission. Thus, the NAWRU and the NAIRU are two concepts that are extremely close to each other. Orlandi (2012) argues that due to difficulties involved in the estimation of the structural unemployment rate, it is more expedient to use the NAIRU for the approximation of the structural unemployment rate. Or simply, the NAIRU should be regarded as the structural unemployment rate (e.g. Ball and Mankiw (2002), D'Auria et al. (2010), Gianella et al. (2008), Gordon (1997), Kajuth (2014)).

2.1 ESTIMATING NAIRU

Based on the literature, the NAIRU may be estimated with the use of both macro and micro data. Based on macro data NAIRU may be estimated using three key approaches. From the equilibrium of a structural model, the NAIRU can be deduced as the function of labour and commodity market variables. In this framework, the equations describe both pricing and wage setting decisions. Based on Gianella et al. (2008), this approach is appealing, but it is difficult to measure a number of explanatory variables in it, which – based on the theory – would be worth including in the model. Thus, it may become difficult to estimate the model.

The next approach is the estimation purely by statistical tools. In this case, only the unemployment rate is used and the NAIRU is identified by a number univariate filters (e.g. Hodrick-Prescott filter). This method is easy to implement, but as it was also pointed out by Fabiani and Mestre (2000), this feature is also its disadvantage: it ignores the interaction between unemployment and other variables.

The third method is the mixture of the previous two. Here, various relationship(s), determining unemployment and inflation, are stated (e.g. Phillips curve, Okun's law), but the model does not describe the functioning of the whole economy. Similarly to the statistical estimation procedures, various constraints are applied to the NAIRU or the unemployment gap. In this framework, the NAIRU is estimated by the Kalman filter. This method is used also by, among others, Driver et al. (2006) . Based on summary prepared by Gianella et al. (2008), of the various approaches this latter one proved to be the most popular and achieved the best results, as it is transparent and easy to estimate, but at the same time it also uses the theoretical definition of the concept of the NAIRU (the unemployment rate at which inflation is stable). In this paper, these two latter methods are used for the estimation of the NAIRU.

Anosova et al. (2013) is an example for the estimation based on micro data; they break down unemployment by industries and employment groups. The change in the unemployment rate can be decomposed as the change in the unemployment rate of the individual groups and the weight of the groups. The change in the weight of the group is structural, while the rate change is cyclical. Tasci (2012) also estimated structural unemployment relying on micro data, i.e. the unemployment flows. However, estimates based on micro data are not discussed in this paper.

2.2 METHODOLOGY

Two of the estimation methods presented in Section 2.1 are used. One of them is a purely statistical tool, the Hodrick-Prescott filter, while the other one is the Kalman filter, used for the semi-structural approach. For the detailed methodology of the Kalman filter see Hamilton (1994).

Relying on the Kalman filter we can optimally estimate a non-observed (or inaccurately measured) variable. This means that if the noise (measurement error) is of normal distribution, the Kalman filter minimises the mean square error of the estimated variable. If the noise is not of normal distribution, then under the given average and variance the Kalman filter provides the best linear estimation. In our case, the observed variable is typically the unemployment rate, which is an "inaccurate measurement" of the NAIRU.

The estimation is performed by a state-space model, which includes two equations. The observation (signal) equation describes the relationship between the observable and non-observable variables. In our case, this is typically the decomposition of the unemployment rate into the sum of NAIRU and the unemployment gap. The Phillips curve and the Beveridge curve, as well as the equation explaining the long-term unemployment are also observation equations. The transition (state) equations describe the non-observed variables. An example of this in the estimates is when the unemployment gap depends on the deviation of the tightness from the average. During the estimation, the volatility of NAIRU may be influenced by the variance of the error terms in relation to each other. Gordon (1997) argues that the underlying economic processes change slowly in time, and thus the estimated time series (e.g. potential output, NAIRU) are relatively smooth. However, as also noted by Driver et al. (2006) and Ball and Mankiw (2002), there is no commonly accepted rule as to the basis for the selection of the proper ratio.

In total, 7 models are estimated, with the Kalman filter used in 6 of these. The first one is constructed with the Hodrick-Prescott filter. In the second one, the Phillips curve is used; this includes the unemployment gap. In the third model, the unemployment gap depends on the deviation of the tightness from its average. In the fourth model, the Phillips curve is used again, in addition to the tightness. The fifth model includes the Beverdige curve, while the sixth model features both the Phillips curve and Beveridge curve. The seventh model includes the long-term unemployment rate.

2.3 THE DATA USED

The vast majority of the used data come from HCSO (see Appendix). The data related to the vacancies (monthly inflow of vacancies, unfilled vacancies at the end of the month, available vacancies during the month) come from the National Employment Service. The number of unfilled vacancies at the end of the month is available from 1993, while the monthly inflow of vacancies and available vacancies during the month are available from 1995. We have figures in subsidised – non-subsidised breakdown from 2000; this breakdown is not available between 1993 and 2000. For this latter period, the dynamics of the unfilled vacancies at the end of the month was appended to the time series of the non-subsidised unfilled vacancies, thus generating a time series for the period between 1993 and 2014. From 2000 to 2008, the dynamics of subsidised and non-subsidised jobs is very similar, as the number of subsidised jobs was relatively low. The differentiation of subsidised jobs from non-subsidised jobs is important, because in the case of a subsidised job (which may be in the form of reduced employer's social security contribution, tax allowance or even a public employment programme) the wage cost is lower, and thus the agreed wages are not shaped (entirely) by market conditions.

These data were used for the calculation of six different tightness indicators. The monthly inflow of vacancies, unfilled vacancies at the end of the month and available vacancies during the month were divided by the unemployment and the active population. The results were not influenced materially by the type of the tightness indicator used in the models; therefore, the one available since 1993 was used.

The productivity is the quotient of the private sector's value added and the private sector's employment without the cross-border commuters from the Labour Force Survey (LFS).

2.4 ESTIMATION OF NAIRU WITH DIFFERENT MODELS

The equations of the models in general are as follows (except for the Hodrick-Prescott filter):

$$u = nairu + ugap \tag{1}$$

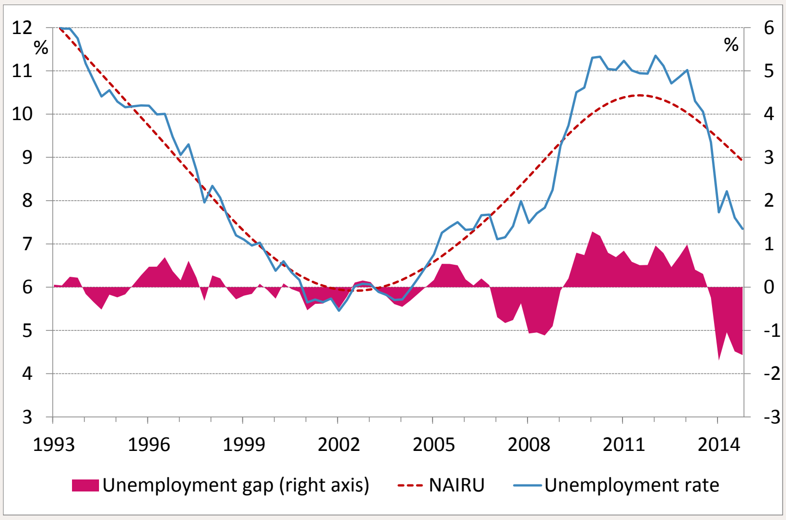
$$ugap = f(x_t) + \varepsilon \tag{2}$$

$$y = g(u_g, z) + \varepsilon \text{ or } y = g(nairu, z) + \varepsilon \tag{3}$$

where, e.g: x_t: tightness; y: inflation, wage, long-term unemployment; z: other variables. The detailed description of the models (except for the Hodrick-Prescott filter) is included in Table 1. Equation (1) is used in every models included in the table.

2.4.1 ESTIMATION WITH HODRICK-PRESCOTT FILTER

Figure 2
Estimation of the unemployment gap and the NAIRU with the Hodrick-Prescott filter



This is a widespread and commonly applied method for the various trend-gap decompositions. However, it does not use any other information for the estimation.

From the time profile of the unemployment gap it is difficult to make a conclusion with regard to the tightness of the labour market; before the crisis it fluctuates around zero, with minor swings, and then in 2007-2008 it takes a negative value, which suggests a tighter labour market. Between 2009 and 2013 it signals a slack labour market, followed by a swift tightening from 2014 (Figure 2). The conclusion that may be drawn from the unemployment gap does not differ materially, even if different lambda parameters are used; however the shape of the NAIRU changes.

In the next 6 models Kalman filter is used for the estimation of the NAIRU.

2.4.2 ESTIMATION WITH THE USE OF PHILLIPS CURVE

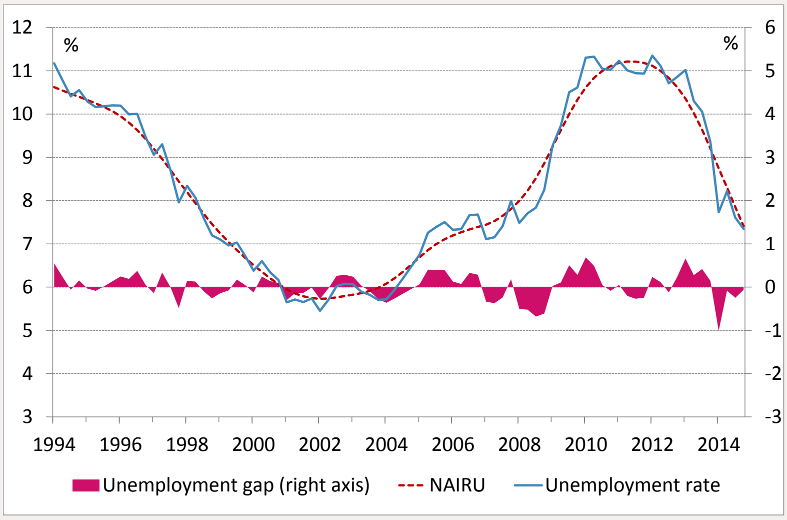
The Phillips curve is used by several authors (e.g.: Gordon (1997), Gianella et al. (2008)) for the estimation of the NAIRU. The Phillips curve links the unemployment gap and the wage setting or price setting. If the link is valid, we can draw conclusions with

Table 1
Equations of the models [a]

[a] Where u: unemployment rate, ugap: unemployment gap, utr: NAIRU, w: private sector wage (gross average wage), oil: oil price, t: tightness, u_l: long-term unemployment rate

Model	Equations explaining the unemployment gap (state equation)	Equations explaining the NAIRU (state equation)	Equations using the unemployment gap or the NAIRU as explanatory variable (signal equation)
(2)	$ugap = \beta_1 ugap_{-1} + \varepsilon_1$	$utr = 2utr_{-1} - utr_{-2} + \varepsilon_2$	$\Delta logw = \beta_2 + \beta_3 \cdot ugap + \beta_4 \cdot \Delta logw_{-1} + \beta_5 \Delta log(oil) + \varepsilon_3$
(3)	$ugap = \beta_6 (t - \bar{t}) + \varepsilon_4$	$utr = 2utr_{-1} - utr_{-2} + \varepsilon_5$	
(4)	$ugap = \beta_7 (t - \bar{t}) + \varepsilon_6$	$utr = 2utr_{-1} - utr_{-2} + \varepsilon_7$	$\Delta logw = \beta_8 + \beta_9 \cdot ugap + \beta_{10} \cdot \Delta logw_{-1} + \beta_{11} \Delta log(oil) + \varepsilon_8$
(5)	$ugap = \beta_{12} ugap_{-1} + \beta_{13} ugap_{-2} + \varepsilon_9$	$utr = utr_{-1} - g_{-1}$, $g = \beta_{14} g_{-1} + \varepsilon_{10}$	$log\left(\frac{100-u}{u}\right) = \beta_{15} + \beta_{16} utr + \beta_{17} t + \varepsilon_{11}$
(6)	$ugap = \beta_{18} ugap_{-1} + \varepsilon_{12}$	$utr = 2utr_{-1} - utr_{-2} + \varepsilon_{13}$	$log\left(\frac{100-u}{u}\right) = \beta_{19} + \beta_{20} utr + \beta_{21} t + \varepsilon_{14}$, $\Delta logw = \beta_{22} + \beta_{23} \cdot ugap + \beta_{24} \cdot \Delta logw_{-1} + \beta_{25} \Delta log(oil) + \varepsilon_{15}$
(7)	$ugap = \beta_{26} ugap_{-1} + \varepsilon_{16}$	$utr = 2utr_{-1} - utr_{-2} + \varepsilon_{17}$	$u_l = utr + \varepsilon_{18}$

Figure 3
Estimation of the unemployment gap and the NAIRU with the Phillips curve



regard to the unemployment gap indirectly from the wages or the prices. In the model presented in this paper, the development of the private sector's gross average wage is explained by its own lag, the oil price and the unemployment gap.

$$\Delta logw = \beta_2 + \beta_3 \cdot ugap + \beta_4 \cdot \Delta logw_{-1} + \beta_5 \Delta log(oil) + \varepsilon_3 \tag{4}$$

The results are similar to those obtained with the use of the Hodrick-Prescott filter (Figure 3). At the same time, from the development of the unemployment gap solid statements may be made even to a lesser extent about the tightness of labour market than in the case estimated by the Hodrick-Prescott filter.

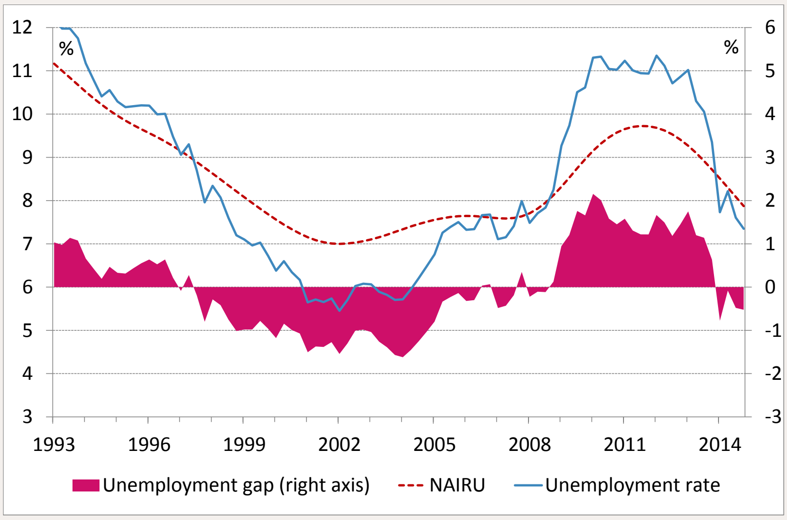
2.4.3 ESTIMATION WITH THE USE OF TIGHTNESS INDICATORS

For this method, the idea is taken from Dickens (2009); however, a simpler version of his equation is used, as an estimate very similar to this one is also estimated by Elkayam-Ilek (2013), which is presented in Section 2.4.5. In this framework, the empirical relation is used according to which there is an inverse link between vacancies and unemployment, which is referred to as the Beveridge curve. If the number of vacancies is high, unemployment is low, as the high demand reduces the free capacities in the labour market (naturally, it also may occur that despite the high labour demand the supply appears in different categories of skills). When unemployment is high and the vacancies are low, we talk about a slack labour market. This situation typically arises during the time of economic downturns. When unemployment is low and vacancies are high, the labour market is tight. The movements ensuing from the cyclical changes of the economy take place along the Beveridge curve; on the other hand, if structural changes occur (e.g. improving efficiency of labour market matching or the labour market regulations are substantially modified), the entire curve will shift. This latter one is the slower process; the cyclical changes can be characterised by the change in the proportion of the vacancies and the unemployment rate. Thus, the unemployment gap in the transition equation depends on the deviation of the tightness from the average:

$$ugap = \beta_6 \cdot (t - \bar{t}) + \varepsilon_6 \tag{5}$$

The underlying assumption of the equation is that the tightness has a long-term average and fluctuates around this. The key advantage of this estimate is that – in contrast to the commonly used methods mentioned in the literature – it uses neither a

Figure 4
Estimation of the unemployment gap and the NAIRU using tightness indicator



price nor a wage variable for the quantification of the unemployment gap, i.e. inflationary pressure from the labour market. Thus, in Section 3 an indicator which is calculated without reliance on wage trends can be used for the wage forecast.

Compared to the previous estimations, this yields an easy-to-interpret result. It can be seen on the available time horizon that starting from 1998 the unemployment gap is negative, i.e. the labour market has tightened, and the gap closed by 2006 and starting from the year of crisis the labour market stayed slack until mid-2014. In parallel with all this, starting from 2008, the NAIRU has gradually risen close to 10 per cent from its previous level of around 7 per cent (Figure 4).

2.4.4 ESTIMATION WITH THE USE OF THE TIGHTNESS INDICATOR AND THE PHILLIPS CURVE

The result of this estimation is almost completely the same as that of the previous one, both in terms of the time profile and the level of the NAIRU. The inclusion of the Phillips curve does not change the estimation result substantially.

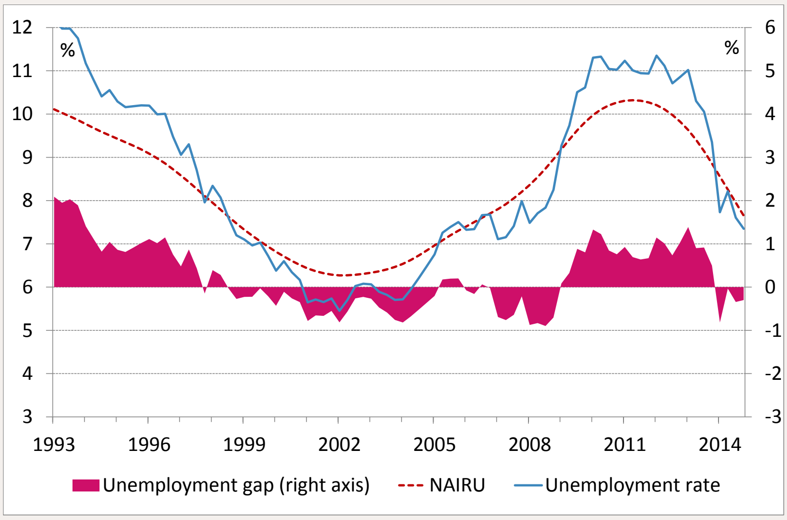
2.4.5 ESTIMATION WITH THE USE OF THE BEVERIDGE CURVE

The equations of Elkayam and Ilek (2013) are used for the estimation of the model. As a first step only the Beveridge curve is included in the Kalman filter. The Beveridge curve describes the link between the vacancies and unemployment. In times of recession, unemployment rises and the number of new jobs falls, while during the period of recovery the situation is the opposite; this is reflected by the negative slope of the curve. The estimate includes a realigned version of the curve; see the derivation at Elkayam and Ilek (2013) or Dickens (2009).

$$log\left(\frac{100-u}{u}\right) = \beta_{15} + \beta_{16}utr + \beta_{17}t + \varepsilon_{11} \quad (6)$$

This estimation also uses the tightness for the determination of the unemployment gap. It produces a similar result as the unemployment gap estimated by the tightness indicator; however, it shows the labour market tight around the millennium for a shorter period than the gap calculated with the tightness indicator (Figure 5).

Figure 5
Estimation of the unemployment gap and the NAIRU using the Beveridge curve



2.4.6 ESTIMATION WITH THE USE OF THE BEVERIDGE AND PHILLIPS CURVES

The equations used for the estimations also come from Elkayam and Ilek (2013).

The results are similar to those when only the Phillips curve is included in the model, the obtained unemployment gap fluctuates around 0 and gives no meaningful indication of whether or not there is an inflationary pressure in the labour market (Figure 6).

2.4.7 ESTIMATION WITH THE USE OF THE LONG-TERM UNEMPLOYMENT

Several authors point out (e.g. Blanchard and Wolfers (2000), Kajuth (2014)) that the long-term unemployed spend less effort on finding a job. In addition, the likelihood of companies employing the long-term unemployed is also less, since the human capital of the long-term unemployed becomes more obsolete than of those who were unemployed for a shorter period. For this estimation, the idea is taken from Kajuth (2014); however, use of the original equation did not yield a NAIRU time series which makes sense in economic terms, and thus instead of the transition equation the long-term unemployment rate is stated as a function of the NAIRU as an observation equation.

$$u_l = utr + \varepsilon_{17} \tag{7}$$

The result in the first part of the sample is very similar to that received from the Hodrick-Prescott filter; however, it properly identifies the slackness of the labour market during the crisis (Figure 7).

2.4.8 OTHER ESTIMATES FOR THE HUNGARIAN NAIRU

The OECD regularly estimates the NAIRU (OECD (2014)), while the European Commission regularly estimates NAWRU for Hungary. OECD uses the inflation expectations for the estimation of the NAIRU, which is performed with the Kalman filter. The European Commission (D'Auria et al. (2010)) estimated the NAWRU relying on the Phillips curve, also using the Kalman filter.

The time profile of the NAIRUs is similar, but the NAIRU in the presented calculations (Model 3) is higher between 1993 and 2006 than the NAIRU published by these organisations, while it is lower since 2006. The European Commission estimates the

Figure 6
Estimation of the unemployment gap and the NAIRU using the Beveridge and Phillips curves

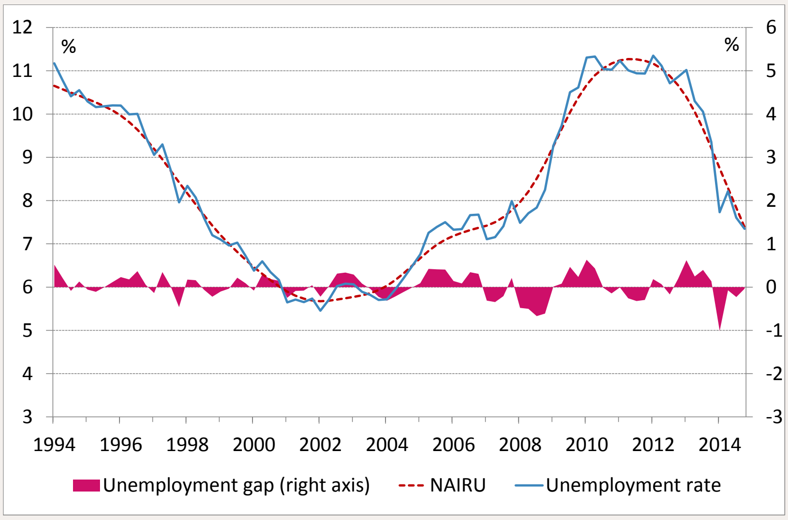
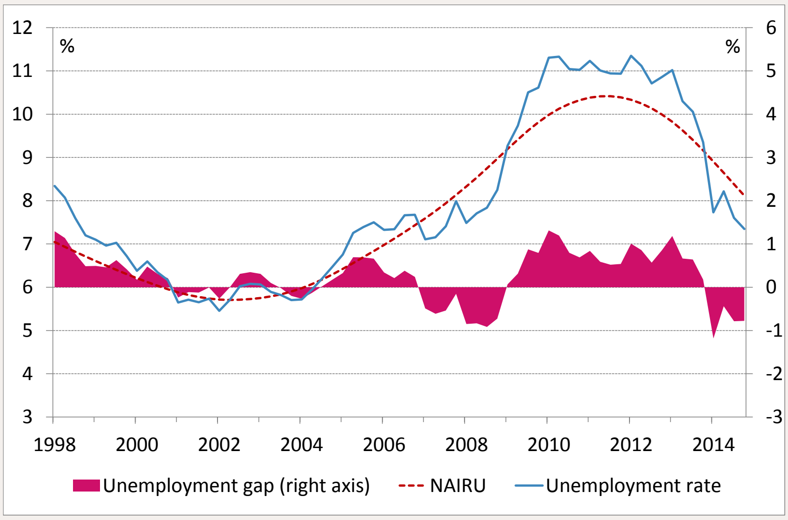
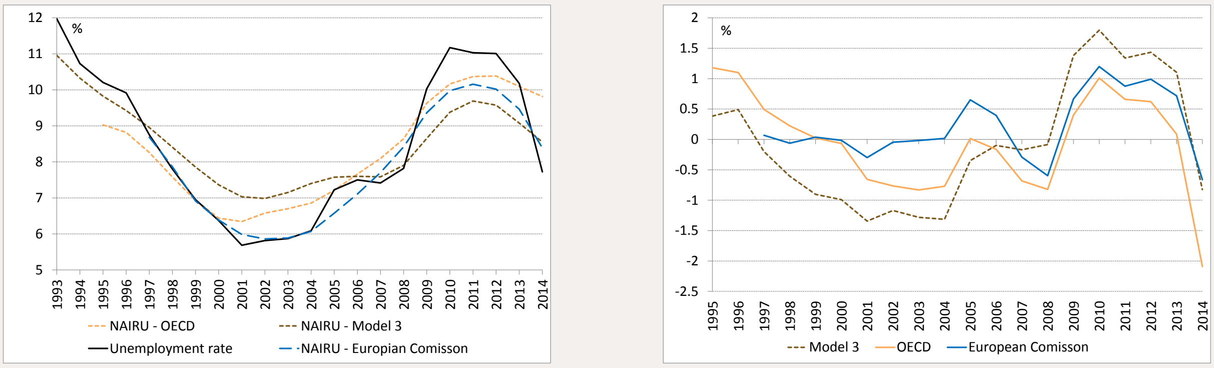


Figure 7
Estimation of the unemployment gap and the NAIRU using the long-term unemployment



unemployment gap between 1997 and 2004 close to zero, while based on the OECD and the presented calculations during this period Hungary had a negative unemployment gap. After the crisis, all three estimates show a loose labour market, but from 2013 the gap is more open based on the OECD's calculations (Figure 8).

Figure 8
NAIRU and the unemployment gap based on various estimates



3 Evaluation

The seven examined estimation procedures are evaluated according to their revision properties and forecast capability. With the use of the NAIRU (and the unemployment gap derived as the difference of unemployment and the NAIRU), it is expected that the forecasting capability of wages should improve and, if possible, be slightly revised. Apart from this, it is emphasised in the literature (e.g. Gordon (1997)) that the NAIRU should be relatively smooth, as it identifies one of the underlying processes of the labour market, and as such it is slow to change over time. The NAIRUs obtained may be all deemed smooth (can be derived in each point), and consequently this characteristic is not examined separately.

3.1 REVISION PROPERTY

Firstly, when examining the revision property, all estimations start from 1999 to ensure comparability, and the sample of the different models is always expanded by one observation. The estimates start from the first quarter of 1999 and the last date is shifted by one observation. The first model is estimated between the first quarter of 1999 and the first quarter of 2005, while the last model is estimated between the first quarter of 1999 and the fourth quarter of 2014. In respect of the individual models, the deviation – in terms of the absolute value – of the NAIRU estimate from the lagged estimate is examined, with a time lag of 1, 2 and 3 years, i.e.:

$$x_s = \frac{\left|nairu_s(t) - nairu_s(t+i)\right|}{nairu_s(t+i)}, \text{ where } i = 1, 2, 3 \tag{8}$$

$$\frac{1}{n} \sum_{s=2005q1}^{2014q4} x_s \tag{9}$$

The deviations are averaged for all three time lags for all models. If the revisions are evaluated by the lags, then in the case of the 1- year lag Model 2, Model 1 and Model 3 are the best. In the case of Model 1, Model 2, Model 6, and Model 7, increasing the lag has not got significant effect on the revision. On the other hand, in the case of the other models by increasing the lags the deviations also increase by increasing the lags (Figure 9). In this examination, in the case of Models 2, 5, 6 and 7 a new lambda (ratio between the variance of the various error terms) must be identified upon each expansion of the sample, as the previous one returns a meaningless result.[2]

The aim is to find the model, in which revision is the smallest on the whole information set, and thus is most suitable for estimating the NAIRU. That is why the above evaluation is made for the whole sample so the estimations of the different models start from different dates (for the availability of each series see Appendix). All other parameters are the same as before.

In this case there are different results. Most of the revision appears in the first year for all seven models. Four of the seven models have roughly similar revision and this is independent of the number of years used for examining the revision ahead. The revisions of the seventh model are larger by one scale compared to the other models. The smallest change is provided by the estimate made by the second model on the complete sample (Figure 10).

[2] In the case of the above-mentioned models no universal lambda can be allocated to the individual dates that would return a result interpretable in an economic context. Thus, a new lambda had to be selected every time a date was added. This process was automated. When the received NAIRU satisfied certain requirements (its average fell between 5 and 10), the lambda belonging to that was selected.

Figure 9
Revisions (with time lag of 1, 2 and 3 years, estimating from 1999)
(The numbering of the models follows the numbering specified in Table 1)

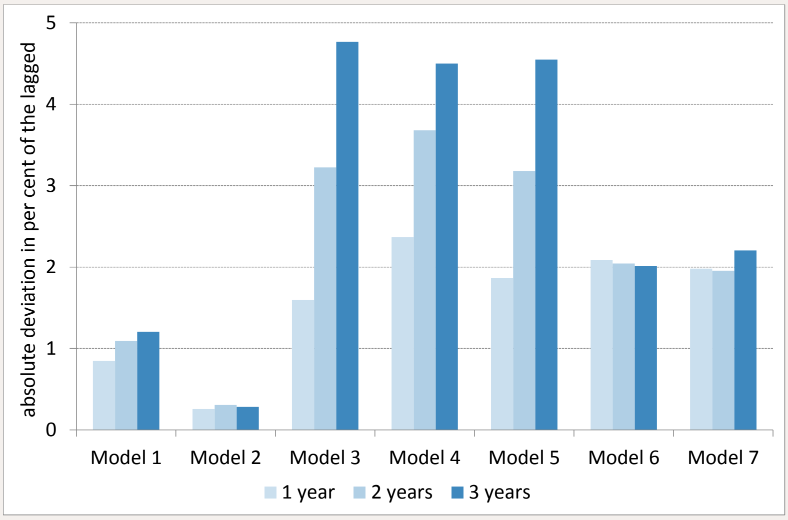
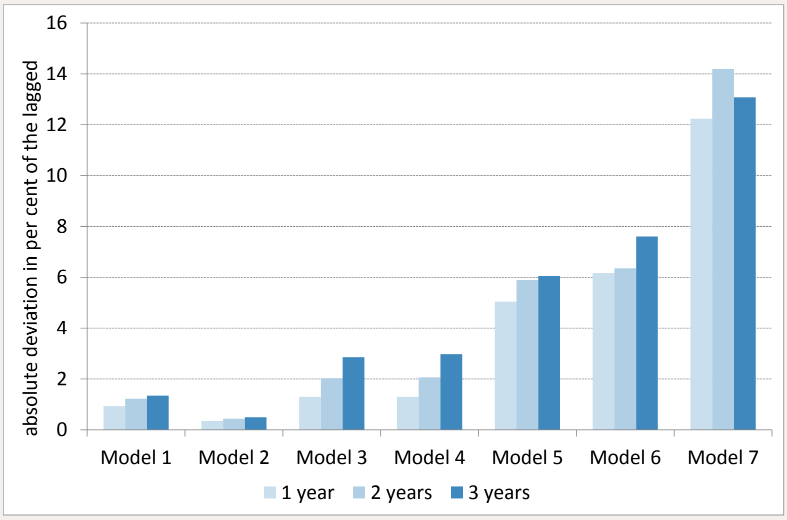


Figure 10
Revisions (with time lag of 1, 2 and 3 years estimating on the whole sample)



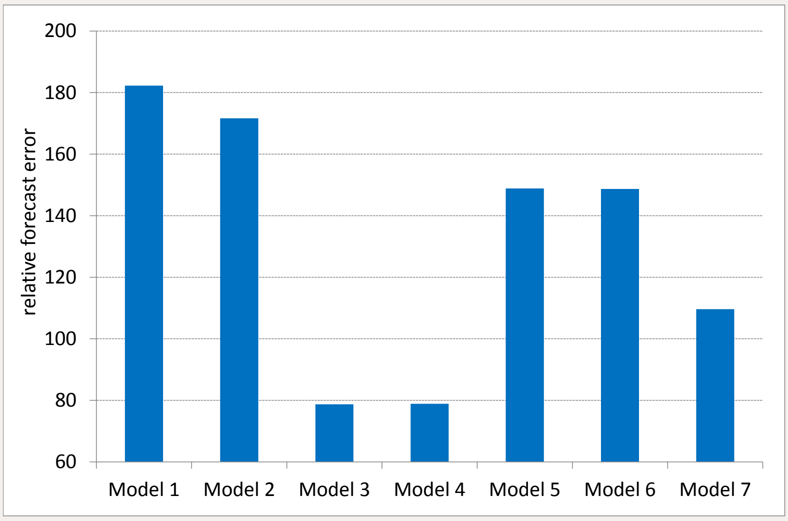
3.2 FORECAST CAPABILITY

The NAIRU-unemployment gap decompositions were also examined in terms of their ability to help forecast the development of wages. For this, the unemployment gap was estimated, expanding the sample with additional observations, also starting from 2005 Q1. The estimation of all models starts from 1999 to ensure the comparability of the obtained results.

As it was not the intention to build a structural model, forecasting capability was examined relying on a simple vector autoregressive (VAR) model. Two types of VAR models were used for testing forecasting capability. The basic model includes real wages, productivity, inflation and unemployment, while in the other models unemployment is replaced with the estimated unemployment gap. With the two types of VAR models, wages for 4 quarters ahead were forecast and it was examined which of the models that use the unemployment gap has a lower root mean squared error (RMSE) compared to the basic model. Thus in total, including the basic model, real wages are forecast with the help of 8 VAR models.

Only the two models that use the unemployment gaps estimated by tightness provide a more accurate forecast of the wages than the basic model (Figure 11). This is valid for each of the reviewed periods; at the same time the accuracy of the forecast varies on the individual forecast samples (starting from 2005, 2007, 2009 and 2011)[3].

Figure 11
Average root mean squared errors of the individual models compared to the basic model between 2009 and 2014



[3] From the central bank's perspective the impact of wages on prices is also important but this is above the scope of this paper. For a short description how this relationship evolved over time see MNB (2015).

4 Sensitivity analysis of the estimates

This section examines the extent to which the estimation of the unemployment gap is affected, if the notion of unemployment is expanded, and variables are used in the individual models which are different in statistical terms, but are almost the same in terms of their economic notion. In this section the model deemed to be the best (presented in section 2.4.3, which uses tightness) is applied.

4.1 EXPANSION OF THE DEFINITION OF UNEMPLOYMENT

Since the crisis, an increasing number of analysts have argued for broader measures of labour underutilisation, because common unemployment does not accurately reflect the free capacities in the labour force. Blanchflower and Levin (2015) found that in the USA the groups which are linked more loosely to the labour market (e.g. discouraged workers) also have an effect on wages; thus it is worth examining these groups as well for the purpose of monetary policy. If the dynamics of the expanded definition of labour force's free capacities considerably deviate from those of the original one, then the models presented earlier filter a different unemployment gap. Thus, it is worth examining whether the view on the labour market tightness changes in this case.

Based on the recommendation of the International Labour Organisation (ILO) the unemployed include those who do not work, actively look for a job and are able to start work within two weeks. If we drop one or two conditions from this definition, we can expand the notion of the unemployed to include those who are linked to the labour market more loosely, but may be more easily involved than those who cannot or do not want to work at all. The number of the unemployed persons can be expanded as follows (see e.g. HCSO (2014)):

a) the unemployment as defined above

b) a) + the discouraged workers (do not work, could take up work, but do not look for a job)

c) b) + those who are marginally attached to the labour force (people looking for a job, but cannot take up work)

d) c) + those who are employed part time for economic reasons (work as part-timers, but would be keen on working a higher number of hours).

Within the above categories, in Hungary the number of the discouraged workers (127,000 persons in 2013) and the underemployed part-timers (96,000 person) is significant, while the other potential labour reserves are negligible (below 10,000 in 2013). Thus, the first two categories are used for the NAIRU estimation.

In addition, the examination covers two additional categories which are not included in the above breakdown, but are important in Hungary based on their magnitude, since they may eventually impact wage-setting in the private sector. One of the categories is people employed abroad, figuring in the Labour Force Survey (LFS), while the other is workers employed in public work programmes (fostered workers). LFS includes those people working abroad who are still considered to be members of a household in Hungary (see more details on the issue in Bodnár and Szabó (2014)). In their case, the chance of returning is higher, and thus they may be regarded as part of the labour force.

According to LFS, fostered workers qualify as employees (in the week preceding the survey they performed at least one hour of paid employment), but as this is not private sector employment, we have good reason to assume that – in the absence of the programme – some of them would belong to the free labour market capacity. Since the literature contains a number of different job finding rates with regard to fostered workers (e.g. Bakó et al. (2014)), no attempt is made to choose the best one in this paper; instead the two extreme values are examined for the purpose of estimating the unemployment gap.

Five cases are examined in total. When the free labour force capacity includes discouraged workers and employees working abroad, and when the free labour force capacity is expanded to include the former two categories and underemployed part-timers. In the other two cases, fostered workers were allocated to the free labour force capacity and to the group of the economically inactive.

For the estimation, the model that uses tightness is applied. Naturally, here the tightness also changes, similarly to the unemployment rate. The received NAIRUs are approximately the equivalents of each other with a level shift, while the unemployment gaps develop similarly. Inclusion of the various groups which are linked more loosely to the domestic labour market in the analysis has no material impact on the view of labour market tightness (Figure 12).

Figure 12
Unemployment gap with different definitions of unemployment

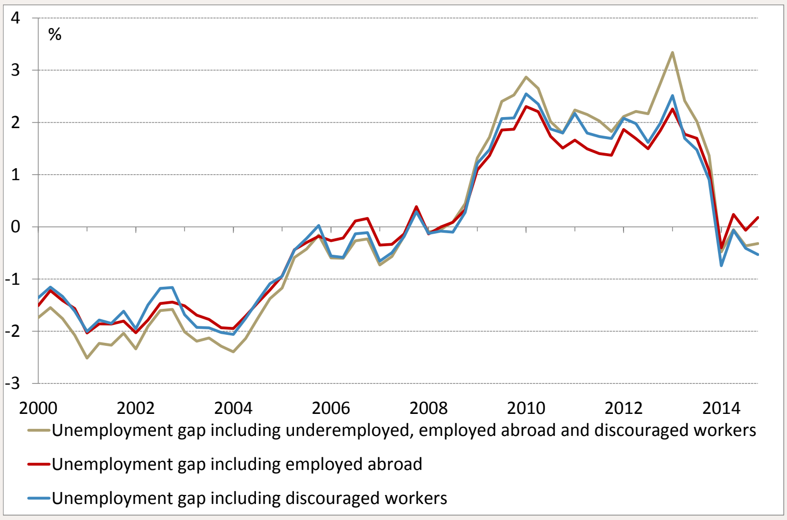
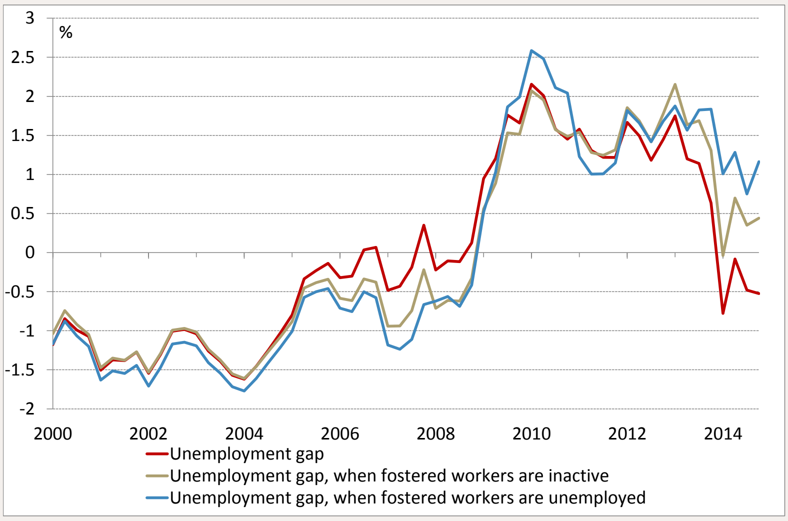


Figure 13
Impact of the different inclusion of public workers on the unemployment gap



In contrast to the aforementioned three cases, a different conclusion can be drawn if the labour market status of fostered workers is changed, as in this case the unemployment gap also changes. Thus, according to these estimates, the labour market may still be deemed slack at the end of 2014 (Figure 13).

4.2 ROBUSTNESS OF THE VARIABLES USED FOR THE ESTIMATIONS

Since the objective is to identify the unemployment gap that helps forecast wages the best, wherever possible the unemployment gap within one model is estimated with the use of several variables, which are similar to each other. In the second model, a price Phillips curve and two wage Phillips curves (with real and nominal wages) are used. The NAIRUs received using the three different Phillips curves are very similar, without any substantial difference between them.

Since the tightness indicator can be calculated in several ways [4] , the estimation for six tightness indicators between 2000 and 2014 was performed. The results are very similar; there are slight differences in the level of NAIRU.

The estimation of the fourth model is neither changed significantly even by the form of stating the Phillips curve (price, nominal wage, real wage). Since it is clear from the LFS whether the unemployed would want to have full-time or part-time jobs, it is possible to calculate the full-time equivalent of the unemployed and from that the full-time equivalent unemployment rate. When estimating the unemployment gap on this rate, we get similar results as originally. It does not influence the view of labour market tightness.

On the whole, the use of the different variables that are similar in economic terms has no substantial effect on the estimation of the NAIRU and the unemployment gap.

4.3 CONCLUSIONS

The unemployment gap estimated by tightness and the combined use of tightness and the Phillips curve performed the best for the purpose of the wage forecasting. In terms of the revision property, using the whole sample four models showed almost identical change when the sample is expanded with an observation. On the whole, the unemployment gap estimated by the tightness and the combined use of tightness and the Phillips curve performed the best. Thus, in the case of the expanded unemployment rates, the unemployment gap is estimated relying on Model 3. The gap showed a significant deviation in two cases: when fostered workers are considered as part of the free labour force capacity and when they are considered as economically inactive. In this case, based on the unemployment gap, the labour market was still slack at the end of 2014.

[4] Six types of tightness indicators are used in total. These are generated as the quotient of three types of vacancies and unemployment and participation.

5 Factors underlying the development of the NAIRU

This section explains the development of the NAIRU deemed best by various factors. Based on the literature, considering the most important factors influencing the structural unemployment rate, the examination focuses on which of those factors may have shaped the development of the structural unemployment rate. Some authors treat the NAIRU and the structural unemployment rate as synonyms (e.g. Ball and Mankiw (2002)), while others use the NAIRU as the approximation of the structural rate (Orlandi (2012)). In the original articles, the factors listed here relate either to the structural or to the non-accelerating inflation rate of unemployment. In this paper, these factors are used to explain the NAIRU. Of the factors listed in Table 2, those are presented in detail, which may have had an impact on the Hungarian NAIRU based on the charts. However, a more comprehensive analysis may yield different results, but this goes beyond the scope of this paper.

Table 2
Most important factors influencing NAIRU based on the literature

Factor	Impact on NAIRU	Literature
Deceleration of the TFP growth rate	increases / ambiguous	Blanchard and Wolfers (2000), Orlandi (2012)
Real interest rate, capital price increase,		
risk premium increase	increases	Blanchard and Wolfers (2000), D'Auria et al. (2010), Gianella et al. (2008), Orlandi (2012)
Increase in the long-term unemployment rate	increases	Blanchard and Wolfers (2000), D'Auria et al. (2010), Irac (2000), Kajuth (2014), Orlandi (2012)
Increase in the number of employees in construction	reduces	Orlandi (2012)
Increase of the tax wedge	increases	D'Auria (2010), Gianella et al. (2008), Nymoen and Sparrman (2015), Orlandi (2012)
Decrease of the labour share	increases	Blanchard and Wolfers (2000)
Generous unemployment benefits;		
increase in unemployment benefit replacement rates (unemployment benefit/net wage)	increases	Blanchard and Wolfers (2000), D'Auria et al. (2010), Gianella et al. (2008), Irac (2000), Nymoen and Sparrman (2015)
Employment protection	ambiguous	Blanchard and Wolfers (2000)
Strength of trade unions; decrease in the bargaining power of employees	reduces	Gianella et al. (2008), Irac (2000), Orlandi (2012)
Change in the distribution of the active population by age and sex	depends on the group	Ball and Mankiw (2002), Irac (2000)

The NAIRU may be influenced by a number of factors. These factors, which affect the trend of unemployment, are independent of the business cycle. Their aggregate impact might as well offset each other, and thus the potentially deterministic effects in the literature are not necessarily striking in the Hungarian data. The factors may be allocated to two major groups: macro environment and the indicators characterising the labour market institutions.

5.1 IMPACT OF THE MACRO ENVIRONMENT

Several authors emphasise that the change in the growth rate of total factor productivity (TFP) affects the NAIRU. Blanchard and Wolfers (2000) argue that the deceleration of the TFP growth rate may lead to higher structural unemployment, since wage expectations adjust to the change in the productivity growth rate more slowly. Ball and Mankiw (2002) point out that in this case the interaction between inflation and unemployment worsens, i.e. the NAIRU increases. At the same time, not all studies find a clear relationship between TFP and the NAIRU (e.g. Orlandi (2012)). The link between the change in the TFP growth rate and the NAIRU appears to be valid for Hungary as well (Figure 14).

Figure 14
Change in the growth rate of the NAIRU and the total factor productivity

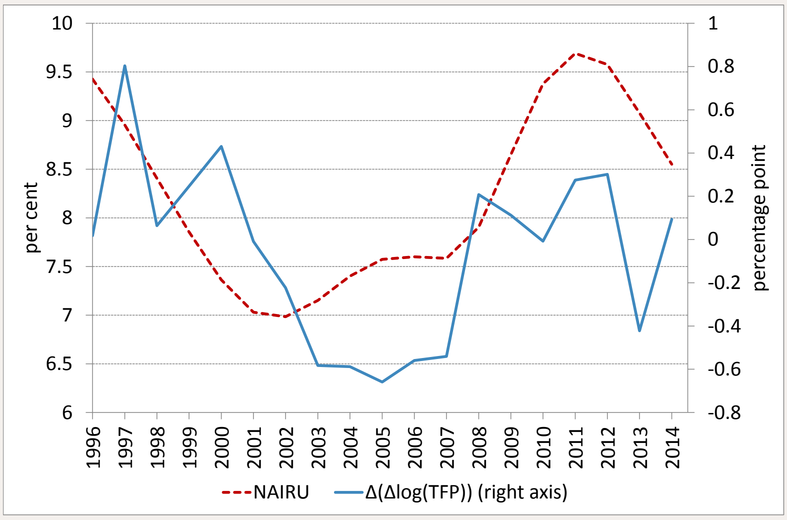
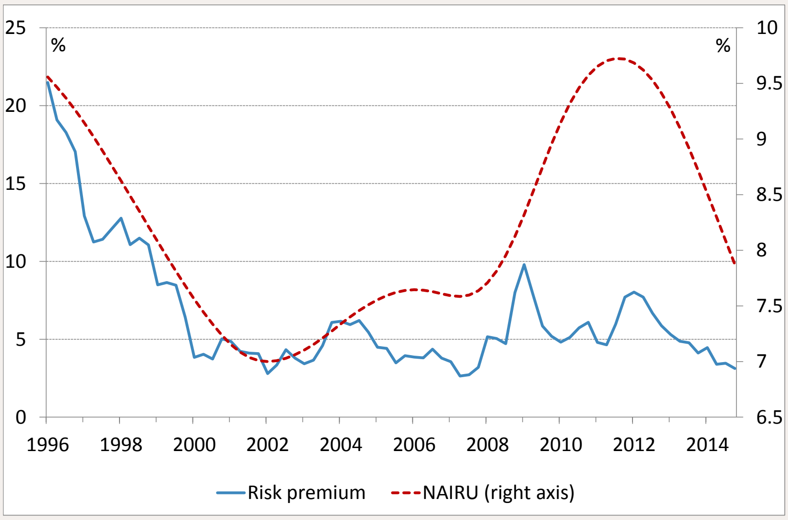


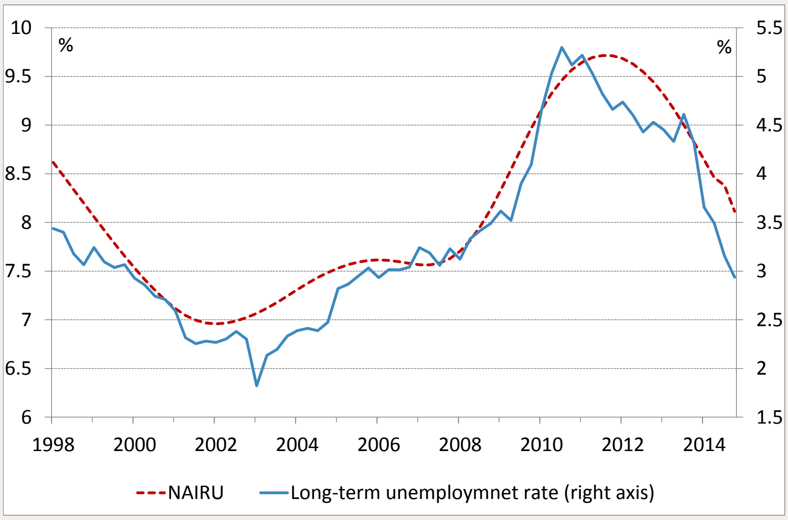
Figure 15
Risk premium and the NAIRU



Many authors also emphasise that an increase in the real interest rate (or risk premium) raises the NAIRU. According to Blanchard and Wolfers (2000), the higher cost of capital also means higher costs for companies, and this may lead to a decline in labour demand. This finding appears to be valid for Hungary as well; however, starting from the 2000s, Hungary's yield spread (the difference in the yield of the 5-year Hungarian and German government bond) became much more volatile, which was not always reflected in the NAIRU (Figure 15).

There is a consensus in the literature about the relationship between the long-term unemployment rate and the structural unemployment rate; i.e. when the long-term rate increases the structural rate also rises. The human capital of the long-term unemployed becomes obsolete, thus companies are more keen on hiring applicants who lost their jobs recently. Even after a potential economic recovery, it is not certain that those searching for a job for more than one year will find a job. Consequently, their number increases the size of the cycle-independent structural unemployment. This link is most probably valid for Hungary as well (Figure 16). In addition, Blanchard and Summers (1986) also point out that in the event of an economic downturn those who remain employed have a greater influence on wages than the those who became unemployed, and thus a dual labour market may take shape. The higher wages negotiated by the employees hamper the employment of the long-term unemployed.

Figure 16
Long-term unemployment rate and the NAIRU



The number of employees in construction may be a good indication of the general economic activity. However, the lending cycle may also be an underlying reason for this, since construction output may increase as a result of the recovering lending activity. In this industry, the number of lower educated employees is relatively higher than in the entire private sector, and as such it is the easiest for them to lose their job and the hardest to find a new one. According to Orlandi (2012) , when the number of employees increases in construction, the structural unemployment rate decreases. This finding is also valid for Hungary (Figure 17).

5.2 IMPACT OF THE LABOUR MARKET INSTITUTIONS

The decrease in trade unions' ability to enforce interests and in employees' bargaining power reduces structural unemployment, since a strong trade union can attain higher wages, which, ceteris paribus, reduces labour demands. This relationship seems to be valid for Hungary until 2002, but after 2002 trade union penetration presumably played a smaller role in the development of the NAIRU (Figure 18).

The structural unemployment rate may also be influenced by the age and sex composition of the active population (see Irac (2000)). If the ratio of the group with high unemployment rate decreases within the active population (e.g. an increasing number of young people enrol in university), the structural unemployment rate also falls. At the same time, Raaum and Røed (2006) point out that – especially among the lower educated young people – unemployment becomes a disadvantage in their later stage of life as well, i.e. it is more likely that they will be unemployed also when they grow older. In addition, they found

Figure 17
Ratio of the NAIRU and the employees in construction

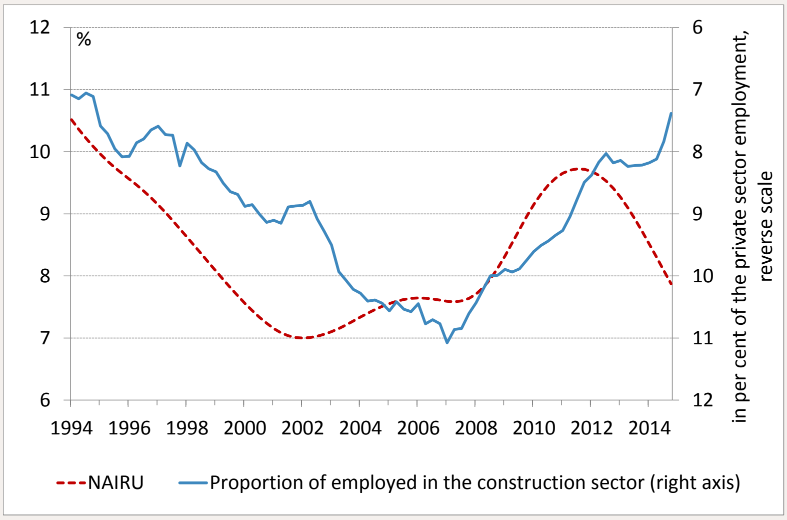
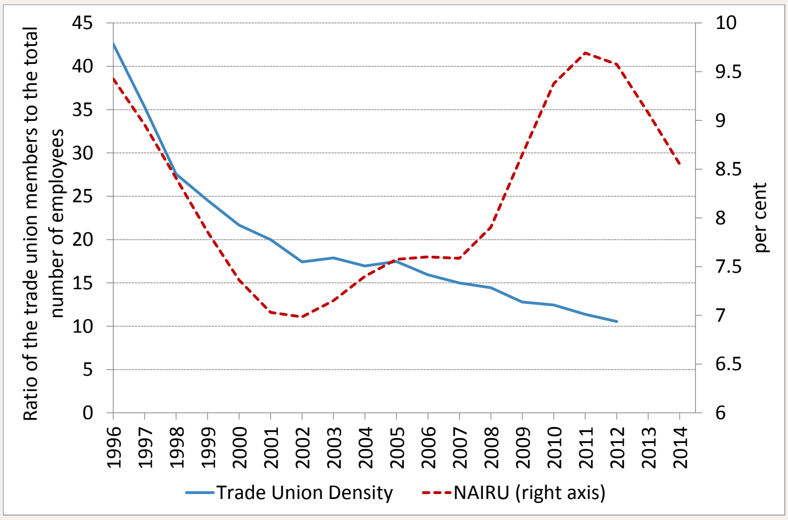


Figure 18
Trade union penetration and NAIRU



that those who were unemployed in their youth during an economic downturn are more likely to be unemployed in their adult age. That is, the ratio of the youth within the active population has an impact on the structural unemployment rate not only today but also in the future through the composition effect.

In the past decades, the unemployment rate of young people (school-leavers) exceeded the average level in Hungary as well. However, the number of full-time students in higher education has increased year by year until 2009. Thus, people in the youth age bracket entered the labour market in decreasing numbers, which might have reduced the NAIRU.

On the whole, it can be stated that in Hungary in the 1990s and 2000s the general economic activity (TFP, long-term unemployed, number of employees in construction, risk premium) had a greater effect on the non-accelerating inflation rate of unemployment than certain labour market institutional changes. At the same time, according to Orlandi (2012) , labour market institutions also play a role in explaining the differences between individual countries.

6 Summary

This paper briefly reviews the conceptual definitions of the non-accelerating inflation rate of unemployment rate (NAIRU) found in the literature and the applicable estimation methods. Based on these, the non-accelerating inflation rates of unemployment rate in Hungary is estimated in several ways. The examined models are evaluated based on their revision property and their wage forecasting capability. Based on these, the model that uses the labour market tightness indicator performed the best.

After these examinations, robustness calculations were also performed with the model which were deemed to be the best. Free labour market capacity was expanded to include groups which are linked more loosely to the Hungarian labour market. In these cases, the re-estimated NAIRU differs from the original one in its level, but there is no significant difference in its time profile. The unemployment gap obtained is very similar to the original one. Accordingly, these categories were not suitable for drawing a different conclusion on the tightness of the labour market and the development of the NAIRU. In addition to the above categories, two more cases were examined. In these, the labour market status of fostered workers was altered in both cases. This resulted in a substantial change, as based on the resulting unemployment gap, the labour market may still be considered slack at the end of 2014.

With regard to the NAIRU obtained from the original model, the factors that may have influenced it were reviewed. The variables that relate more closely to the economic activity, such as total factor productivity, the long-term unemployment rate, the number of employees in construction and the risk premium, have considerablely had an effect on the NAIRU, which may have been complemented by certain labour market institution changes. At the same time, labour market institutions (eg. tax wedge) also play a role in explaining the differences between countries.

As an expansion of this study, it may be worthwhile to examine the NAIRU estimated using micro data and the extent of correspondence with the results presented here. In addition, it could be also useful to examine the effect of the presented factors on the NAIRU with econometric methods, especially how recent developments on the Hungarian labour market (decrease in the tax wedge, transformation of the unemployment benefit system etc.) affected the NAIRU.

References

Anosova, D., K. Sonin, A. Vanags and A. Zasova (2013), *Structural or Cyclical? Unemployment in Latvia Since the 2008-09 Financial Crisis*, CEPR Discussion Papers 9525, C.E.P.R. Discussion Papers.

Bakó, T., Z. Cseres-Gergely, J. Kálmán, G. Molnár and T. Szabó (2014), *People at the edge of the labour market and the budget (A munkaerőpiac peremén lévők és a költségvetés)*, tech. rep., MTA-KTI.

Ball, L. and N. G. Mankiw (2002), 'The NAIRU in Theory and Practice', *Journal of Economic Perspectives*, vol. 16 no. 4, pp. 115–136

Blanchard, O. and J. Wolfers (2000), 'The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence', *Economic Journal*, vol. 110 no. 462, pp. 1–33

Blanchard, O. J. and L. H. Summers (1986), 'Hysteresis and the European Unemployment Problem', in, *NBER Macroeconomics Annual 1986, Volume 1*, pp. 15–90, National Bureau of Economic Research, Inc.

Blanchflower, D. G. and A. T. Levin (2015), *Labor Market Slack and Monetary Policy*, Working Paper 21094, National Bureau of Economic Research.

Bodnár, K. and L. T. Szabó (2014), *The Effect of Emigration on the Hungarian Labour Market*, MNB Occasional Papers 2014/114, Magyar Nemzeti Bank (Central Bank of Hungary).

Daly, M. C., B. Hobijn, A. Sahin and R. G. Valletta (2012), 'A Search and Matching Approach to Labor Markets: Did the Natural Rate of Unemployment Rise?', *Journal of Economic Perspectives*, vol. 26 no. 3, pp. 3–26

D'Auria, F., C. Denis, K. Havik, K. M. Morrow, C. Planas, R. Raciborski, W. Roger and A. Rossi (2010), *The production function methodology for calculating potential growth rates and output gaps*, European Economy - Economic Papers 420, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Dickens, W. (2009), 'A New Method for Estimating Time Variation in the NAIRU', in Fuhrer, J. *Understanding Inflation and the Implications for Monetary Policy: A Phillips Curve Retrospective*, pp. 205–228, The MIT Press.

Driver, R. L., J. V. Greenslade and R. G. Pierse (2006), 'Whatever Happened to Goldilocks? The Role of Expectations in Estimates of the NAIRU in the US and the UK', *Oxford Bulletin of Economics and Statistics*, vol. 68 no. 1 (Feb.), pp. 45–79

Elkayam, D. and A. Ilek (2013), *Estimating the NAIRU using both the Phillips and the Beveridge curves*, Discussion Paper No. 2013.10, Bank of Israel.

Fabiani, S. and R. Mestre (2000), *Alternative measures of the NAIRU in the euro area: estimates and assessment*, Working Paper Series 0017, European Central Bank.

Friedman, M. (1968), 'The Role of Monetary Policy', *The American Economic Review*, vol. 58 no. 1, pp. 1–17

Gianella, C., I. Koske, E. Rusticelli and O. Chatal (2008), *What Drives the NAIRU? Evidence from a Panel of OECD Countries*, OECD Economics Department Working Papers 649, OECD Publishing.

Gordon, R. J. (1997), 'The Time-Varying NAIRU and Its Implications for Economic Policy', *Journal of Economic Perspectives*, vol. 11 no. 1, pp. 11–32

Guichard, S. and E. Rusticelli (2011), *Reassessing the NAIRUs after the Crisis*, OECD Economics Department Working Papers 918, OECD Publishing.

Hamilton, J. D. (1994), 'State-space models', chap. 50 in Engle, R. F. and D. McFadden (eds.), *Handbook of Econometrics*, pp. 3039–3080, Elsevier.

HCSO (2014), 'Statistical Reflections', *Labour Market Trends, 2014Q1-Q3, Hungarian Central Statistical Office*,

Irac, D. (2000), *Estimation of a Time Varying NAIRU for France*, Working papers 75, Banque de France.

Kajuth, F. (2014), 'NAIRU Estimates for Germany: New Evidence on the Inflation–Unemployment Tradeoff', *German Economic Review*, pp. 1–22

MNB (2015), *6.2. Prices and wages – reasons behind the changing economic relationship*, Inflation Report, Magyar Nemzeti Bank (Central Bank of Hungary).

Nymoen, R. and V. Sparrman (2015), 'Equilibrium Unemployment Dynamics in a Panel of OECD Countries', *Oxford Bulletin of Economics and Statistics*, vol. 77 no. 2 (Apr.), pp. 164–190

OECD (2014), 'OECD Economic Outlook, Volume 2014 Issue 2', *OECD Publishing*,

Orlandi, F. (2012), *Structural unemployment and its determinants in the EU countries*, European Economy - Economic Papers 455, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Raaum, O. and K. Røed (2006), 'Do Business Cycle Conditions at the Time of Labor Market Entry Affect Future Employment Prospects?', *The Review of Economics and Statistics*, vol. 88 no. 2, pp. 193–210

Richardson, P., L. Boone, C. Giorno, M. Meacci, D. Rae and D. Turner (2000), *The Concept, Policy Use and Measurement of Structural Unemployment: Estimating a Time Varying NAIRU Across 21 OECD Countries*, OECD Economics Department Working Papers 250, OECD Publishing.

Tasci, M. (2012), *The Ins and Outs of Unemployment in the Long Run: Unemployment Flows and the Natural Rate*, Koç University-TUSIAD Economic Research Forum Working Papers 1233, Koc University-TUSIAD Economic Research Forum.

Appendix

A SOURCES OF DATA

Table A.1
Sources of data

(HCSO: Hungarian Central Statistical Office, LFS: Labour Force Survey, inst: institutional labour statistics, NES: National Employment Service, na: national accounts)

Time series	Start	Source	Note
Participation	1993 Q1	HCSO, LFS	
Employment	1993 Q1	HCSO, LFS	
Unemployment	1993 Q1	HCSO, LFS	
Underemployed workers	2000 Q1	HCSO, LFS	Persons who work in part-time, but would be willing to work more hours
Discouraged workers	2000 Q1	HCSO, LFS	Persons who do not work, do not look for a job, but would take a job if they had the opportunity
Value added	1995 Q1	HCSO, na.	
Persons working abroad	1999 Q1	HCSO, LFS	People working at a foreign site, but have residence in Hungary and counted as the member of domestic household
Fostered workers	2008 Q1	HCSO, inst.	
Wage data	1993 Q1	HCSO, inst.	The real wage is deflated by the consumer price index.
Vacancies	1993 Q1	NES	Number of job vacancies on the closing date is available from 1993, while the new jobs and the jobs available during the month are available from 1995. We have figures in subsidised – non-subsidised breakdown from 2000; this breakdown is not available between 1993 and 2000. For this latter period, the dynamics of the job vacancies on the closing date was appended to the time series of the non-subsidised job vacancies, thus generating a time series for the period between 1993 and 2014.
Total factor productivity (TFP)	1995	MNB estimate	
Tax wedge	1996	The Hungarian Labour Market [a], OECD	Ratio of net wage and total wage costs
Labour share	1995 Q1	HCSO, na.	
Trade union penetration	1995	OECD	Ratio of the trade union members to the total number of employees
NAIRU estimate of EC	1997	DG Ecfin	AMECO Database
NAIRU estimate of OECD	1995	OECD	OECD (2014): OECD Economic Outlook: Volume 2014/2, OECD Publishing

[a] Fazekas, K. and Neumann, L. (eds), The Hungarian Labour Market 2014, Institute of Economics, Centre for Economic and Regional Studies, Hungarian Academy of Sciences

MNB Working Papers 5

Estimates of the Non-accelerating Inflation Rate of Unemployment (NAIRU) for Hungary

Budapest, December 2015