ANALYSIS OF THE LABOUR MARKET AND ITS IMPACT ON INFLATION IN SERBIA

Jelena Momčilović and Mirjana Miletić

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Economic Research and Statistics Department

NATIONAL BANK OF SERBIA

Belgrade, 12 Kralja Petra Street

Telephone: (+381 11) 3027 100

Belgrade, 17 Nemanjina Street

Telephone: (+381 11) 333 8000

www.nbs.rs

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Abstract: In this paper we showed how labour market factors are included in the macroeconomic model which the National Bank of Serbia uses for the medium-term inflation projection, thus enabling an insight into labour market trends, as well as an analysis of the link with other macroeconomic indicators, notably their effect on inflation. The estimates obtained by applying the Kalman filter indicate that NAIRU is still below the unemployment rate, suggesting a positive unemployment gap and showing that the labour market in Serbia is not exerting any major pressures on inflation.
The paper also presents the results of testing the relevance of the hysteresis effect in the unemployment rate for Serbia. The hysteresis effect was confirmed by applying the unit root test and estimating the statistical significance of the stochastic trend in the NAIRU series.

Key words: labour market, inflation, NAIRU, monetary policy
[JEL Code]: C53, E17, E58

Non-Technical Summary

Labour market factors may impact inflation from the supply-side, as the rise in employment and wages increases production costs, as well as from the demand-side, by impacting consumption. Due to the implications this may have on monetary policy, central banks pay great attention to the labour market. The effects of labour market factors in inflation projection models used by central banks are mostly monitored through the real wage gap and the unemployment gap. The NBS Working Paper Bulletin from September 2022 explains how private sector wages are included in the National Bank of Serbia's medium-term inflation projection model, while this paper will elaborate in more detail the equations through which the unemployment gap is included in the model.

The unemployment gap is the difference between the actual unemployment rate and the efficient unemployment rate which does not drive inflation up, i.e. which is consistent with maintaining medium-term price stability. This is known in literature as NAIRU (non-accelerating inflation rate of unemployment). When the unemployment rate is above NAIRU, i.e. when the unemployment gap is positive, there is a labour surplus, which should drive wages and inflation down. The same is true vice versa, when the unemployment rate is below NAIRU, the labour market is considered tight because the environment of low unemployment exerts increasing pressures on wage growth and by extension on inflation.

However, unlike the unemployment rate, which is measurable and obtained based on data from labour force surveys, NAIRU is an unobserved component. There are different techniques for estimating NAIRU, and the estimate in this paper was obtained based on the structural New Keynesian model that contains a large number of equations that connect key macroeconomic variables from the domestic and international environment and estimate the effect on inflation, using the Kalman filter.

NAIRU is impacted by the structural factors and frictions in the labour market, and it can also be influenced by aggregate demand, i.e. the level of unemployment from the prior period. Extended periods of unemployment, which mostly occur in periods of higher unemployment rates, result in the loss of workers' skills, thereby decreasing their negotiating power, which results in growth of structural unemployment and lowers the potential output. In literature, this effect is known as hysteresis and is often tested in empirical literature. The presence of hysteresis suggests a more lasting impact of shocks on unemployment, as well as that economic policy measures can be utilised for lowering unemployment.

In our estimate, NAIRU is still lower than the unemployment rate and will remain so until the end of the projection horizon, which indicates that the labour market should not have a large inflationary effect in the coming period, despite the fact that we anticipate a further decline in the unemployment rate and real wage growth.

Contents

1 Introduction

Though labour market factors were not a key source of global inflation growth in the wake of the coronavirus pandemic outbreak, they can result in inflation turning out to be more persistent than anticipated and in slowing the disinflation process. A spike in consumer demand after the initial phase of the pandemic triggered labour force demand, hence conditions in the labour markets of many countries tightened increasingly over time because nominal wages recorded significant growth, and unemployment was at a historical minimum in a number of countries. Also, inflation trending at an elevated level longer than initially expected increased the risk of opening the wage-inflation spiral, i.e. the risk of increased pressures towards further wage growth in order to keep up the pace with inflation or even exceed it, given that wages in many countries were declining in real terms, despite nominal growth. In a number of countries, the unemployment rate dropped so low that we may wonder if it is below the NAIRU level. This brought the so-called Phillips curve concept back into the game. For a long time during the low inflation period in the wake of the 2008 world financial crisis, the Phillips curve was claimed to be vertical and that the reverse proportion between inflation and economic activity (unemployment) is invalid.

Because of this, the analysis of the labour market and the estimate of its impact on inflation gains special importance in the current circumstances, and is increasingly more often the subject of central banks' empirical analyses. Also, central banks adjust their inflation projection models to have a more adequate view of the potential effects of the labour market on inflation.

One of the concepts used for assessing the impact of labour market factors on inflation is the unemployment gap, which compares the unemployment rate with NAIRU – the unemployment rate that generates neither inflationary nor disinflationary pressures, i.e. at which the labour market exerts no pressures on inflation and the output potential. As an indicator of the level of labour market tightness, the unemployment gap is among the more significant factors affecting nominal wages and inflation. When negative, it leads to increased pressure on wages and inflation.

Given that unemployment in Serbia was on the decline in the previous decade, i.e. in the period 2014–2024, that there is a shortage of workforce in some groups of occupations and that wages in the prior period posted two-digit growth rates, the question arises as to whether conditions in the labour market are tight and therefore exert an inflationary effect. From the aspect of monetary policy conduct, this is a very important thing that must be estimated because an adequate monetary policy response may mitigate the effect of cyclical factors on unemployment and, by extension, on inflation, arising on this account. Therefore, this paper will show how the National Bank of Serbia's (NBS) medium-term inflation projection model includes labour market factors and estimates their effect on inflation. Data on wages that we

use pertain to private sector wages. At the same time, we will give an assessment of the NAIRU level for Serbia based on the estimated model.

The paper is structured into several sections. In the second section, we will present the definition of NAIRU and its relevance for the monetary policy; in the third, we will briefly present the methodology used for the estimate; and in the fourth, the results of empirical analyses for other countries (Central, Eastern and Southeast Europe). In section five we will present the dynamics of the labour market in Serbia over the past decade according to the key indicators. In section six, we will show the manner in which the labour market is included in the model used by the NBS for medium-term inflation projection. The section with the results of the empirical analysis provides an estimate of NAIRU based on models used for medium-term inflation projections; it also tests Okun's law and the hysteresis effect. The final section provides a summary of the main conclusions of the analysis.

2 The definition of NAIRU and its relevance for monetary policy

The labour market yields significant effects on the level of production activity and inflation, which is why central banks carefully monitor labour market indicators (wages, employment, unemployment rate, etc.), project their movement, and estimate the impact on other macroeconomic indicators. One of the key labour market indicators in terms of monetary and fiscal policy measures is NAIRU (non-accelerating inflation rate of unemployment), which was first defined by Modigliani and Papademos (1975). According to the definition, NAIRU is the unemployment rate that does not accelerate or decelerate inflation, i.e. the unemployment rate consistent with price stability in the medium term. As such, it is used to estimate the degree of unutilised capacities and the strength of inflationary pressures. The difference between the actual unemployment and the estimated NAIRU rate is called the unemployment gap. Generally, when the unemployment rate is above NAIRU, i.e. when the unemployment gap is positive, there is a labour surplus, which should drive wages and inflation down. The same is true vice versa, when the unemployment rate is below NAIRU, the labour market is considered tight because the environment of low unemployment exerts increasing pressures on wage growth and by extension on inflation. The reverse proportion between unemployment and inflation is known as the Phillips curve.

The Phillips curve was sharply criticised by monetarists, notably Friedman, who believed that a certain trade-off between unemployment and inflation only exists in the short term, while the long-term Phillips curve is vertical. Friedman (1968) introduced the term NAIRU as the unemployment rate at which inflation is stable. In contrast, Phelps (1967) believed that the Philips curve is valid in the long term as well.

The practical implementation of the NAIRU concept is enabled by the New Keynesian models, based on the assumed nominal rigidity of wages. According to this group of models, corporate profits decline in periods of economic slowdown, which companies can compensate for either by trimming nominal wages or by downsizing their workforce. Given that wages are rigid downward, the adjustment is mostly made through layoffs. Moreover, unemployment growth widens the unemployment gap, which results in lower wages of the newly employed. This way it is possible to project wage movements, therefore this approach becomes an

important analytical instrument that central banks may use in the process of monetary policy decision-making.

NAIRU is often interchangeably used with the natural rate of unemployment (NRU), for instance, by Gordon and Blanchard, though there are some differences between the two terms. When the unemployment rate is equal to the so-called natural rate of unemployment, this means that all who are able and willing to work are employed, i.e. there is no cyclical unemployment which is under the impact of the production cycle phase (demand-side factors), but it is determined only by the structural factors and labour market friction. Both NAIRU and the NRU are under the impact of structural factors and labour market friction; however, NAIRU is not a measure of the equilibrium unemployment rate, but rather a measure that is estimated based on the link between the unemployment rate and inflation, which is why it fluctuates more than the NRU. Still, in the long term, NAIRU converges toward the NRU, because of the exhaustion of the effect of shocks that may impact its movement. With the NRU, the markets are in equilibrium, but this need not be the case with NAIRU. While NAIRU is primarily important for the monetary policy conduct, because monetary policy can reduce fluctuations of cyclical unemployment, monetary policy has quite a small or no impact on the equilibrium unemployment rate which is determined by structural factors, therefore the NRU is relevant primarily for the fiscal policy conduct. Beside NAIRU and the NRU, the concept of NAWRU (non-accelerating wage rate of unemployment) is also used, linking structural unemployment with wages instead of with inflation, and in empirical analyses this concept is used by the European Commission, for example. The NAIRU concept can be distinguished from the short-term NAIRU, which indicates unemployment that stabilises inflation in the coming period at the current inflation level.

In theoretical literature, factors determining the level of NAIRU are usually macroeconomic factors (total factorial productivity, real interest rate, risk premium, etc.), **demographic factors** (share of active population in total population, migration indicators, etc.), **degree of labour market regulation and strength of workers' unions** (minimal wage level, facilities in the labour market such as partial work hours, flexible forms of employment, unemployment benefit system, etc.), **education system** (possibility of dual education), **tax treatment of the labour market**, etc. Economic conditions can have an extended effect on NAIRU, which is known as the hysteresis effect in literature and was introduced in economic theory by Blanshard and Summers (1988). At the same time, this is one of the explanations why NAIRU is not a constant, but changes over time. Thus, for instance, longer periods of unemployment, which mostly occur in periods of a high unemployment rate, result in the loss of workers' skills, which in turn degrades their negotiating power. This results in the rise of structural unemployment and reduced potential output. In conditions of high hysteresis, the consequences of shocks on the labour market are greater – in case of recession, unemployment rises more, and it also remains elevated even after the recession. This implies that NAIRU also depends on the actual unemployment rate from the previous period.

Although the theoretical concept of NAIRU is quite important in the inflation and wage analysis and forecasting, as well as the economic policy conduct, its practical implementation poses an issue since NAIRU, and by extension the unemployment gap, are not variables that

can be directly measured or identified. In view of this, several different techniques for the assessment of NAIRU are used in literature, which we will describe in more detail below.

3 Methods for estimating NAIRU

Several different ways for modelling NAIRU are used in empirical analysis, which can be divided into three main groups. The first group includes statistical models based on the estimate of the unemployment rate trend on the basis of Hodrick-Prescott or Baxter-King filters, and the Beveridge–Nelson model (1981), but a shortcoming of these models is the fact that they do not take into account the impact of other factors on its level (Fabiani and Mestre (2000)). The other group includes models based on the concept of a reduced form of the Phillips curve, taking into account the unemployment and inflation rates, but can also include the impact of other factors, such as imported inflation or inflation expectations, while assessments are made by applying the Kalman filter which enables the modelling of variables that are not directly measurable **or are unobserved**, such as NAIRU. The third group of models are the **New Keynesian** structural models which enable us to estimate NAIRU, as well as to estimate the NRU **in the equation system** (Galí, J., Smets, F. & Wouters, R. (2011)).

The simplest version of the Phillips curve is based on the theory that the deviation of unemployment (U_t) from the equilibrium level (U^{NAIRU}) is reversely correlated with inflation (π_t), i.e. that a level of unemployment higher than NAIRU lowers inflation and vice versa, which can be presented as the following equation:

$$\pi_t = \pi_t^e + \beta(U_t - U^{NAIRU}). \quad (1)$$

If expectations are adaptive, then the following is true:

$$\pi_t - \rho\pi_{t-1} = \beta(U_t - U^{NAIRU}) + \Delta\psi_t. \quad (2)$$

This means that inflation will rise or fall until the unemployment rate is equal to NAIRU.

If there is the hysteresis effect, i.e. if NAIRU is dependent on the previous unemployment rate, and not just structural factors (Z_t), the following is true:

$$U^{NAIRU} = \varphi U_{t-1} + Z_t. \quad (3)$$

Given that the hysteresis effect assumes a change in NAIRU over time, this effect is tested in empirical analyses via a deterministic or stochastic trend in the movement of NAIRU. Alternatively, this effect can also be tested using unit root tests that estimate the stationarity of the NAIRU series (Gordon (1997)). If the existence of the unit root in NAIRU is confirmed, the hysteresis effect is identified.

When it comes to structural New Keynesian models, the so-called gap analysis models, NAIRU is estimated starting from whether it can be presented in the following manner:

$$U_t^{NAIRU} = U^* + \hat{U}_t^{NAIRU}, \quad (4)$$

where $U^*$is the long-term balanced unemployment rate, which is, statistically, the provisional medium in the model, and $\hat{U}_t^{NAIRU}$is the cyclical deviation from the equilibrium unemployment rate.

Further:

$$\hat{U}_t^{NAIRU} = \lambda \hat{U}_{t-1}^{NAIRU} + \epsilon_{t.} \quad (5)$$

This means that in the short term, NAIRU may deviate from the natural rate due to the effect of cyclical factors whose impact on NAIRU can turn out to be more persistent.

Okun's law is assumed to be valid in this group of models, thus the link between the unemployment gap ($U_t - U_t^{NAIRU}$) and the output gap ($\hat{y}t$) is established as follows:

$$U_t - U_t^{NAIRU} = \beta\left(U_{t-1} - U_{t-1}^{NAIRU}\right) - (1-\beta)\varphi\hat{y}_t. \quad (6)$$

In his paper [Okun, A. M. (1962)], Arthur Okun empirically examined the relationship between changes in the unemployment rate and changes in real GDP. The analysis established that a 1 pp reduction in real GDP growth increases the unemployment rate by 0.3 pp. Many studies have confirmed this finding and in a way, Okun's law has become a formula and a useful reference for calibration when estimating macroeconomic models. When estimating trends (e.g. U_t^{NAIRU}) and gaps (e. g. output gap $\hat{y}_t$) unidimensional (HP) and multidimensional filters (Kalman) can be used. We also use the Kalman filter to estimate trends and gaps in equations in our medium-term inflation projection model.

4 An overview of empirical literature on NAIRU estimate and Okun's law

Below we will present a brief overview of the results of empirical studies of NAIRU estimate conducted for Central and Eastern European countries (Table 1). The results of analyses were mostly based on unit root tests (time series or in panel) and for the most part they corroborated the non-stationary nature of the NAIRU series and the hysteresis effect.

Table 1 **Overview of empirical literature on NAIRU estimate and testing the hysteresis effect for CESEE countries**

Author(s)	Sample	Method of analysis	Findings of analysis
Leon-Ledesma, McAdam (2003)	Czech Republic, Poland, Hungary, Slovenia, Slovakia, Latvia, Lithuania, Estonia, Bulgaria, Romania, Russia, Croatia and EY15; 1991: M1-2002: M3	Unit root testing of time series and in panel, Markov models	Unit root testing rejects the hysteresis hypothesis for Central and Eastern European countries if the effects of structural changes and the production cycle are controlled, but the adjustment effect is faster than in EU-15
Camamero, Carrion-i-Silvestre, Tamarit (2005)	Czech Republic, Poland, Hungary, Slovenia, Slovakia, Latvia, Lithuania, Estonia, Romania, Croatia, Malta and Cyprus; 1998: M1-20007: M12	GLS unit root testing which tests the hysteresis in contrast with the natural unemployment rate	The hysteresis effect is confirmed, but rejected if the presence of two structural breaks is allowed during unit root testing
Cuestas, Gil-Alana, Staehr (2011)	Czech Republic, Poland, Hungary, Slovenia, Slovakia, Latvia, Lithuania, Estonia; 1998: M1-20007: M12	Unit root testing and ARFIMA models	Unemployment is non-stationary, thus confirming the hysteresis effect, the least persistence is recorded in Hungary and Slovenia, and the strongest in Poland
Nemec, Vasicek (2011)	Czech Republic and New Zealand; 1996: Q1-2007: Q3	Bayesian estimation, DSGE model, Kalman filter	The hysteresis effect is confirmed for the Czech Republic, while testing for New Zealand was completed using the Bayesian model that enables the estimation of time-varying parameters. In the Czech Republic, NAIRU is influenced by previous unemployment, and in New Zealand by the structural factors

Author(s)	Sample	Method of analysis	Findings of analysis
Gözgör (2013)	Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Poland, Slovakia, Slovenia; 1998: M1-2012: M1	Unit root testing in panel	Hysteresis effect confirmed
Marjanović, Maksimović, Stanišić (2014)	Bulgaria, Romania, Czech Republic, Poland, Hungary, Slovenia, Slovakia, Croatia; 2000: Q1-2012: Q4	Kalman filter for the NAIRU estimate; unit root testing for estimating the hysteresis effect; panel regression with fixed effects for estimating the link between NAIRU and inflation	Hysteresis effect confirmed for the greater part of the sample; significant fall in NAIRU for all countries except Hungary, in 2012 the Czech Republic had the lowest NAIRU (6.5%), and Bulgaria the highest (9.7%); inflation has a significant effect on NAIRU
Szabo (2015)	Hungary; 1998–2014	HP filter, state-space model with Kalman filter for estimating NAIRU and the unemployment gap, VAR models for estimating prediction power	The best results in terms of the wage prediction power were recorded by the model based on the Phillips curve, halt in the labour market is still present at end-2014
Mladenović (2016)	Bulgaria, Romania, Hungary, Slovenia, Croatia; 2004: M1-2015: M7	Unit root testing and ARFIMA models	Hysteresis effect confirmed for Hungary and Slovenia, systemic component of the trend is impacted by strong shocks and the series show a greater degree of persistence than purely stationary series
Kaderabkova, Jasova (2020)	Czech Republic and Poland; 2000: Q1–2016: Q4	Phillips curve, HP filter for NAIRU estimate	Low slope coefficient of the Phillips curve in the case of the Czech Republic (-0.19) and Poland; NAIRU for the entire observed period for the Czech Republic is 6.7%, and for Poland 12.5%. NAIRU is impacted by unemployment incentives, in the Czech Republic also by the minimum cost of labour, and in Poland by imported inflation

In his paper, Andreescu, F. D. (2024) analysed to which extent Okun's law is valid in Central and Eastern European countries. The sample in this paper covers the period from 2010 to 2019, observed quarterly. Okun's coefficient varies among observed countries and the conclusion is that it can be used as a tool for comparing labour market performance among countries. The coefficient of determination is low, indicating that the parameter does not have a high statistical significance, but can be used for projections of relationships between the observed variables bearing in mind the tests of the significance of the tested relationship. The paper concluded that the unemployment rate in developing countries is less sensitive to changes in real GDP than in advanced economies, which the author associates with different employment policies implemented in those countries.

In their paper, An, Z., Ball, L., Jalles, J., and Loungani, P. (2019) tested whether Okun's law is applicable on data for 70 countries in the period between 1990 and 2015 on several groups of countries, yielding results for each individual country. The authors used the estimate of a simple linear relationship between changes in the unemployment rate and changes in real GDP, and analysed how well this relationship can be forecast on the grounds of the historically-based estimated coefficients. The paper gives a detailed overview of the obtained coefficients by groups of countries according to their income level, suggesting the conclusion that on average, the estimated coefficients confirm Okun's law in the majority of high-income advanced countries, i.e. the values of estimated coefficients are around 0.3, while the value of this coefficient is on average lower for lower-income countries. As in the previously mentioned paper, this can be attributed to structural differences in the labour market.

5 Dynamics of movement of labour market indicators in Serbia in the past decade

The labour market recovery in Serbia over the past decade (2014–2024) was brought about by favourable macroeconomic movements, responsible economic policy conduct, accelerated economic growth and a more favourable business and investment environment, resulting in a high inflow of FDI and the creation of new jobs. Improved labour market indicators and the market's increased efficiency was also the result of labour market reforms and the implementation of active employment measures, enabled by amendments to the Law on Labour, adopted in 2014. The amendments enabled the extension of the maximum length of the fixed term contract from one to two years, work from home and part-time work, while severance pay and the past years of service are calculated according to the years of service with the latest employer, and not in total, etc.

All key indicators in the Labour Force Survey – activity, employment and unemployment rates – suggested an improvement in the labour market. Though data for the past period are not fully comparable because of methodology changes in the Labour Force Survey, in which as of 2021 indicators according to the 2022 population census were presented, it is clearly evident that all key indicators displayed an upward trend over the past decade.

The activity (participation) rate, that measures the share of labour force in working age population, averaged 62.5% in 2014, only to exceed 66% in 2020. In the past three years the participation rate rose further, reaching around 72% in 2023. With the rise in activity, the total employment rate also increased: in the period 2014–2020 it climbed almost 7 pp to 47%. Calculated according to the new methodology, in 2023 this rate exceeded 50%. Thanks to FDI, which were diversified not only in terms of production sectors but geographically as well, better alignment of labour market indicators by region was secured.

Table 2 **Labour market indicators according to the Labour Force Survey**

Year	Participation rate (15–64)	Activity rate (15+)	Employment rate	Unemployment rate	Long-term unemployment rate	Inactive population rate
2013	62.2	50.3	38.3	24		49.7
2014	62.5	50.7	40.3	20.6		49.3
2015	62.7	50.3	40.7	18.9		49.7
2016	64.6	51.8	43.3	16.4		48.2
2017	65.6	52.4	44.8	14.5		47.6
2018	66.7	52.9	45.6	13.7		47.1
2019	66.8	52.9	47	11.2		47.1
2020	66.4	52.2	47.1	9.7		47.8
2021*	69.7	53.8	47.8	11.1	5.5	46.2
2022	70.9	54.7	49.5	9.5	4.4	45.3
2023	71.7	55.4	50.2	9.4	4.2	44.6
Q1 2024	72.5	56.2	50.9	9.4	4.1	43.8

Note: Since 2021, data were revised in line with the 2022 population census. The table shows annual averages.

Increase in activity and employment was accompanied by a significant decrease in the total unemployment rate, which was practically halved in six years, from 20.6% in 2014. In the past two years the rate stabilised at around 9.5%, with a mild fall in long-term unemployment to the level of slightly above 4%. According to data of the National

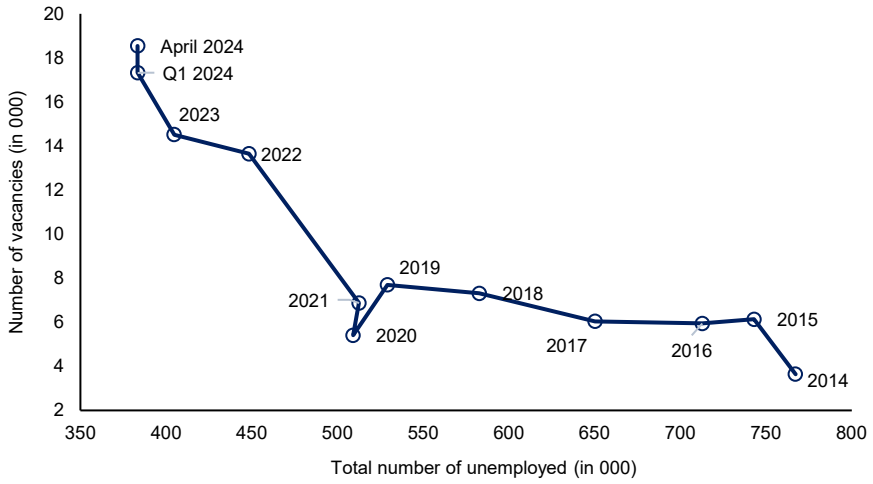
Employment Service, in July 2023 total unemployment dropped below 400,000 persons, and in April 2024 measured slightly more than 382,000 compared to 742,000 at end-2014.

The total number of the formally employed rose by almost 380,000 persons in the past ten years, to 2.4 mn persons in April 2024. Formal employment rose primarily in the private sector, measuring close to 1.75 mn persons in April, having risen by almost 407,000 persons relative to the average employment level from 2014. By activity, the biggest employment increase was recorded in manufacturing (128,000 persons), followed by trade (60,000) and the ICT sector (59,000). The number of employed persons decreased only in agriculture (by around 11,000), as did the number of individual agricultural producers, where the share of the so-called vulnerable employment (self-employed and family workers) is the highest. Concurrently with the increase in total formal employment, there was a decrease in the share of informal employment, i.e. the percentage of persons working without a formal employment contract in the total number of employees – from the average of 21% in 2014 to around 12.5% in 2023, owing to stepped-up inspections and a more efficient fight against the grey economy.

The following charts show the relationship between the average number of unemployed persons and the number of job vacancies (approximated with the corporates' reported demand for employment by age) – **Beveridge curve**, as well as the relationship between the unemployment rate and average core inflation by year – **Phillips curve**.

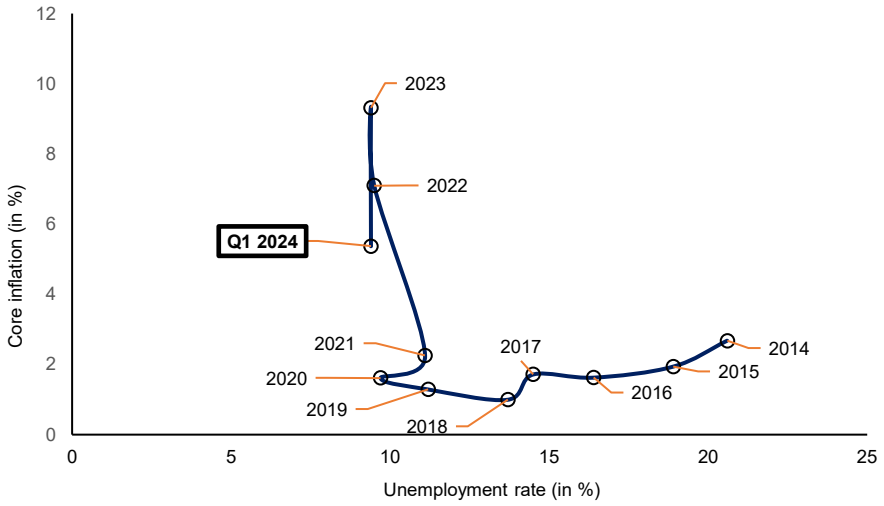
The Beveridge curve graph shows that the curve had a negative slope during the observed period – it moved left and up, indicating an increase in labour market flexibility and efficiency in connecting labour force supply and demand, as well as that the total economic recovery spilled over onto the labour market by creating new jobs and lowering unemployment numbers.

Chart 1 **Relationship between unemployment numbers and the job vacancy rate – Beveridge curve**



Source: National Employment Service and NBS calculation.

Chart 2 **Relationship between the unemployment rate and core inflation – Phillips curve**



Source: SORS.

For the bulk of the observed period (2014–2020), the Phillips curve did not have a negative slope which would have been anticipated according to economic theory. Because of the fact that unemployment was high in the prior period and above NAIRU, its decrease did not reflect on inflation growth, which was extremely low in this period, owing to the full coordination of monetary and fiscal policy measures, with efficient fiscal consolidation and the preserved relative stability of the exchange rate in the domestic market, as well as low prices of primary commodities in the global market.

Since 2021, against the backdrop of rising global prices of energy and other primary commodities and halts in supply chains, further intensified with the outbreak of the conflict in Ukraine, inflation rose both globally and at home. Despite stronger inflationary pressures and monetary tightening, labour market conditions did not deteriorate, and the unemployment rate did not increase, but rather started to edge down slightly. With wages simultaneously posting two-digit y-o-y growth rates, and labour force shortages occurring for some occupation groups, the question arises as to whether conditions in the Serbian labour market have become tight and whether they are having an inflationary effect. This is why the model used for medium-term inflation projection was supplemented to include labour market factors to a greater degree.

6 Inclusion of the labour market into the NBS medium-term inflation projection

The medium-term inflation projection model, whose main postulates are explained in a paper in the NBS *Working Papers Bulletin*,[1] has been adjusted to improve the monitoring of labour market factors and estimate their impact on inflation and economic activity.

[1] wp_bulletin_09_22.pdf (nbs.rs).

In the current model, real wages are an important factor impacting inflation. It has been assumed in the model that the movement (deviation) of real wages, together with the real exchange rate and real production – relative to their potential, i.e. the equilibrium level – ultimately determine the total marginal costs included in inflation equations. The definition of real wages ($dl\_realwage$) is standard:

$$dl\_realwage_t = \pi_t^{wage} - \pi_t, \quad (7)$$

i.e. nominal wage growth (π_t^{wage}) is adjusted by inflation movement.

The measure of inflationary wage pressures is presented by the deviation of real wages from equilibrium:

$$wage\_gap_t = l\_realwage_t - l\_realwage\_tnd_t. \quad (8)$$

To achieve the equilibrium real wage, real wage growth should be equal to productivity growth in the long run. In this case, productivity growth is defined as productivity growth per worker or GDP growth adjusted to employment growth. In equilibrium, this definition of productivity growth ($ss\_dl\_realwage\_tnd$) would become potential GDP ($ss\_dl\_y\_tnd$) adjusted to equilibrium employment growth ($ss\_dl\_empl\_tnd$) (Karel, M, Pranovich, M. & Vlcek, J. (2018)).

The equation of real wage trend ($dl\_realwage\_tnd$) is as follows:

$$dl\_realwage\_tnd_t = a_{11} \cdot dl\_realwage\_tnd_{t-1} + (1 - a_{11}) \cdot ss\_dl\_realwage\_tnd + \varepsilon_t^{wedge}, \quad (9)$$

where

$$ss\_dl\_realwage\_tnd = ss\_dl\_y\_tnd - ss\_dl\_empl\_tnd. \quad (10)$$

As we assume in the model, the steady state of potential GDP growth rate ($ss\_dl\_y\_tnd$) will equal 4% in the long run. Employment growth ($ss\_dl\_empl\_tnd$) is assumed to measure 0.6% in the long run, and the steady state of the real wage growth trend ($ss\_dl\_realwage\_tnd$) will be 3.4%.

After defining the equations for real wages and their trend, in the model, the real wage gap ($wage\_gap_t$), as a component of real marginal costs of the Phillips curve, is obtained as a difference between real wages and their trend.

The real wage gap approximately reflects unit labour costs that employers face. In fact, the real wage gap reflects real wages adjusted to equilibrium productivity, while the definition of unit labour costs concerns real wages adjusted to current productivity. The real wage series was previously logarithmed.

Though real wages are the reason why inflation deviated from the target, the basic equation we start from concerns nominal wages. In the model, nominal wages follow the Phillips curve (wage inflation), which depends on the wage expectation and and nominal wages from the previous period. The movement of nominal wages is also depended on the real wage and output gaps. The real wage gap plays an equilibrium role: if it is positive, it is not only that nominal wages rise above headline inflation, but real wages rise above productivity as well.

The productivity gap in the model is measured through the difference in the GDP gap and the employment gap ($y\_gap_t - empl\_gap_t$), which is why employers will be forced to reduce nominal wages. The employment gap will be explained further on, once we introduce the equations relating to labour market dynamics (Botha, B., Jager, Sh., Ruch, F. & Steinbach, R. (2017)).

The nominal wage equation is as follows:

$$\pi_t^{wage} = a_{12} \cdot \pi_{t-1}^{wage} + (1 - a_{12}) \cdot E_t\pi_t^{wage} + (a_{13} \cdot (y\_gap_t - empl\_gap_t) - a_{14} \cdot wage\_gap_t) + \varepsilon_t^{\pi wage}, \quad (11)$$

which means that nominal wages depend on past wages, expectations of future wages and the difference between the productivity gap and the real wage gap. Compared to the model changes presented in the paper in the *Working Papers Bulletin* for 2022, in the meantime we added a new equation for the wage expectation . It is a combination of the model projection of the expected change of nominal wages and the movement of inflation expectations ($E_t\pi 4_{t+4}$), adjusted by the equilibrium level of wages:

$$E_t\pi_t^{wage} = a_{15} \cdot \pi_{t+1}^{wage} + (1 - a_{15}) \cdot (ss\_dl\_realwage\_tnd + E_t\pi 4_{t+4}) + \varepsilon_t^{e\pi wage}. \quad (12)$$

Introducing the labour market in the medium-term projection model, New Keynesian model, implied a previous estimate of unobserved components (gap and trend), by using the HP filter.

Given the specificities of the labour market and data from the Labour Force Survey, we analysed the period from Q1 2010 to Q1 2024. First, we had to estimate potential employment for Serbia as the equilibrium level of wages is obtained once potential GDP growth is adjusted for potential employment growth.

We used the Labour Force Survey data on the working-age population outside agriculture[2] ($pop64_t$), the activity rate outside agriculture[3] (pr_t) and the unemployment rate (unr_t), with the assumption that there are no unemployed persons in agriculture. We applied the HP filter to each of the specified series, and obtained their trend components. The $unr\_tnd\_hp_t$ series is used in our analysis only temporarily as the NAIRU measure to obtain the estimate of potential employment. Finally, based on the obtained data, we can calculate potential employment ($empl\_tnd_t$) by applying the following:

$$empl\_tnd_t = pop64\_tnd\_hp_t * pr\_tnd\_hp_t * (1 - unr\_tnd\_hp_t). \quad (13)$$

The employment gap equation ($empl\_gap_t$) is an autoregression processes adjusted by the unemployment rate gap. The trend in employment is an autoregression process, assuming the employment growth trend measures around 0.6% in the long run.

[2] The working-age population outside agriculture includes persons aged 15 to 64, not engaged in agriculture. This number is obtained by excluding from the total number of employed persons those who are employed in agriculture and family workers.

[3] The activity rate outside agriculture is a share of the active population outside agriculture in the working-age population. The active population, i.e. the labour force, consists of all employed and unemployed persons aged 15+.

$$empl\_gap_t = a_{21} \cdot empl\_gap_{t-1} - a_{22} \cdot unr\_gap_t + \varepsilon_t^{emplgap} \quad (14)$$

$$empl\_tnd_t = a_{23} \cdot empl\_tnd_{t-1} + (1 - a_{23}) \cdot ss\_dl\_empl\_tnd + \varepsilon_t^{empltnd} \quad (15)$$

$$empl_t = empl\_gap_t + empl\_tnd_t \quad (16)$$

Also, the equation for gap in the unemployment rate (unr_gap_t) is estimated according to Okun's law, with the unemployment rate trend, i.e. NAIRU, estimated in line with it. Given that our model estimates gaps, we estimated this relationship by using the GDP gap and the unemployment gap.

$$unr\_gap_t = a_{31} \cdot unr\_gap_{t-1} - a_{32} \cdot y\_gap_t + \varepsilon_t^{unrgap} \quad (17)$$

$$nairu_t = a_{33} \cdot nairu_{t-1} + (1 - a_{33}) \cdot ss\_nairu + \varepsilon_t^{nairu} \quad (18)$$

$$unr_t = unr\_gap_t + nairu_t \quad (19)$$

We calibrated to -0.15 the coefficient with the GDP gap in the unemployment rate gap equation, bearing in mind the econometric analysis that we carried out on data for Serbia (section 7) and empirical findings from literature. This means that the growth of 1 pp in the GDP gap narrows the unemployment gap by 0.15 pp. We assumed that the equilibrium level of the unemployment rate in the long run (ss_nairu) is 6%.

The equations for inflation of food and non-food products and services, and the equation for aggregate demand, did not change compared to data presented in the 2022 *Working Papers Bulletin*.

The equation for inflation of non-food products and services is as follows:

$$\pi_t^{nonfood} = a_{41} \cdot \pi_{t-1}^{nonfood} + a_{42} \cdot \pi_t^M + (1 - a_{41} - a_{42}) \cdot E_t\pi 4_{t+4} + a_{43} \cdot z\_gap_{t-1} + \\ + a_{44} \cdot y\_gap_{t-1} + a_{45} \cdot wage\_gap_t + \varepsilon_t^{nonfood}. \quad (20)$$

The equation for inflation of industrial-food products is as follows:

$$\pi_t^{food} = a_{51} \cdot \pi_{t-1}^{food} + a_{52} \cdot \pi_t^M + (1 - a_{51} - a_{52}) E_t\pi 4_{t+4} + a_{53} \cdot RMCP\_gap_{t-1} + \\ a_{54} \cdot z\_gap_{t-1} + + a_{55} \cdot y\_gap_{t-1} + a_{56} \cdot wage\_gap_t + \varepsilon_t^{food}. \quad (21)$$

The aggregate demand equation is as follows:

$$y_{gap_t} = a_{61} \cdot y_{gap_{t-1}} - a_{62} \cdot rmci_t + a_{63} \cdot y_{gap_t^{ez}} + a_{64} \cdot fi_t + a_{65} \cdot wage_{gap_{t-1}} + \varepsilon_t^{ygap}. \quad (22)$$

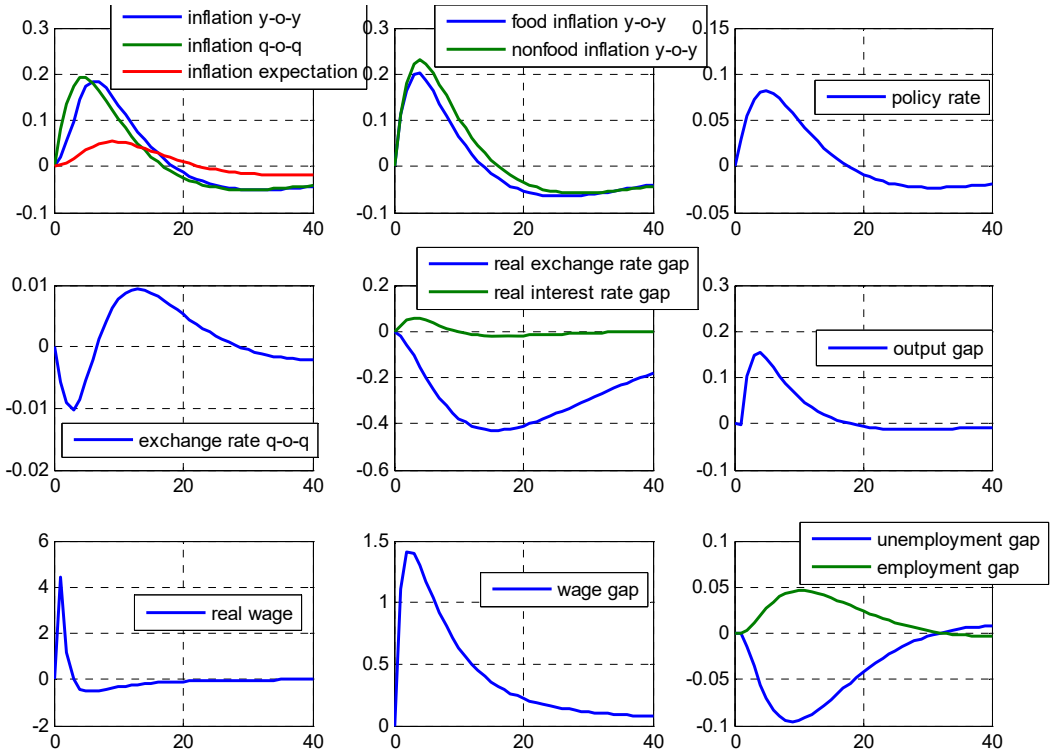
We observed the behaviour of variables in the estimated New Keynesian model through the impact of shocks in inflation, nominal wages, aggregate demand and monetary policy response, which we shall present later in the text. For identification of the notation given in the equations see Appendix.

6.1 Shock in nominal wages

If we assume the autonomous nominal minimal wage growth of 1% in a single quarter,[4] this directly leads to the y-o-y nominal wage growth in the following four quarters.

[4] The growth rates in the model are annualised, i.e. multiplied by four, which is why the nominal wage growth in Chart 3 equals 4% in Q1, although the shock is 1%.

Chart 3 **Function of response to the shock in wage movement**



The nominal wage growth that is faster than inflation increases real wages, opening the positive gap in real wages due to employer costs being higher than productivity growth. Higher company costs (a positive gap in real wages) place inflationary pressures in the food and non-food inflation component. Also, higher consumption opens a positive output gap. Higher demand reduces the unemployment rate following Okun's law, due to employment growth. Real wage growth higher than productivity growth quickly reduces nominal wages due to rising labour costs, which closes the positive gap in real wages.

The central bank responds by raising its key policy rate, basing that decision on projected headline y-o-y inflation for four periods ahead. A rise in nominal interest leads to a rise in real interest and the opening of the positive gap in real interest. Tight monetary policy, along with a reduction in real marginal costs of net importers, generates disinflationary pressures. Prices rise for a while longer as a consequence of inertia, exerting pressure on a reduction in real wages, while the central bank's response returns inflation to the target. A reduction in real wages contributes to the gradual opening of the negative output gap in the coming period.

6.2 Shock in the key policy rate

A shock simulation in the function of monetary policy response assumes a 1 pp rise in the key policy rate in one quarter. The function of monetary policy response in the medium-term projection model defines the way in which the central bank makes key policy rate decisions (i_t):

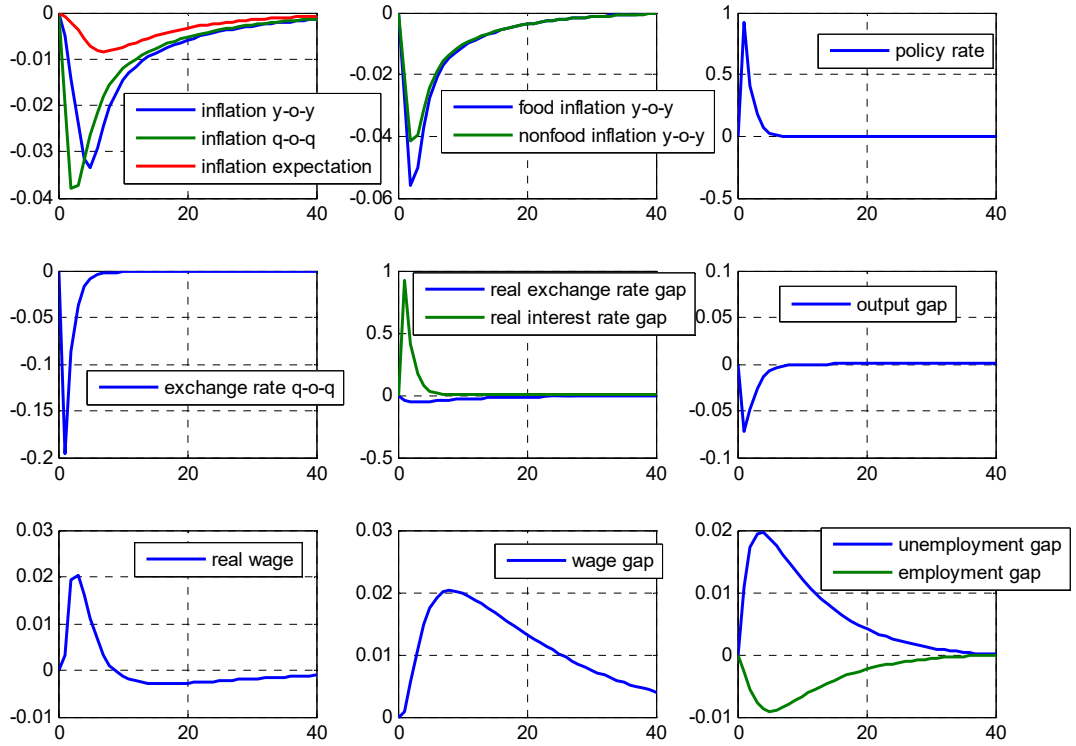
$$i_t = a_{71} \cdot i_{t-1} + (1 - a_{71}) \cdot [i_t^n + a_{72} \cdot ((1 - a_{73}) \cdot (\pi 4_{t+4} - \pi_{t+4}^{tar}) + a_{73} \cdot y\_gap_t))]. \quad (23)$$

Given the price rigidity, a rise in nominal interest leads to a rise in real interest. According to the uncovered interest rate parity, a rise in real interest triggers real appreciation, which leads to a drop in real marginal costs of net importers. This opens a real appreciation gap, which produces disinflationary pressures.

The opening of a positive gap in real interest, i.e. a rise in borrowing costs to finance consumption and investment, triggers a fall in demand, which also has a disinflationary effect. Reduced aggregate demand impacts unemployment growth and the opening of a positive gap in unemployment, i.e. a negative gap in employment.

In the following period, inflation's decline leads to a rise in real wages and the opening of their positive gap. However, a fall in productivity and real wage growth above trend impacts a reduction in nominal wages, which, together with a rising interest rate, gradually brings inflation back to the target.

Chart 4 **Function of response to a rise in the key policy rate**

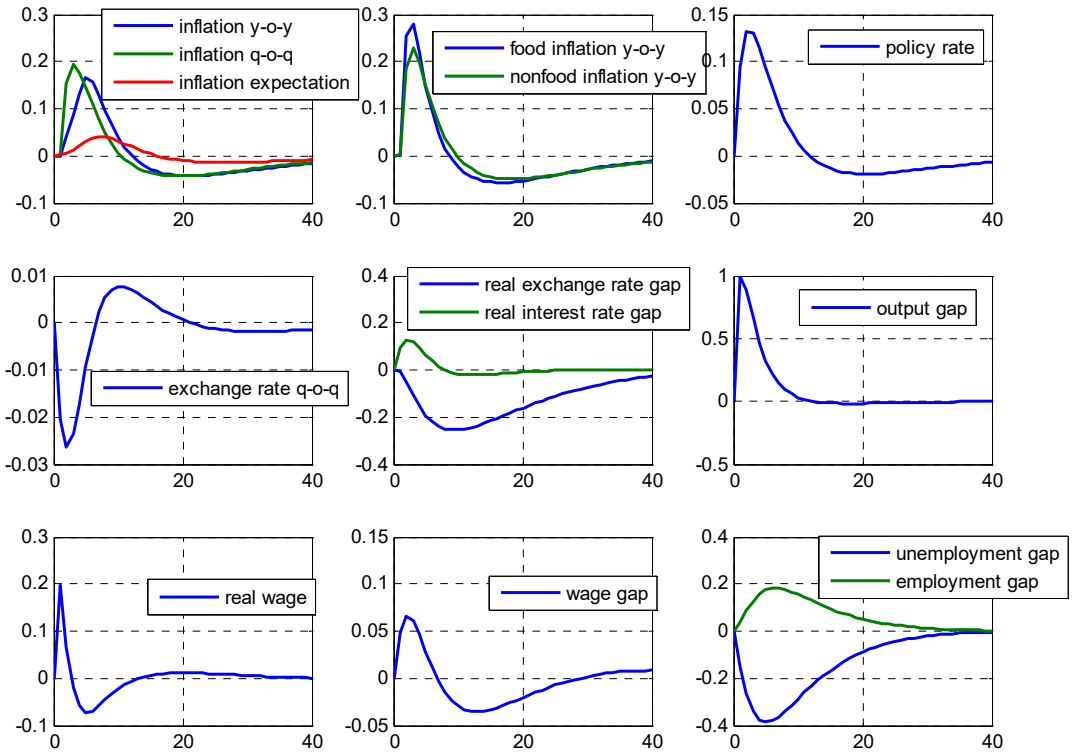


The central bank is forced to ease monetary policy in the coming quarters in order to return inflation to the target. The lowering of the key policy rate calms appreciation pressures, which, along with inflation going back to the target , leads to the closing of the appreciation gap, and thus of the negative output gap. This leads to the closing of the gap in real wages, employment and unemployment.

6.3 Demand shock

Let us assume that the autonomous demand growth of 1% took place and that the effects of this shock will remain for some time yet. Demand growth impacts a rise in real wages because productivity goes up. This results in an increase in nominal wages and employment, which opens a negative gap in unemployment. After two quarters, the negative gap in unemployment, together with demand, pushes inflation up. The central bank responds by raising the key policy rate, which, due to its movement rigidity, touches its peak five quarters later, resulting in the closing of the output gap and further influencing a reduction in productivity. By extension, all of this leads to a decline in nominal wages, which, along with real appreciation, leads to inflation's reduction.

Chart 5 **Function of response to shock in the output gap**



7 Results of the estimate of NAIRU and other labour market indicators based on the medium-term inflation projection model and testing the hysteresis effects

7.1 Empirical analysis of Okun's law for Serbia

This section elaborates on the empirical relation between real GDP and the unemployment rate. To prove the link between the unemployment rate and the GDP growth rate, Okun applied two different approaches:

1. Gap method – based on the estimate of the linear relationship between the deviation of the unemployment rate from NAIRU and the deviation of real GDP from potential GDP:

$$unr_{gap_t} = \beta \cdot y_{gap_t} + \varepsilon_t^{unrgap}, \beta < 0. \quad (24)$$

2. Difference model –based on the relationship between a change in the unemployment rate and the GDP growth rate:

$$\Delta unr_t = \alpha + \beta \cdot \Delta y_t + \omega_t. \quad (25)$$

By using data for Serbia, we estimated the relationship between unemployment and real GDP in the 2010–2024 period at the quarterly level, by applying the above two methods. Before estimating the coefficients that confirm whether there is a link between unemployment and GDP, we checked the stationarity of the series in levels and implemented the Granger causality test. The stationarity of the series of the unemployment rate and real GDP are tested by the Augmented Dickey-Fuller (ADF) test. The time series we have analysed – the unemployment rate and real GDP – are stationary in the first difference, while the deviations of these series from their trends, which we have estimated with the HP filter for these purposes, are stationary in levels.

Table 3 **Results of the Granger causality test**

Zero hypothesis	F statistics	Probability	Order of integration (ADF)
Y does not Granger Cause U	*5.64889*	*0.0062*	*I(1)*
U does not Granger Cause Y	*1.32450*	*0.2753*	

The Granger causality test confirms that real GDP growth impacts a reduction in the unemployment rate and that the reverse relationship is not true.

Table 4 **Results of the ADF stationarity test**

Variable	Order of integration	ADF		Exogenous
		T statistics	Probability	
ΔY	I(0)	–3.867328	0.0043	constant
ΔU	I(0)	–3.660437	0.0077	constant
Y_gap	I(0)	–4.296239	0.0001	–
U_gap	I(0)	–4.797625	0.0002	–

By estimating the equations (24) and (25) by the OLS method, the hypothesis of the negative relationship between unemployment rate and GDP is confirmed, when it comes both

to the gap method and the first difference method. According to the results obtained, the higher GDP growrh rate of 1 pp will decrase the unemployment rate by 0.12 pp at the quarterly level. It should be noted that Okun's coefficient may be sensitive to the approach used to estimate cyclical components (HP filter). In case of Serbia, the coefficient estimated by the gap method is similar with the first difference method estimation, which confirmed the direction and intensity of the relation we have estimated.

Table 5 **Estimate of Okun's law**

Okun's coefficient		*p value*		*R value*	
Gap method	Difference method	Gap method	Difference method	Gap method	Difference method
-0.111904	-0.123185	0.0256	0.0001	0.090539	0.247098

7.2 Estimate of NAIRU and other labour market indicators based on the medium-term inflation projection model and testing the hysteresis effects

We estimated NAIRU based on the model used for the medium-term inflation projection and the Kalman filter.

First, when it comes to the estimated NAIRU, the Chart below shows that in the past years it had a downward trajectory, supported by a reduction in the unemployment rate. However, the NAIRU remained below the level of actualunemployment rate. According to our estimate, the NAIRU currently stands at around 8%.

Chart 6 **Unemployment rate and NAIRU** (in %)

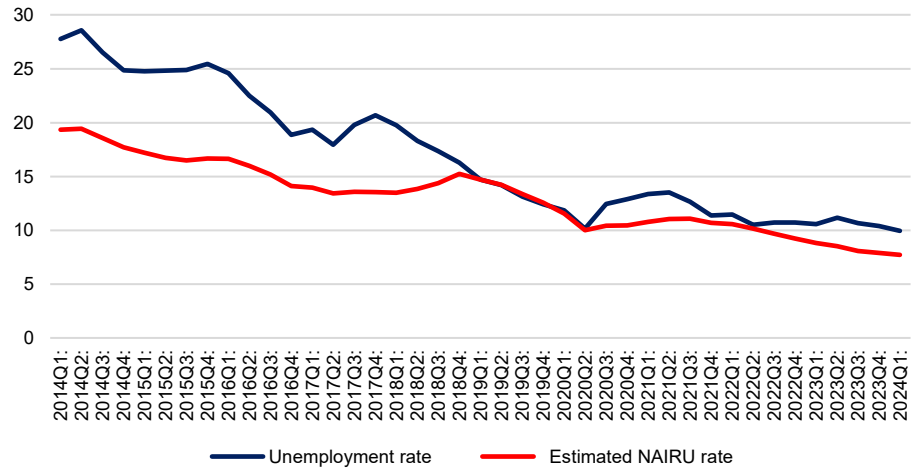


Chart 7 **Employment (without agriculture) and the trend**

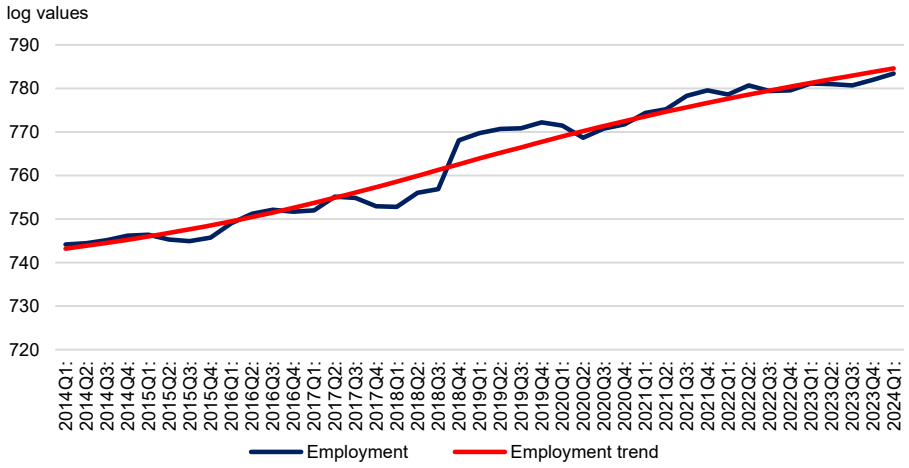
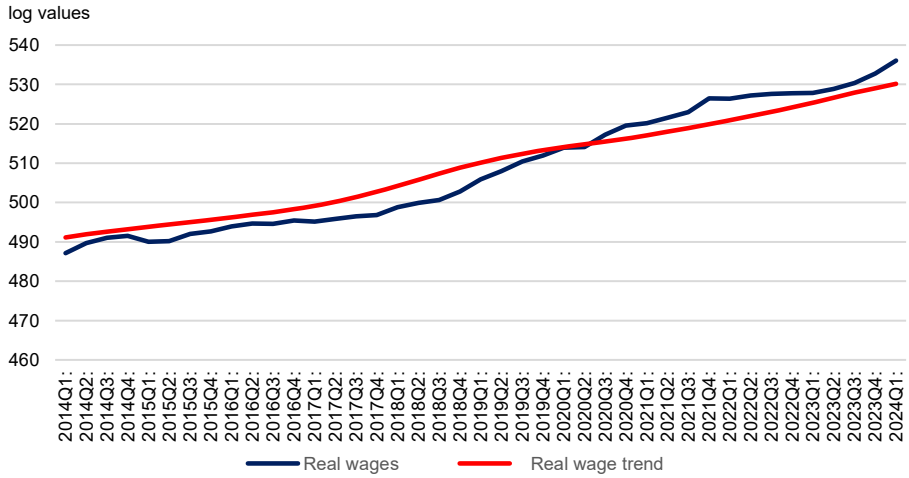


Chart 8 **Real wages (private sector) and the trend**



Given that the hysteresis effect means a change in NAIRU over time, we tested this effect by checking the statistical significance of the stochastic trend in the estimated NAIRU series. A negative and statistically significant trend value (-0.1626) is confirmed for the period from Q1 2014 to Q1 2024. We also tested the hysteresis effect by applying the ADF unit root test, as shown in the table below. The ADF also confirmed that the NAIRU series is non-stationary in the level, and stationary at the level of first differences, meaning that hysteresis effect is confirmed.

Table 6 **Testing of NAIRU stationarity**

Unit root test	***ADF***	
	H0: series contains the unit root	
	test value	number of lags
Level	–2.821952	1
First difference	–3.414401**	0

Note: ** refers to the statistical significance of 5%. The model with a constant and trend is estimated in the level, and the model with a constant is estimated in the first difference.

8 Conclusion

Empirical analysis of the labour market and the estimate of its impact on inflation are particularly gaining in importance in the current circumstances, notably for central banks. As the unemployment rate in Serbia is declining and there is high demand for some types of occupations, with wages recording two-digit growth rates in the past two years, an adequate estimate of labour market factors on inflation is important for the NBS.

To more adequately examine the effect of labour market factors, the NBS has upgraded its medium-term inflation projection model. While the paper in the September 2022 *Working Papers Bulletin* of the NBS elaborates on the model coverage of the impact of wages on inflation both on the supply- and demand-side, this paper outlines the impact of other labour market factors, starting from the concept of the unemployment gap, i.e. the difference between the achieved unemployment rate and the unemployment rate that does not raise inflation (NAIRU).

By applying the Kalman filter, NAIRU was estimated – it currently stands at around 8% and is likely to decline to around 6.6% until end-2026. According to our projections, it is likely to stay below the unemployment rate, indicating that the labour market is still not tight and is not generating any major inflationary pressures.

By means of impulse response functions, we have also shown the effects of the autonomous increase in wages, the key policy rate and demand on the key model variables (notably inflation).

At the end of the paper, by applying unit root tests and the statistical significance of the stochastic trend, we tested and confirmed the existence of the hysteresis effect – which points out that economic policy measures on the demand side can influence unemployment rate.

Appendix

Series used in the analysis

Code	Description	Source of data
l_wage_t	s-a nominal wages in the private sector, log series	SORS, seasonal adjustment carried out by tramo-seats method
π_t^{wage}	quarterly change in nominal wages	SORS, authors' calculation
$l\_realwage_t$	real wages, log values	authors' calculation
$dl\_realwage_t$	change in real wages	authors' calculation
$l\_realwage\_tnd$	real wage trend, log values	authors' calculation
$dl\_realwage\_tnd$	change in real wage trend	authors' calculation
$wage\_gap_t$	real wage gap	authors' calculation
$empl_t$	number of employed persons in the economy, excl. the agricultural sector, log values	SORS
$empl\_tnd_t$	employment trend	authors' calculation
$empl\_gap_t$	employment gap	authors' calculation
unr_t	unemployment rate	SORS, Labour Force Survey
$nairu_t$	unemployment rate trend	authors' calculation
unr_gap_t	unemployment gap	authors' calculation
$pop64_t$	number of working-age population outside agriculture	SORS, authors' calculation
pr_t	activity rate outside agriculture	SORS, authors' calculation
$pop\_64\_tnd\_hp$	trend of working-age population obtained by HP filter	authors' calculation
$pr\_tnd\_hp_t$	activity rate outside agriculture obtained by HP filter	authors' calculation
$ss\_dl\_realwage\_tnd$	equilibrium real wage growth rate	authors' calculation
$ss\_dl\_y\_tnd$	potential GDP growth rate in the long run	authors' assumption
$ss\_dl\_empl\_tnd$	equilibrium employment growth	authors' assumption
ss_nairu	equilibrium level of the unemployment rate in the long run	authors' assumption
$E_t\pi 4_{t+4}$	one-year ahead inflation expectations	
$\pi_t^{nonfood}$	quarterly inflation of non-food products and services, s-a series	SORS, authors' calculation
π_t^{food}	quarterly inflation of industrial-food products, s-a series	SORS, authors' calculation
y_gap_t	output gap, obtained based on the series of non-agricultural value added	SORS, authors' calculation
$rmci_t$	real monetary conditions index	authors' calculation
$y\_gap_t^{ez}$	euro area output gap	Eurostat, authors' calculation
z_gap_{t-1}	real exchange rate gap	authors' calculation
$RMCP\_gap_t$	gap of real marginal costs in agriculture, ratio of prices of primary agricultural commodities and food prices	
fi_t	fiscal impulse, difference between two structural fiscal deficits	Ministry of Finance, authors' calculation
i_t	central bank policy rate	National Bank of Serbia
i_t^n	neutral interest rate	authors' assumption
π_{t+4}^{tar}	inflation target, four quarters ahead	National Bank of Serbia
$\pi 4_{t+4}$	y-o-y inflation, four quarters ahead	authors' assumption

Model coefficients

Coefficients	Values	Coefficients	Values
Wages		*Labour market*	
a_{11}	0.9	a_{21}	0.8
a_{12}	0.5	a_{22}	0.25
a_{13}	0.1	a_{23}	0.9
a_{14}	0.1	a_{31}	0.9
a_{15}	0.7	a_{32}	0.15
		a_{33}	0.9
Non-food inflation		*Food inflation*	
a_{41}	0.35	a_{51}	0.25
a_{42}	0.15	a_{52}	0.2
a_{43}	0.125	a_{53}	0.15
a_{44}	0.18	a_{54}	0.135
a_{45}	0.1	a_{55}	0.25
Output gap		a_{56}	0.1
a_{61}	0.2	*Monetary policy*	
a_{62}	0.15		
a_{63}	0.7	a_{71}	0.8
a_{64}	0.15	a_{72}	2
a_{65}	0.1	a_{73}	0.3

References

An, Z., Ball, L., Jalles, J. and Loungani, P. (2019). ”Do IMF forecasts respect Okun’s law? Evidence for advanced and developing economies“, *International Journal of Forecasting*, 35 (3): 1131–1142.

Andrescu, F. D. (2024). *Empirical Evidences Regarding Okun’s Law in the Central and Eastern Europe in the Post – Financial Crisis Period*. https://sciendo.com/es/article/10.2478/picbe-2024-0031.

Blanchard, O. J. & Summers. L. H. (1986). “Hysteresis and the European Unemployment Problem”, in *NBER Macroeconomics Annual*. S. Fischer, ed. Cambridge, Mass.: MIT Press, pp. 15–78.

Botha, B., Jager, Sh., Ruch, F. & Steinbach, R. (2017). “The Quarterly Projection Model of the SARB”, South African Reserve Bank, *Working Paper Series*, WP/17/01.

Camarero, M., Carrion-i-Silvestre, J. & Tamarit, C. (2005). “Unemployment dynamics and NAIRU estimates for accession countries: A univariate approach”, *Journal of Comparative Economics*, 2005, vol. 33, issue 3, 584–603.

Cuestas, J., Gil-Alana, L. & Staehr, K. (2011). “A further investigation of unemployment persistence in European transition economies”, *Journal of Comparative Economics*, 2011, vol. 39, issue 4, 514–532.

Cusbert, T. (2017). “Estimating the NAIRU and the Unemployment Gap”, Reserve Bank of Australia, *Bulletin*, June.

Đukić M., Momčilović M. & Trajčev Lj. (2011). “Structure and use of the medium-term projection model in the National Bank of Serbia”, *Economic Annals*, volume LVI, no. 188 / UDC: 3.33 ISSN: 0013-3264.

Fabriani, S. & Mestre, R. (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”, *American Economic Review*, March, 58, pp. 1–17.

Galí, J., Smets, F. & Wouters, R. (2011). “Unemployment In An Estimated New Keynesian Model”, *National Bureau Of Economic Research*, vol. 17084.

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.

Gözgör, G. (2013). “Testing Unemployment Persistence in Central and Eastern European Countries”, *International Journal of Economics and Financial Issues*, 3 (3), 694–700.

Hamilton, J. D. (1994). *Time Series Analysis*, Princeton University Press.

Heimberger, P., Kapeller, J. & Schütz, B. (2017). “The NAIRU determinants: What’s structural about unemployment in Europe?”, *Journal of Policy Modeling*, 39 (5), 883–908.

Kaderabkova, B., Jasova, E. (2020). “Phillips Curve During the Economic Cycle in the Czech Republic and Poland in the years 2000 to 2016”, 14th Economics & Finance Virtual Conference, Lisbon.

Karel, M, Pranovich, M. & Vlcek, J. (2018). “Structural Quarterly Projection Model for Belarus”, *IMF Working Paper*, WP/18/254.

Michaillat P., Saez, E. (2019). “Beveridgean unemployment gap”, *NBER Working Paper 26474*. http://www.nber.org/papers/w26474.

Mladenović, Z. (2016). "Econometric testing of unemployment hysteresis in selected CEE countries: lessons for the Serbian economy", *Ekonomika preduzeća*, 64 (7–8), 403–413.

Modigliani, F., Papademos, L. (1975). "Targets for monetary policy in the coming year", *Brookings Papers on Economic Activity*, vol. 1, pp. 141–163.

Nemec, D., Vasicek, O. (2011). "Estimating NAIRU in small open economies: models with adaptive and rational expectations", nr1215388989.pdf (nzae.org.nz).

Okun, A. M. (1962). "Potential GNP: Its measurement and significance", *Proceedings of the Business and Economics Statistics Section of the American Statistical Association*, pages 98–104.

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.

Phelps, E.S. (1968). "Money-wage dynamics and labour market equilibrium", *Journal of Political Economy*, vol. 76, no. 4, pp. 678–711.

Szabo, L. (2015). "Estimates of the Non-accelerating Inflation Rate of Unemployment (NAIRU) for Hungary", *MNB Working Papers 5*.

NBS Working Papers Bulletin, September 2022. wp_bulletin_09_22.pdf (nbs.rs).