WORKING PAPER

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NATURAL RATE OF UNEMPLOYMENT – REDUCED FORM APPROACH

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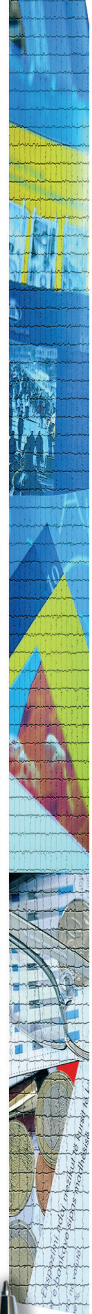

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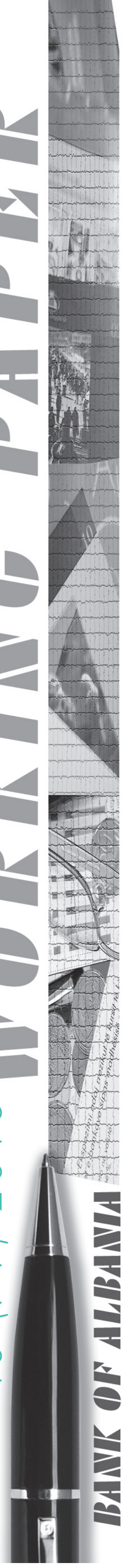

BANK OF ALBANIA

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Note: The views reflected in this paper are of the authors alone and do not represent views or policy stances of the Bank of Albania.

C O N T E N T

ABSTRACT

In this paper, we attempt to estimate a series of the natural rate of unemployment (NAIRU) for Albania in the period 1998-2012 applying a State-Space model featuring Kalman Filter. The approach is based on an Augmented Phillips Curve with NAIRU specified as an unobserved variable. The constraint is activated upon the path of the NAIRU. After determining the NAIRU series, we proceed with calculating the unemployment gap. According to the results, the unemployment gap is estimated as largely negative in the earlier part of the sample and closes up in the late 2002 - early 2003 (based on different estimations). The period 2003-2008 is characterized by a positive gap, which again turns slightly negative in the final years of the sample.

Keywords: NAIRU, Kalman Filter, State-Space model.

1. INTRODUCTION

An important aspect to be kept under consideration in economic policymaking is connected to the utilization rate of production factors: capital, labor and technology. Knowledge on these indicators is crucial in establishing the differences between actual and potential exploitation rates and the respective policy measures to be undertaken. In general terms, optimal levels of utilization are related to moderate and stable inflation. Inflation variations (increasing or decreasing) represent signals of deviation from potential utilization rates and the need for policy intervention (fiscal, monetary or structural).

The determination of optimal utilization rates comes in different fashions. In the early days, the Wharton index (Klein & Summers, 1967), minimum capital to output ratio and output peak (Mukherjess & Misra, 2012) represented some of the examples. However, a common indicator is the natural or structural rate of unemployment. The concept was first contemplated by Friedman (1968) and Phelps (1968). The term Non-Accelerating Inflation Rate of Unemployment (NAIRU) was first introduced by Modigliani & Papademos (1975). Also, Elmeskov (1993) suggested the application of wage inflation instead of price inflation. The general idea regards utilization of labor resources up to the point of moderate and stable inflation.

Economic theory emphasizes that, in the long run, unemployment is determined only by structural factors whilst inflation is a pure monetary phenomenon. However, in the shorter term, a trade-off exists between the two: inflation pressures pick up when unemployment rates fall below the natural rate. After the unemployment gap closes, inflation stabilizes at higher rates. The Phillips Curve is the most well-known model, which proxies the inflation-unemployment relationship. According to the "triangle model" (Gordon, 1997), inflation is modelled on expectations, unemployment and short-term supply shocks. Expectations represent the core effect while demand and supply shocks define the variations. Supply shocks are associated with temporary shock effects.

Empirically, there are two levels of the natural rate of unemployment (Turner et al. 2001). The long-term rate is established once all long-term and short-term effects on inflation are accounted for. Long-term structural and politicy effects are to be included in the estimation process. On the other hand, the short-term natural rate is defined when short-term shocks are accounted for. Based on this categorization, the short-term natural rate of unemployment features larger volatility and is subject to the actual rate of unemployment. Economic policy is more focused on the short-term rate since long-term natural rates are very complex to define and the adjustment process might take substantial time.

This paper attempts to estimate a quarterly series for the natural rate of unemployment (NAIRU) for the Albanian economy in the period 1998-2012. The methodology is defined as State-Space "reduced form" approach. It is based upon the identification of the Gordon Triangle Phillips Curve equation and the NAIRU path transition equation. The first equation includes backward looking expectations, the unemployment gap, unemployment shifts (speed-limit effects) and supply side short-term shocks. The explanatory variables are combined in different modes with the NAIRU series estimated through the Kalman Filter.

After estimating the natural rate of unemployment, we proceed with calculating the unemployment gap. The results show that, in the earlier part of the sample, the unemployment rate was much higher compared with the natural rate. The gap eventually closes in late 2002- early 2003. The period 2003-2008 is characterized by a positive gap (unemployment rate lower than the natural rate) with the remaining years reflecting a slightly negative gap.

2. ALTERNATIVE METHODS IN ESTIMATING THE NATURAL RATE OF UNEMPLOYMENT

The empirical literature on the estimation of the natural rate of unemployment follows three general approach. The first and earlier approaches included the so-called structural methods of estimation. According to this approach, the natural rate of unemployment regards the long-term equilibrium condition after taking into account all long-term and short-term factors affecting inflation and wages. The main principle according to Layard et al. (1994) is that "inflation stabilizes once real wages as desired by wage setters equal real wages as desired by price setters and the consistency is achieved through the natural rate of unemployment". In other words, stable inflation requires an unemployment rate equal to the natural rate. The typical structural model is defined as the Wage Setting-Price Setting. It was first proposed through the union economic theory (Dunlop, 1944) and later applied empirically by Nickell & Andrews (1983), Layard & Nickell (1986), L'Horty & Rault (1999). According to this approach, wages and prices are modelled simultaneously and through common variables.

The approach bears certain distinct advantages. First, the structural relationship between inflation, wages and the natural rate of unemployment (or the unemployment gap) is fully taken into account. At the same time, all long-term and short-term influences are accounted for leaving no room for omitted variables. In the end, as the estimated natural rate of unemployment represents a long-term rate, the structural approach is the most supported by the theoretical literature.

On the other hand, it is important to emphasize certain disadvantages featured in structural estimation models. Empirical literature has generated a strong debate on the most appropriate model to apply. Rowthorn (1999) points to certain long-term effects, which are very intricated to model and interpret. These include effects from interest rate, tax wedge indicators and general production factor productivity. Structural models also include estimated or calibrated substitution parameters for production factors. The appropriate parameters are also subject of debate in empirical literature.

Certain crucial disadvantages are related to specification issues in the model. First, empirical literature is concerned with the inclusion of common variables in explaining wages and inflation (Turner et al, 2001) and the associated endogenity problems. Secondly, it is extremely complicated to include several long-term variables, which are not expressed quantitatively and not included in official statistics. The difficulty is associated with certain institutional variables that include: unions' bargaining power, level of state power, the general business environment, population and labor force behavior, etc. Carlin & Soskice (1990) and Blanchard & Wolfers (1999) emphasize that structural models could not be called such if these variables are omitted from them. Lastly, pure structural models are unable to generate precision statistics such as error terms. Considering the enormous implementation difficulties, structural models are quiet rare in empirical literature with examples concentrated primarily in advanced economies, where time series for institutional variables are available.

Statistical models are featured in the second group of major estimation methods. A typical example of such models is the Hodrick-Prescott filter (Hodrick & Prescott, 1981), which disaggregates unemployment into a long-term trend component and a short-term cyclical component. The natural rate of unemployment is enbedded in the long-term term trend component assuming that the actual unemployment rate generally pursuits this trend. Possible deviations are considered temporary with the actual rate expected to return to equilibrium eventually due to automatic correction mechanisms present in the economy. In addition to the Hodrick-Prescott filter, statistical models also include the natural rate of unemployment as a random walk process (Watson, 1986).

Aside for the application ease and quickness, statistical models incorporate several disadvantages. Most importantly, the structural connection between inflation (wages) and the natural rate of unemployment (or unemployment gap) is not taken into account and the output series are generally unable to explain headline inflation or core inflation dynamics. At the same time, results are very sensitive to the input unemployment rate series. The level of sensitivity is further augmented considering that different prior calibrations of the filter generate different results. Furthermore, the filters feature the end-point-bias phenomenon as the natural rate of unemployment is artificially pushed towards the actual rate on both sides of the sample. Last but not least, the unavailability of error term statistics represents another shortcoming.

The third group in the estimation literature includes the reduced form models also called intermediate approaches. They bear the name from the fact that intermediate models represent hybrid forms between structural and statistical models with the purpose of merging as many advantages as possible and, at the same time, correct much of the disadvantages. An important advantage is the accountability of the structural inflation-unemployment (or wage unemployment) relationship as in the case of structural models. The catch is that only short-term shocks are incorporated. Accordingly, the estimated natural rate of unemployment is short term in nature and, therefore, more volatile in time if compared with the output of structural models.

The statistical influence emerges in the necesity to determine the time trajectory of the natural rate of unemployment. When first suggested the concept, Friedman suggested for a time invariant rate. However, empirical literature has moved even more towards the acceptance of a time variant rate (Dobrescu et al, 2011). As a result, alternative trajectories are suggested in the form of random walk, trend random walk or first order autoregressive processes.

Elmeskov (1993) has introduced one of the earliest variants of intermediate approaches. The model, which is based upon a Phillips Curve concept, features a wage inflation related natural rate of unemployment that is generated through a simple derivation. According to this derivation, the structural relationship is accounted for, but is considered as pale since input series are included as moving averages. Holden & Nymoen (1998) and Nymoen & Rødseth (2003) argue the importance in accounting for a strong inflation-unemployment relationship in the estimation of the natural rate of unemployment.

The intermediate approach has been enriched with the State-Space model optimized with the Kalman Filter as a deeper importance is attached to the inflation-unemployment relationship. The model core is the Phillips Curve equation, which expresses inflation differentials as a function of various variables including the unemployment gap. The natural rate of unemployment trajectory is introduced through an auxilliary equation based on the priciples mentioned above (usually in the form of random walk or first order autoregressive process). Therefore, the equation sets the bounds of volatility for the natural rate of unemployment which is time-variant.

Intermediate models feature important advantages compared with structural methods in terms of specification and diagnostic tests. First, the simplier specification enables the omission of long-term effecting variables. As mentioned previously, the inclussion of such variables, in particular institutional ones, is almost impossible giving data unavailability. At the same time, the residual in the Phillips Curve equation explains some of the inflation dynamics and is not necessary to include all variables affecting inflation. Subsequently, the model is able to generate an error term in the form of estimation precission statistic. This represents a clear advantage compared with the other approaches. In the end, the Kalman Filter introduction mitigates somehow the presence of end-point-bias.

Aside for the main advantages, it is fair to mention certain disadvantages for the intermediate approaches. First, the simplier specification compared with structural models comes at the cost of relative weakening in the inflation-unemployment connection as long-term variables are omitted. Secondly, the simplified structure is unable to entirely eliminate the output sensitivity to the Phillips Curve specification and the determined trajectory of the natural rate of unemployment.

Examples of intermediate models and in particular of those including State-Space structures are quite abundant and take an even more solid position in empirical literature. King (1999) applies this approach in the case of the United Kingdom to emphasize labor market effects on policy rate determination. Irac (2000) applies this method in generating the natural rate of unemployment in the case of France. A reduced form if the Kalman Filter is applied in the case of Kazakhstan by Agambayeva (2008). Turner et al. (2001) implement this approach in a comparative study for OECD countries.

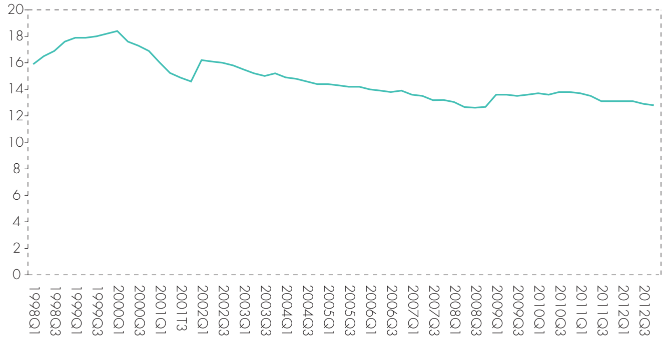
In the case of Albania, the intermediate technique according to the Elmeskov derivation is applied by Kota (2007) in the estimation of the natural rate of unemployment and the unemployment gap in the years 1996-2006. According to this contribution, it is estimated that the actual rate of unemployment stood higher compared with the natural rate in the years 1996-2001. The unemployment gap is deemed deeper at the beginning of the sample but gradually closing. After 2001, it is estimated that the positive gap persisted as actual rates fell below the natural rate of unemployment. At the end of the sample, it is estimate that the actual rate once again jumped above the natural rate but the negative gap was marginal.

3. DATA AND METHODOLOGY

3A. DATA AND MODEL SPECIFICATION

In this paper, we provide a short-term NAIRU series generating approach for Albania applying a State-Space model with the Kalman Filter in the period 1998-2012. The method incorporates the inflation and the unemployment rate as the principal components in the filter. In the case of the unemployment rate, the times series reflect administrative statistics by INSTAT. The time series is shown in the following graph:

Chart 1 Unemployment rate according to administrative data



Source: INSTAT.

Chart 1 reflects a falling unemployment rate throughout the sample, but there are not major shifts in the time series. The other statistics involved in the analysis include wages, labor demand, GDP, import shares and foreign prices. The approach is based upon Irac (2000) and Turner et al. (2001) where inflation differentials are specified with the following triangle Phillips Curve equation:

$$\Delta\pi_t = (V)\alpha * \Delta\pi_{t-n} + \beta * (NAIRU_t - UN_t) + \gamma * \Delta UN_t + \delta * (V)\Delta S_{t-k} + \varepsilon_t \quad (1)$$

Based on equation 1, inflation differentials ($\Delta\pi_t$) are a function of backward looking expectations $(V)\alpha * \Delta\pi_{t-n}$; short-term supply shocks, $(V)\Delta S_{t-k}$. ΔUN_t is included to capture the so-called "speed limit effects" defined as inflation movements resulting from unemployment differentials since unemployment affects inflation not only based on its level. Sharp unemployment movements can affect inflation disregarding the fact that the actual rate might be above or below the natural rate.

The unemployment gap is determined as a difference between NAIRU and the actual rate of unemployment. The latter represents the only unobserved variable, which is constrained in the transition equation specified in three different forms:

$$NAIRU_t = NAIRU_{t-1} + \varepsilon_{1t}; \quad (2)$$
$$NAIRU_t = c + NAIRU_{t-1} + \varepsilon_{1t}; \quad (3)$$
$$NAIRU_t = \varphi * NAIRU_{t-1} + \varepsilon_{1t}; \quad (4)$$

According to the three specifications, NAIRU is defined as pure random walk, a random walk with drift and a first order autoregressive process. In all cases, the constraints are place on the variation of the error term. The variance proportions are chosen based on literature as well as in terms of the error terms obtained after the model is optimized. The higher the volatility of the NAIRU, the more inflation differentials are explained by the unemployment gap and less by the error term in the inflation equation. However, higher volatility would produce larger error terms. In other words, an accommodation has to be achieved between allowed volatility and series precision. Therefore, as suggested in the empirical literature, a "sensitive analysis" is conducted based on different calibrations of the error term in the transitory equation. The generated series further undergo judgment in the aftermath.

Since the output is most sensitive to the subset, different combinations of the explanatory variables were implemented. The model enables the contemporaneous estimation of the NAIRU series (with error term bands) and Phillips Curve coefficients. The generated output gap is further included with the exact specifications of the other variables in an actual OLS regression to apply the necessary diagnostic tests.

3B. SUPPLY SHOCKS

The main element of supply shocks is associated with import prices, which are proxied through import deflators. According to the literature, deflators are included individually or weighted with trade-openness. Fuel prices are included separately considering their importance in inflationary pressures. The applied index is derived from the Dated Brent series from IMF commodity prices. Once again, the generated deflators are included individually or weighted with the share of fuel imports on overall imports.

A particular specification taken after Turner et al. (2001) includes import prices and import fuel prices as a difference with inflation from the previous period again weighted in the same fashion. This specification is applied to add a degree of proportionality in the effects. Import prices can affect inflation both in terms of value and in terms of whether they are substantially different from it in the previous period/s.

Additionally, Unit Labor Cost (ULC) is included in three different specifications as follows:

$$\text{ULC} = \frac{NW*EM*3}{NGDP};$$

$$\text{ULC} = \frac{NW*EM*3}{RGDP};$$

$$\text{ULC} = \frac{RW*EM*3}{RGDP};$$

NW and RW represent the nominal average and real average monthly wage, respectively. The latter is calculated by deflating nominal wage with inflation. EM represents the number of employed persons and NGDP and RGDP stand for nominal and real GDP, respectively. Another specification is based upon Çeliku and Metani (2011) with ULC calculated from the short-term statistics of real wage and value added indices.

We also attempted to generate other supply shock series associated with tax wedges and mark up rates. The attempts were not successful in improving the equation explanatory power.

4. RESULTS

4A. EQUATIONS

Table 1 summarizes the results based on different specification combinations. They include OLS estimation after the NAIRU series was generated from the State-Space model.

Based on the results, the unemployment gap shows the expected negative sign and is statistically significant at 1% intervals in all cases. Speed limit effects, on the other hand, do not show significant effects in all specifications. That is not entirely surprising considering the small movements the series of unemployment features throughout the sample. Import prices also show the expected sign and are statistically significant in all cases. Fuel prices, on the other hand, do not seem to produce much additional effect as was the case with ULC.

Diagnostic tests reveal issues of normality and stability in the residuals. These were mitigated by including non-linear gap specifications as ratio of output gap over the unemployment rate. Regression results and diagnostic test statistics are reflected in Table 2.

Table 1. Results using a linear specification for the unemployment gap

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6
Δinf_{-3}					0.13*	0.1
Δinf_{-4}		-0.21***	-0.21***	-0.2***	-0.38***	-0.39***
Δinf_{-5}		-0.19***				
Δinf_{-6}	-0.32***		-0.19***	-0.2***		
Δinf_{-8}					-0.32***	-0.31***
ΔUn		-0.01				1.02
Nairu-Un	*0.51****	*1.15****	*0.86****	*0.4****	*0.52****	*0.89****
Δw_d_imp(-1)	0.26***	0.017				
Δw_d_oil(-1)						
w_(d_imp-inf(-1))			0.3***	0.32***	0.1*	0.08*
w_(d_oil-inf(-1))				-0.33*	0.06	
R^2	0.44	0.61	0.63	0.64	0.75	0.78
Adj. R^2	0.42	0.59	0.61	0.61	0.73	0.75
S.E.	1.83	1.55	1.51	1.5	1.25	1.19
JB	0	0.08	0	0	0.12	0.36
LM	0.65	0.05	0.2	0.27	0.65	0.9
BPG	0	0.18	0.7	0.64	0.7	0.14
Ramsey Reset	0	0	0	0	0	0
RMSE (SSM)	0.59	0.36	0.55	0.55	0.58	0.36

Source: authors' calculations; *** significance at 1% intervals

Table 2: Results applying a non-linear gap specification

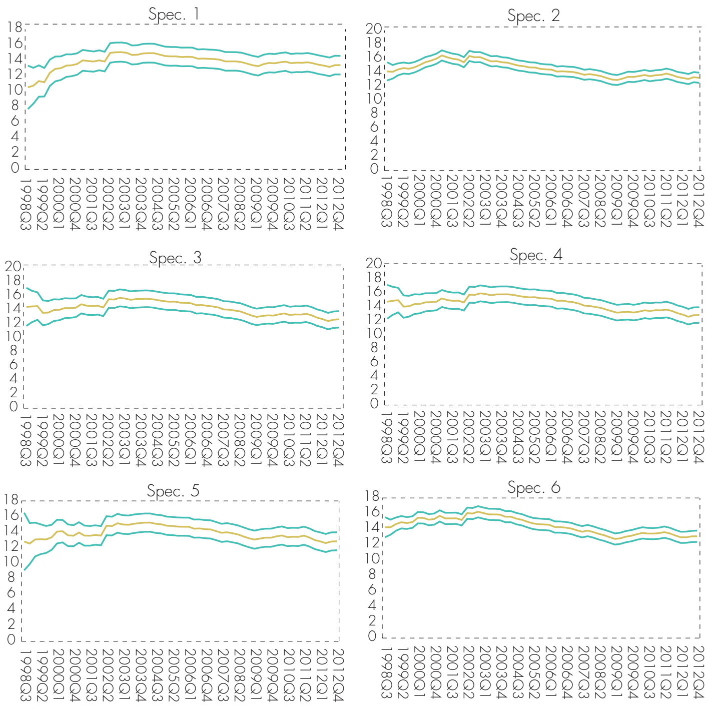
	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6
Δinf_{-3}					0.16*	0.12*
Δinf_{-4}		-0.19***	-0.17*	-0.17**	-0.38***	-0.37***
Δinf_{-5}		-0.18**				
Δinf_{-6}	-0.3***		-0.17**	-0.19***		
Δinf_{-8}					-0.34***	-0.37***
ΔUn		1.19				1.98
(Nairu-Un)/Un	*8.8****	*19.2****	*6.17****	*6.65****	*6.73****	*14.4****
Δw_d_imp(-1)	0.24***	0.017				
Δw(d_imp-inf(-1))		w	0.3***	0.33***	0.14**	0.09*
Δw_(d_oil-inf(-1))				-0.39*	0.03	
R^2	0.44	0.59	0.61	0.63	0.72	0.76
Adj. R^2	0.42	0.56	0.59	0.60	0.70	0.74
S.E.	1.84	1.6	1.55	1.52	1.32	1.22
JB	0	0.11	0	0	0.12	0.36
LM	0.8	0.03	0.31	0.34	0.75	0.9
BPG	0	0.25	0.23	0.28	0.21	0.1

Source: Authors 'calculations

4B. NAIRU AND UNEMPLOYMENT GAP

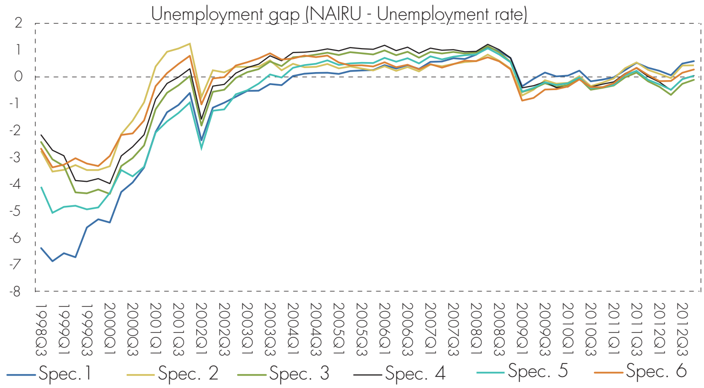
In Chart 2 are summarized the various NAIRU time series from the six previous specifications incorporating ± 2 standard deviations bands. Chart 3 features the summarized unemployment gaps. The results reflect a large negative gap in the earlier part of the sample. It gradually closes up and turns positive in 2002-2003 remaining in positive territory until late 2008. For the remaining years, the unemployment gap was slightly negative.

Chart 2 NAIRU series with ± 2stdev bands



Source: Authors' calculations.

Chart 3 Unemployment gap series



Source: Authors' calculations.

These results do reflect certain implications associated with capacity utilization in the economy. It is estimated that the economy has operated largely below potential in terms of labor utilization in the earlier part of the sample. The labor utilization rate has gradually converged towards potential. The economy has generally operated above equilibrium in the years 2003-2008. Marginal negative gaps were associated with the later part of the sample.

5. CONCLUSIONS AND DISCUSSIONS

The paper attempts to apply a reduced form State-Space model approach in generating the natural rate of unemployment (NAIRU) for the Albanian economy in the years 1998-2012. The method features a Phillips Curve combined with a transition NAIRU equation setting the path as a random walk or autoregressive process. The Phillips Curve equation includes inflation backward looking expectations, unemployment gap, speed limit effects and short-term supply shocks. Import prices, fuel prices and ULC were featured in the supply shocks. The NAIRU path equation placed constraints on the variance of the error terms setting up the volatility of the NAIRU series. The Kalman Filter estimates the NAIRU and, at the same time, the coefficients in the Phillips curve.

The unemployment gaps reflects negative values in the early sample and gradually closes in the years 2002-2003. The actual unemployment rate has fluctuated below natural unemployment until 2008. In the remaining part of the sample, the actual rate jumps slightly above the natural rate.

There are certain similarities with the findings from Kota (2007). In both cases, the earlier part of the sample features negative unemployment gaps with unemployment rates fluctuating above natural rates. However, estimations in this material reveal the gap closing slightly. Additionally, the period featuring positive unemployment gap is slightly longer.

Possible future improvements in the methodology are associated with the inclusion of the unemployment rate based on Labour Force Survey data. Additional supply shock variables include: tax wedges and mark-up rates; capacity utilization rates and productivity shifts. Further examples involve input prices and alternative unit labor cost estimations. Future research should also focus on purely structural models able to generate long-term natural unemployment rates. This would enable the comparison of long-term and short-term rates for natural unemployment.

On a final note, it is worth discussing on the reasons behind the marginal negative unemployment gap in the post-2008 period in spite of lower output growth rates as a result of the global financial crisis and EU debt crisis. One explanation could be that the labour market tends to be slowly reactive to developments in output and financial markets. On the other hand, the possibility of structural changes in the economy is also a valid explanation. Deeper research in the matter enhanced by improved statistics will be crucial in determining the reasons behind the slow reaction in the labour market.

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