II. NEW KEYNESIAN PHILLIPS CURVE FOR ROMANIA

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Abstract

The paper aims to estimate the New Keynesian Phillips curve in the case of Romanian economy. The empirical model estimates simultaneously the potential output and the output gap; the natural rate of unemployment and the cyclical unemployment as an Okun Law type relationship; and the New Phillips curve linking inflation to output gap. We estimated two models that differed only in the assumption regarding the speed of adjustment of the cyclical unemployment to changes in output. The estimation results proved that the Phillips curve is not very different. It can be observed that the forward-looking component of the NKPC is only marginally larger than the backward looking component in both specifications.

Key worlds: New Keynesian Phillips curve, Inflation, Potential output

JEL Classification: E31, E32, E50, C11, C22

I. Inflation and unemployment rate in Romania

Romania, similarly to all socialist countries, started the transition with virtually no unemployment and strictly controlled prices, therefore a stable inflation rate. Subsequent Romanian Governments opted for a slow transition process, with a very gradual liberalization of the administered prices. Even so, the inflation rate was very high, over 0.5 in most years up to 2000.

Most companies/managers were not equipped to deal with the requirements imposed by the new economic environment and the result was a massive reduction in output, since in the beginning firms were reluctant to lay off workers, long with to a high inflation rate. No steps were taken, in the beginning, in order to restructure them, they were allowed to operate under soft budget constraints and consequently there was a

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huge increase in companies' arrears. Governments were forced to conduct loose fiscal policies and hence a high inflation rate.

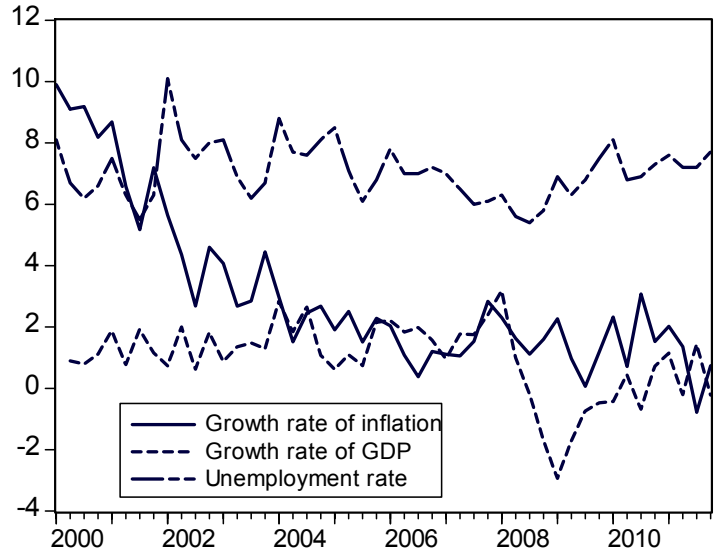
The subsequent increase in the unemployment rate, which was inevitable since very few new jobs were created, happened gradually over a period of five years, when the unemployment reached 0.08, the highest value. Efforts have been made to control its increase by several early retirement schemes. The schemes have moved the pressure from the unemployment fund to the pension fund, which was running a surplus at that point.

The turning point was around 2000, when the decision to adopt policies in order to keep inflation in line was made, the inflation rate kept declining and 2005 was the first year when inflation declined under 10%. This reason together with data availability has determined us to use data series starting with 2000.

In Figure 1 the evolution of the growth rate of real gross domestic product and inflation together with the unemployment rate is presented. The strong effect that the crises had on the Romanian output is very evident in the graph. Since then the growth rate of the output has recovered but it is still oscillating around zero, and at much smaller rates. The effect is visible on the unemployment rate as well, the unemployment reached a minimum of less than 6% in 2008 and afterwards it started to steadily increase. The unemployment rate is symmetrical to the growth rate of real output giving evidence to Okun's law.

Figure 1

Unemployment rate and growth rate of real GDP and inflation



II. Phillips curve and the New Keynesian Phillips curve

The origins of the Phillips Curve is the observation by A.W. Phillips in 1958 that there is a negative relationship between the wage inflation rate and the unemployment rate, which was observed when graphing the UK data from 1861 to 1957. This finding appears to indicate that there is a trade-off between inflation and unemployment, hence if a country wants to achieve zero inflation the price it would pay is higher unemployment, and if a country wants low unemployment, this could be attained by higher inflation.

In the late 1960s the economists discredited the idea of a trade-off between inflation and unemployment by stating the long-run expectation augmented Phillips curve is vertical at the natural rate of unemployment. Therefore, the new expression of the Phillips curve became:

$$\pi_t = \mathrm{E}_{t-1}(\pi_t) + \alpha(y_t - y_t^*) + \varepsilon_t$$

where: π_t is the inflation rate at t;

$\mathrm{E}_{t-1}(\pi_t)$ is the expected inflation at t based on the information at t-1;

y_t^* is the potential output, and therefore $y_t - y_t^*$ is the output gap.

The expression states that only unanticipated inflation results in output fluctuations, therefore changes in unemployment. Under the Rational Expectations theory which states that agents' forecasts are not systematically wrong, which in our case means $\mathrm{E}_{t-1}(\pi_t) = \pi_t$ it can be easily observed that the Phillips curve is vertical and that the output is at the potential output, and therefore both monetary and fiscal policy could have no effect on output and employment.

In reaction to the ineffectiveness of the expectation augmented Phillips curve a new theory started to make headway in the 1990s, namely the New Keynesian Phillips curve (see Roberts 1995, for an example). The main idea behind the model is that wages and prices do not instantly adjust to the equilibrium level.

The first models named the New Keynesian Phillips curve were of the following form:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t + \varepsilon_t$$

where mc_t is the average real marginal cost.

Most often, in the literature another form is used. Under certain conditions, mainly restrictions regarding the technology and labor market structure (see Gali et al., 2001) the marginal cost can be expressed as a linear function of the output-gap, then the estimated New Keynesian Phillips curve becomes:

$$\pi_t = \beta E_t \pi_{t+1} + \tau(y_t - y_t^*) + \varepsilon_t$$

The NKPC specified above has some limitations that are identified (Roberts, 1998), the model could not explain the output losses which are experienced whenever a reduction in inflation is desired and achieved. In this way, if the central bank

announces its policy to decrease inflation and the central bank is credible, than the expectations would be adjusted according to central bank's announcement. The adjustment of expectations translates into reduced inflation even in the absence of output loss, therefore, no trade-off between inflation and unemployment.

In this context there was a need to move from rational expectations to a different model regarding the formation of expectations. Hence the idea of expectations which are not entirely rational but are also adaptive, in the typical sense (agents look at past inflation for makeing expectations for future inflation) and the new hybrid versions of model incorporate both expected and lagged inflation in the specification of the Phillips curve.

The backbone of the New Keynesian Phillips curve models is the existence of sticky prices determined by monopolistic firms. Firms are monopolistic in the sense that they are not price takers as in the case of competitive firms, but they set prices according to their specific price setting mechanism, in which expectations of the future prices play an important role.

Most articles opted for a specification of the following form:

$$\pi_t = \beta E_t \pi_{t+1} + \zeta(L)\pi_t + \lambda Z_t + \varepsilon_t$$

where: $\zeta(L) = \zeta_0 + \zeta_1 L + \zeta_2 L^2 + ...$ is a lag polynomial, the order of which captures the number of inflation lags that the backward-looking agents use for making expectations of the future price. Typically, the number of lags is determined by means of information criteria.

The New Keynesian Phillips curves typically differ with respect to the variable chosen to quantify the inflationary pressure of the real sector (Z_t). In a series of articles Gali et al. (1999), Gali et al. (2001) and Gali et al. (2005) argue about the so-called "marginal cost-based" New Keynesian Phillips curve model, considering that the marginal costs are a better measure of the inflationary pressure of the real economy in comparison the output gap, another measure used widely in the literature (see Zhang et al. (2011). In their articles the authors show that the NKPC so specified explained the inflation dynamics of different countries, using unit labor costs as measures of average real marginal costs.

The model is similar to the one presented by Zhang, et al. (2011). The starting point of a New Keynesian Phillips curve is an economy with monopolistic firms. At any point in time not all firms are free to change their prices if the change in the economic environment dictates it. Changing prices is costly for the firms (the theory of "menu costs"), but also firms are restricted by contracts which fix the price for their products. The probability that a firm is able to change the price at a given time is θ. Similarly to Calvo (1983) we assume that the probability that a firm adjusts its prices is independent of the time elapsed from the last change in prices.

Similarly to Gali et al. (1999) we assume that the firms are identical, with the exception of the product they produce and the price history and they face a constant price elasticity demand function. Under this condition, the aggregate price level is a combination between the price level in the previous period (p_{t-1}) and the optimal price of the current period (p_t^*).

$$p_t = \theta p_{t-1} + (1-\theta)\, p_t^*$$

As mentioned before, traditionally writers considered that firms have a forward-looking price setting mechanism.

We consider in our paper[3] (similarly to Zhang et al., 2011) that firms differ in the fact that a proportion of them are backward looking with respect to their price setting mechanism and the other are forward looking in terms of the price setting mechanism. The proportion of forward looking firms in the economy is ω. The implication regarding the price setting mechanism of a backward looking firm is that the firm uses only information from the past in order to adjust its price in the future.

The new price that the firms which change prices in the current period is an weighted average of the price set by "forward-looking" firms and "backward-looking" firms.

$$p_t^* - p_t = \omega(p_t^F - p_t) + (1-\omega)(p_t^B - p_t)$$

Gali et al. (1999) included only the first lag of inflation in the price setting mechanisms of backward looking firms:

$$p_t^B - p_t = p_{t-1}^* - p_t + \pi_{t-1}$$

We agree with the view presented in the Zhang et al. (2011) with respect to the fact that introducing only one lag is not enough firms consider the history of the inflation in setting their prices and this is especially true when considering the frequency of the data, with higher frequency data; (for example monthly) the inflation of the previous month is not the sole determinant of the future inflation rate. The decision regarding the length of the lag can be made only when estimating the model. Therefore the price setting mechanisms of the backward-looking firms is of the following form:

$$p_t^B - p_t = p_{t-1}^* - p_t + \pi_{t-1} + \rho^*(L)\Delta\pi_{t-1}$$

Forward looking firms set their prices by maximizing profits, bearing in mind the future inflation expectations. Since it is not possible to change prices in every interval, in the decision for the next period price enter not only the next period, as well as all future periods.

The price set by the forward-looking firms is of the following form:

$$p_t^F - p_t = \theta\beta E_t\pi_{t+1} + (1-\theta\beta)Z_t + \theta\beta E_t(p_{t+1}^F - p_{t+1})$$

where: β is a discount factor.

Combining the equations we derive the following specification for the New Keynesian Phillips curve:

$$\pi_t = \alpha_f E_t\pi_{t+1} + \alpha_b\pi_{t-1} + \alpha_p(L)\Delta\pi_{t-1} + \alpha_Z Z_t + \varepsilon_t$$

In the above specification Z_t can be either the output gap or the average real marginal cost, depending on the specification that one wants to test. In cases when the author's introduced the average marginal cost in the equation of the NKPC, the variable used was the unit labor costs.

[3] *The derivation of the New Keynesian Phillips curve borrows from Zhang et al. (2011).*

III. The Multivariate Model with Unobserved Components

In this section we present the multivariate model with unobserved variables that were estimated for Romania. The variables modeled are output, inflation and unemployment. The database consists of quarterly data, which cover the period between the first quarter of 2000, and the fourth quarter of 2011 for which definitive data was available. The variables are included in the model as follows: y_t is the natural logarithm of seasonally adjusted quarterly GDP in constant prices, π_t is the CPI in the 2000 base year and u_t is the quarterly unemployment rate.

In the multivariate model we are interested in decomposing the output and unemployment in the trend and the cyclical component. There are numerous methods that are could be used, starting with statistical models in which to the variable of interest is applied a filter like for example: Hodrick Prescot, Beveridge Nelson, Kalman, etc. Other employed methods are the economic methods. The estimation of the potential output, for example, is performed by specifying output by means of a Cobb-Douglas production function, with unit elasticity of the inputs. In order to obtain potential output, one needs to compute the potential value of the inputs. This is the method that the EU currently uses in order to compute the potential output for all member states[4]. The similar production function approach was used by Dobrescu in its most recent version of the macro-model of the Romanian economy.

III.1. Output

We assume the classic decomposition of output:

$$y_t = y_t^* + y_t^c + e_t \tag{1}$$

where y_t^*, y_t^c represent the unobserved permanent component and the cyclical component with the interpretation of potential output and output gap.

Usually, potential output is specified as a random walk with drift (Berger, 2011), but our sample data showed output as I(2) so we model instead the growth of potential output as a random walk:

$$y_t = y_t^* + y_t^c \tag{2}$$

$$\Delta y_t^* = \Delta y_{t-1}^* + \varepsilon_t^p \tag{3}$$

There is no evidence of shifts in growth rate of the potential output so we did not include a drift in the equation.

The cyclical component, i.e. the output gap, is modeled as an AR process:

$$y_t^c = \phi_1 y_{t-1}^c + ... + \phi_q y_{t-q}^c + \varepsilon_t^{yc}. \tag{4}$$

The error terms are white noise, Gaussian with mean zero.

[4] *See D'Auria et al. (2010).*

III.2. Unemployment rate

The unemployment rate was decomposed, similarly to the output, into two latent components, a non-stationary trend seen as the natural rate of unemployment (NRU) u_t^* and a cyclical component u_t^c:

$$u_t = u_t^* + u_t^c \tag{5}$$

where the NRU is a random walk process modeling shocks to the long-run unemployment rate as Gaussian mean-zero white noises that will have a permanent effect on the NRU:

$$u_t^* = u_{t-1}^* + \varepsilon_t^u \tag{6}$$

The unemployment gap is linked to output gap by a Okun's Law type relationship:

$$u_t^c = \Gamma(L) y_t^c + \varepsilon_t^{uc} \tag{7}$$

where: $\Gamma(L) = \gamma_0 + \gamma_1 L + ... + \gamma_p L^p$ is a polynomial of contemporaneous and lagged output gap.

This is a versatile specification allowing adjustments of the unemployment to happen contemporaneously to changes in output, if $\gamma_0 \neq 0$. If $\gamma_0 = 0$ and other coefficients of the Γ(L) polynomial are different from zero, the specification suggests that unemployment rate adjusts with some lag to changes in the output.

We have tried two specifications for the cyclical unemployment. In the first case we consider that cyclical unemployment reacts instantly to changes in the output gap (1st model). In the second case we consider that the cyclical unemployment does not adjust instantly, i.e. there is a delay in the adjustment process (2nd model). We consider the second model to be more realistic, due to the labor market rigidities.

We also tried the reverse relationship that considers that the output gap depends on the unemployment gap and modelled the cyclical unemployment as an AR process but the estimated results were implausible.

III.3. The Phillips curve

We considered a new Keynesian Phillips curve (NKPC) stating that inflation is determined by lagged inflation, expected inflation and a measure of marginal costs. The debate over which is the best variable to measure marginal costs, as a valid determinant of inflation is not concluded and has not given a single answer.

There are authors that advocate labor income share as determinant of inflation (Gali and Gertler (1999); Gali et. al. 2001), others (Rudebusch and Svensson, 1999; Rudd and Whelan, 2005; Zhang et. al. 2008) empirically demonstrated that output-gap is the driving force in NKPC.

We consider the output gap in the Phillips curve specification, as it is most often in the literature, because we want to derive natural rates of output and unemployment and long-run inflation jointly using a multivariate model with unobserved components.

We decompose inflation into inflation trend π_t^* interpreted as long-run forecast of inflation (Beveridge and Nelson, 1981) and a stationary mean-reversing cyclical inflation π_t^c:

$$\pi_t = \pi_t^* + \pi_t^c \tag{8}$$

For the trend we use the specification already presented in the previous section. The cyclical component is a function of the output gap:

$$\pi_t = \alpha_f E_t(\pi_{t+1}) + \alpha_b \pi_{t-1} + \alpha_p(L)\Delta\pi_{t-1} + \pi_t^c + \varepsilon_t^{\pi} \tag{9}$$

$$\pi_t^c = \Pi(L) y_t^c + \varepsilon_t^{\pi c} \tag{10}$$

with $E_t(\pi_{t+1})$ as expected inflation and $\Pi(L)$ as polynomial of lagged output gap assuming transitory inflation is linearly determined by output gap.

IV. Estimation results

We estimated two models using equations 2-10 with output gap modeled as an AR(1) process (eq. 4). The models allow for correlation between shocks to natural rates and corresponding gaps.

Model 1 states a contemporaneous relation between cyclical unemployment and output gap taking into consideration a rapid adjustment of labor market to the production market. Model 2 relaxes this assumption considering that adjustment is made within the next quarter, so it takes a polynomial with one lag in equation 7.

In both models the coefficient for the cyclical component of GDP from NKPC equation has a positive sign as expected and is statistically significant. The coefficient of output gap in Okun's Law must be view considering the difference in magnitude of the variables.

The cyclical unemployment is symmetrical to the output gap since they are link by Okun's law.

The inflation trend that could be interpreted as core inflation evolves smoothly and the transitory component is volatile.

Model 1

$$\underset{(0.0002)}{y_t^c = 0.0003 y_{t-1}^c} + \underset{(0.679)}{\varepsilon_t^c [Var = \exp(-12.108)]} \tag{11}$$

$$\underset{(5.411)}{u_t^c = -14.145 y_t^c} + \underset{(0.143)}{\varepsilon_t^{uc} [Var = \exp(-0.482)]} \tag{12}$$

$$\underset{(0.021)}{\pi_t = 0.494 * \pi_{t-1}} + \underset{(0.006)}{(1 - 0.494) * \pi_{t+1}} + \underset{(0.209)}{0.020 * y_{t-1}^c + [\text{var} = \exp(-8.590)]} \tag{13}$$

Model 2

$$y_t^c = \underset{(0.039)}{0.814} y_{t-1}^c + \underset{(0.420)}{\varepsilon_t^c [Var = \exp(-10.748)]} \quad (14)$$

The relation (15) accounts for the negative correlation between unemployment rate and the lag one of output gap.

$$u_t^c = \underset{(2.176)}{-52.480} y_{t-1}^c + \underset{(0.076)}{\varepsilon_t^{uc} [Var = \exp(-0.494)]} \quad (15)$$

$$\pi_t = \underset{(0.022)}{0.497 * \pi_{t-1}} + \underset{(0.002)}{(1 - 0.497) * \pi_{t+1}} + \underset{(0.196)}{0.015 * y_{t-1}^c + [\text{var} = \exp(-8.608)]} \quad (16)$$

We modeled output gap as an AR(1) process. The relations 12 and 15 account for the negative correlation between unemployment and output gap.

Figure 2 and 3 show the estimated unobserved components together with the original data.

The two estimated models produced similar results with respect to the New Keynesian Phillips curve of Romanian economy. The potential output follows the gross domestic product quite closely in both specifications. However, there are important differences with respect to the shape of the output gap. In the first specification the output gap is quite erratic, as it moves from positive to negative in almost all periods. The second output gap is more credible, since it displays longer same sign periods, which are consistent with periods in which the economy systematically grows or declines such that the inputs are over-employed or under-employed. It is not very credible that the economy moves from overemployment to underemployment from quarter to quarter. The decomposition of unemployment into NRU and the cyclical component is also more credible in the second model. It can be observed that the in the second model NRU has a more stable shape, as opposed to the first model in which the slope of the NRU is changing quite frequently. Beside the motivation regarding the credibility of the estimated results, the labor market features show also that the second model more realistically describe the Romanian economy. Labor market rigidities present in the labor market prevent an employer to instantly adjust to changes in demand. Therefore, the model in which there is a delay in the adjustment of the unemployment is more realistic.

Figure 2

Unobserved Component Model 1

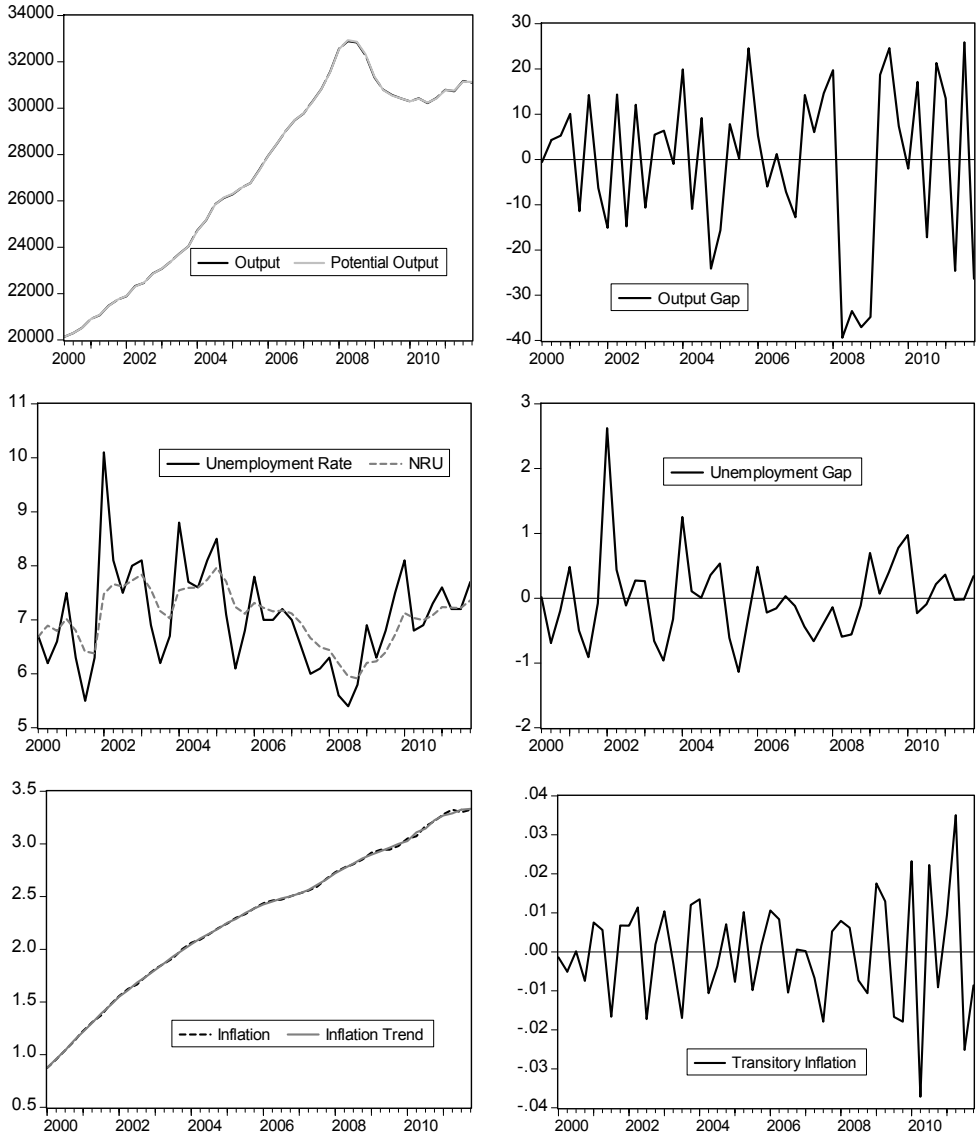
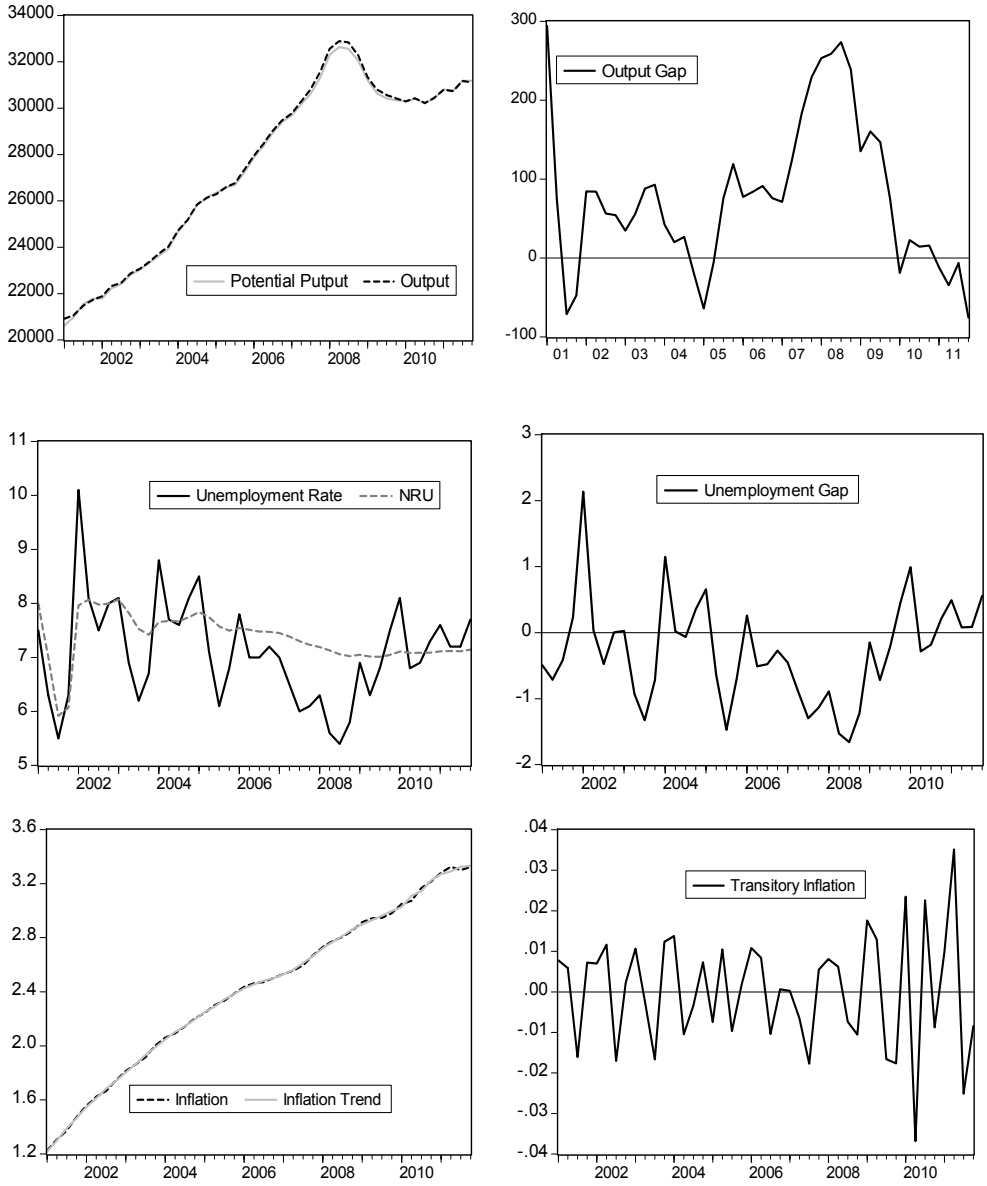


Figure 3

Unobserved Component Model 2



Note: The output and potential output are expressed in million lei.

With respect to the estimated NKPC, it seems that the Romanian inflation fits the model quite well. The output gap has a significant positive influence on the inflation rate, which means that there are inflationary pressures in an economy that operates above the potential. With respect to the importance of forward looking component as opposed to backward looking one of the NKPC, it can be observed that they are equally important.

Conclusions

The two models produce similar results with respect to the New Keynesian Phillips curve of the Romanian economy. But, estimated output gap and the NRU are more credible in the case of the second specification. Since the second specification differed from the first one only with respect to the speed of adjustment of the cyclical unemployment with respect to fluctuations in the output gap, the results confirmed our suspicion that there are still rigidities present in the labor so that unemployment instantly reacts to the changes in output.

The NKPC model adequately describes the inflation in Romania. The output has the expected sign, proving that an increase in inflation is accompanied by a positive output gap. In terms of the backward looking and forward looking components of the NKPC it seems that both are equally important, suggesting that the recent history of high inflation is still fresh in people's mind and the central bank still has some credibility to build.

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