BANKA QENDRORE E REPUBLIKËS SË KOSOVËS
CENTRALNA BANKA REPUBLIKE KOSOVA
CENTRAL BANK OF THE REPUBLIC OF KOSOVO

Working Papers

Estimanting Potential Output and the Output Gap in Kosovo

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08/2014

CBK Working Paper No. 05

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Abstract

This paper makes the first attempt to estimate potential output and the output gap in Kosovo, for the period 2002 to 2011. Given the structural changes and relatively short time-series data, this paper utilises a Kalman filter approach, whose complex structure is more appropriate in the case of transition countries that has undergone structural changes and have relatively short time-series. This approach is novel for Kosovo case. Furthermore, an added value of this paper is a thorough interpretation of the Kalman filter technique in business cycle analysis. This study finds that the Kosovo economy was performing below its potential from the beginning of the period up to 2008, reaches an equilibrium during 2009 and performs with low levels of above potential output from 2010 onwards. The paper concludes that the fiscal policy is the main driver of the business cycle in Kosovo.

JEL Classification: **E32, O41, O47**

Key words: **Kosovo, Potential Output, Output Gap, Kalman Filter**

Prishtina, 2014

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1. Introduction

The objective of this paper is to estimate potential output and the output gap in Kosovo economy. This is the first study undertaking business cycle analysis in Kosovo. However, estimating potential output and the output gap in an economy that has undergone considerable structural changes and experienced a number of shocks, as is the case in Kosovo, is subject to large uncertainties, because the conventional theories may not apply and the estimated results should be interpreted with caution.

Estimates of potential output and the output gap serve as useful indicators for the conduct of monetary and fiscal policy. However, due to unilateral euroisation since 2002, the scope of monetary policy in Kosovo is extremely limited. In effect, fiscal tools come out as the only means to address macroeconomic issues and to withhold external shocks. Thus, the fiscal policy in Kosovo, virtually the only macroeconomic policy available to the policymakers, has played an important role in the business cycle developments.

Kosovo represents one of the late comers in the transition process, whose transition process started in year 2000. The evolution of the Kosovo economy was somewhat turbulent at the beginning of 2000s, followed by relatively steady growth afterwards. The shift in regime in 1999[2] in Kosovo caused considerable output loss in the economy and the new government inherited a largely obsolete capital stock. In the next two years, while the economy was struggling to recuperate managed to approximately double its GDP, however the base remained relatively low.

From 2002 until 2007, the economy experienced a more steady growth (3.8 percent on average), mainly driven by remittances, donors and private consumption. During this time the external balance continued to deteriorate, given a very low export base, and a heavily dependence on imports. Meanwhile, the fiscal authorities were conducting a rather conservative policy approach, by continuously concluding the fiscal balance with surplus. The reason for conducting a conservative fiscal policy were partially political (unresolved political status), as well as, due to the restricted the monetary tools to enforce macroeconomic stability and particularly to finance budget deficits. The unemployment rate is considered to be the highest in the region (45% in 2009; 30.9% in 2012, Kosovo Agency of Statistics (2014)[3]), whereas the inflation rate was fairly low (even deflation in 2004 and 2005). Adding here the budget surpluses and the low base of exports, a presence of a large output gap in the economy may be inferred.

[2] During February – June 1999 Kosovo experienced an armed conflict with former Yugoslavian forces.

[3] The workforce questionnaire was realised taking into account methodological changes such as Eurostat guidelines, interviewing all family members, gathering of the data around the year etc., which may explain the relatively large difference in the unemployment rate between 2009 and 2012. The Kosovo Agency of Statistics did carry out a questionnaire for measuring unemployment rate in 2010 and 2011.

Another important year in terms of economic activity was 2009, when the impact of the global financial crisis that commenced in 2007, started to show. Even though Kosovo was one of the few countries in Europe not to experience a recession at that time, the signs of economic slowdown were expressed in the form of the export decline due to a fall in external demand, slowdown in imports due to a decline in domestic demand and a slowdown in lending activity because of the perceived uncertainty from the banking system. The influence of the financial crisis and the more recent budget crisis in some of the European countries may still be present, thus it should be of interest to investigate whether this effect is permanent (attributed to the trend) or transitory (attributed to the cycle).

The paper estimates potential output and the output gap for Kosovo between 2002 and 2011. The potential output and output gap are estimated with unobserved components model via the so-called Kalman filter, which is considered as one of the most appropriate methods for countries with structural changes and short time-series. The findings indicate that the economy in Kosovo was performing below its potential since the start of the transition process until 2008, reached its potential during 2009 and from 2010 onwards the economy was performing with low levels of above potential output..

The paper is organised as follows. In the next section the theoretical background on potential output and the output gap along with their usefulness in monetary and fiscal context is elaborated. In section 3, 4 and 5 a technical analysis of the unobserved components method and the Kalman filter is carried out. In Section 6 and 7 the data and the estimated results on potential output are discussed. Section 8 concludes.

2. Theoretical background

Potential output can be defined as the output level generated when the factors of production are fully employed at the current state of technology. Full employment of factors of production is understood as the maximum production that does not generate inflationary pressures (Okun, 1962), i.e. the sustainable rate of employment. The difference between actual output and the potential output is defined as the output gap. The output gap, otherwise referred as the cyclical position of the economy, indicates whether an economy is operating below its potential, is in equilibrium or above its potential (the so-called overheated economy).

The potential output and the output gap are two useful indicators that inform the policymakers *what would be the* stable and non-inflationary growth, so that the future forecasts and policymaking efforts would focus on that direction. Having said that, the potential output and the output gap are relevant indicators because they help in evaluating if the variations in actual growth can be attributed to cyclical factors (e.g. slowdown in exports, lack of financing credit etc.) or longer-run changes in potential growth (e.g. changes in factors of production, such as technology).

In particular, information on unobserved potential output and the respective output gap is relevant for the conduct of monetary and fiscal policy. In most cases, the main objective of monetary authorities is to ensure price stability, which in turn requires the prevention of excess demand and deviations of inflation from its desired targeted trajectory.[4] The price stability depends heavily on the level of output consistent with stable, non-accelerating inflation i.e. potential output. Thus, from the central bank perspective, in order to set the right monetary targets and analyse future money demand, usually the potential output should be considered instead of the actual one. Further, given the lags in the money transmission mechanisms, it is the potential output (e.g. in two years' time) that informs the choice of money supply. Therefore, the information on potential output helps monetary policy channelling the inflationary developments in the desired way. The output gap emerges as a key indicator of inflationary pressure. For instance, a positive output gap, that is when the actual output is above the potential output, may be seen as a pro-inflationary signal. Further, monetary policy, in addition to its main and long-term objective of maintaining price stability, should, in the short-term, be focused on reducing output fluctuations, i.e. keeping the actual output as close as possible to the potential output (Mishkin, 2004). In Kosovo case, the second objective of the Central Bank of the Republic of Kosovo (CBK) is to contribute in achieving and maintaining price stability in economy. However, the CBK exerts a limited scope of monetary policy instruments to pursue its target, due to unilateral euroization of the economy. In this respect, the CBK is left only with required reserves as an instrument to influence the money supply, hence the price stability. However, even though this instrument could have been used in service of the price stability, to date it has not served this function, given that the fixed rate of 10 percent have not been changed from the beginning of the functioning of the banking system. Having said that, the inflation rate in Kosovo mostly reflects the prices of imports rather than reflecting the demand pressures, due to the low domestic production and high dependence on imports.

On the other side, the importance of potential output to the corresponding output gap refers to the stabilizing and stimulating function of the fiscal policy via discretionary and automatic stabilisers.[5] The effectiveness of the discretionary and automatic fiscal stabilisers is heavily dependent on the cyclical position of the economy as measured by the output gap. The deliberated discretionary policy is effective only in the cases when the economy is performing far below its potential, thus a fiscal action taken (e.g. a reduction in tax rate) will stimulate spending and increase aggregate demand, resulting into a higher economic growth rate.

[4] The second objective of the Central Bank of the Republic of Kosovo is to contribute in achieving and maintaining domestic price stability.

[5] Another definition of potential output is also called the optimal rate of output, which is assumed to be achieved in an economy with no market imperfections (monopolistic competition, distortive taxes etc.), (Primiceri, 2008). This part of the definition is also relevant for policymakers since it is assumed that addressing such market imperfections in the economy may rather fall under the fiscal authorities' responsibility rather than by central bankers, which take these imperfections as given (Kydland and Prescott, 1977).

Whereas, when the actual economy is performing near its potential, the automatic stabilisers will only cause inflationary pressures.

Whether yearly planned fiscal spending is feasible depends on the medium or long-run growth. In line with this, the cyclical position, as expressed by the magnitude and sign of the output gap is an important component for calculating structural fiscal balance. Girono et al. (1995) argue that output gap is useful in helping to isolate the impact of cyclical factors on the budget. For example, when economy is undergoing a downturn phase, the estimation of the output gap may be helpful in quantifying the policymakers' measures to stabilize the demand and helping it move towards the equilibrium; whereas, when the economy is in the state of overheating, the output gap indicates that contractionary measures should take place (less budgetary spending). For example, these indicators may highlight the need to conduct fiscal discipline when expansionary periods are anticipated (e.g. booming period and faster catch-up of many of the European transition countries during 2004-2007) and the opposite policy stance when recession threatens (El Ganainy and Weber, 2010). These downward and upward budget fluctuations represent the fluctuations of the actual budget around the structural balanced budget. The structural balanced budget represents the level of budget revenues and expenditures if the economy was operating at its potential output. Thus, potential output and the corresponding output gap should give indications of how much of the budget revenues and expenditures reflect the cyclical component and how much reflect other imbalances such as the structural changes or shocks (Bouis, 2012).

Therefore, information on potential output and the output gap provides key insights on current macroeconomic performance and serve as a guide for appropriate decision-making regarding monetary and fiscal policies, by also increasing the viability of the policymaking (Darvas and Vadas, 2003; Pomenkova et al., 2011).

3. The estimation of potential output and output gap

Potential output and the output gap are unobservable variables, which cannot be found in any of the publicly available databases, thus need to be estimated independently by researchers. The importance of these estimates, as discussed in the previous section, encouraged researchers to develop many estimation techniques, generally divided into univariate and multivariate methods. In practice, different methods provide inconsistent results which pose problems in correctly identifying the cycle and in formulating macroeconomic policies (Canova, 1998). Even though there is no consensual or correct approach and the generated estimates will be substantially uncertain, some methods may be considered as more appropriate to others, based on the country, aim of the study or the data used (Fuentes et al., 2007; Magud and Medina, 2011).

Given that Kosovo represents one of the late comers in transition process undergoing structural changes, purely statistical techniques alone, like time trend or Hodrick-Prescott filters cannot be used. The conventional method of production function cannot be implemented due to the lack of data on capital stock. This paper will present the estimation of potential output and the output gap using unobserved components method, operationalised by the so called Kalman filter algorithm. This method is more appropriate for Kosovo case as it is less data demanding, enables incorporating of economic theory during estimation process and also encompasses a more advanced structure to handle short time series with structural changes, which in turn eliminates the estimation bias of end-sample data. The framework and the advantages of the unobserved components method will be presented in the following section.

4. Unobserved Components Model

The main objective of the UC model, similar to other decomposing techniques, also lies in decomposing and estimating unobserved components (variables) such as potential output, output gap, natural rate of unemployment (NAIRU), etc. using all the information available from the observed variables (e.g. actual output, unemployment rate, inflation rate, etc.); in other words, extracting the signal from the noise (signal processing technique). The UC method represents a flexible framework, where all components may be optional, that is, one can add seasonal effects into the equation in the case of non-seasonally adjusted data, or the trend may be first-order deterministic or second-order stochastic process and the cyclical component may be either stationary or stochastic process (Harvey and Trimbur, 2008). However, the UC approach is much richer and complex in structure, and models like least-squares or instrumental variables cannot be used for estimating the model. The unobserved components model is usually operationalised via the so called Kalman filter. The more advanced framework of the UC model enables the estimation of unobserved variables with less error.

One of the simplest applied forms for economic data is the Watson (1986) model, where the potential output (the trend) is modelled as a stochastic process, represented by a random walk with drift process and the output gap denoted by the cyclical component is an autoregressive process of order two. The UC representation takes the following form:

$$y_t = \tau_t + c_t \qquad (1)$$

where the trend is modelled as a random walk with drift:

$$\tau_t = \mu_\tau + \tau_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim IID(0, \sigma^2_\varepsilon) \qquad (2)$$

and the cycle is modelled as an autoregressive process of order two:

$$c_t = \phi_1 c_{t-1} + \phi_2 c_{t-2} + \upsilon_t \qquad \upsilon_t \sim IID(0, \sigma^2_\upsilon) \qquad (3)$$

In this framework, t represents the time index t = 1,.....n. The y is the actual output (real GDP) and the trend τ_t is a random walk process. The error term ε_t is assumed to be individually and independently distributed over time, with mean zero and variance σ^2_ε. Thus, the disturbance is serially uncorrelated and independent of any other disturbances related to y_t in the equation (2). Here, τ_t and σ^2_ε are unobserved and thus need to be estimated. The drift term is represented by the constant μ_g which stands for the average growth rate of potential output.

The cycle c_t, which by definition denotes the output gap, is an autoregressive process of order two AR(2), with autoregressive coefficients ϕ_1 and ϕ_1. The output gap is assumed to follow an autoregressive process of order two-AR(2); i.e. two lags and a zero unconditional mean (Gerlach and Smets, 1997). Nelson and Plosser (1982) and Clark (1987) suggested that the output gap should follow an AR(2) process mainly based on empirical grounds, rather than having any explicit theoretical explanation. Further, the conventional autoregressive coefficients are criticized on the grounds that are generated based on the case of the developed countries such as U.S.A. as well as the fact that the sum of the two autoregressive coefficients is very close to unit root (Commandeur and Koopman, 2007).

The error term ε_t in (2) stands for permanent shocks whereas the error term v_t in (3) stands for transitory shocks. In the UC framework, the cycle (output gap) and the trend (potential output) shocks are assumed to be uncorrelated over time. In random walk processes where transitory and permanent shocks have different impacts on the actual output, an output gap appears. Thus, a diffusion process of the two shocks is desirable, 'since the economy is likely to remain in its production possibility frontier as adjustments unfold' (Darvas and Vadas, 2003). The assumption that the trend and cycle error terms are not correlated was first suggested by Kalman (1960), followed by Watson (1986), Clark (1987) and recently Kichian (1999), Welsch and Bishop (2006), etc.. In the UC approach, this assumption represents the main restriction. The *a priori* assumption that innovations or shocks affecting the potential output and the cycle are not correlated is necessary to make the model econometrically identifiable (Kuttner, 1994; Gerlach and Smets, 1997; Harvey, 2005). This assumption enables the identification of the transitory shocks with and without impact on the permanent component. If both variances are zero ($\sigma^2_\varepsilon = 0$ and $\sigma^2_\upsilon = 0$) then the trend is deterministic; however, allowing the σ^2_υ to be positive and σ^2_ε to be zero, the estimated trend will be relatively smooth (Harvey, 2005). Nevertheless, in our representation, both variances are allowed to vary.

The UC method can be implemented using the Kalman filter, with the trend modelled as a random walk with drift and the cycle as an AR(2) process, once it is written in a state space notation (see below). A state space representation of the UC approach means formulating all the components of interest, that in our case are potential output, output gap, parameters of unobserved variables and error terms, as a system of matrices and vectors. Afterwards, each component is separately modelled by an appropriate dynamic stochastic process, which usually depends on normally distributed disturbances (Koopman et al., 2008). This approach basically groups all the observed and unobserved variables in two equations, the so called *measurement* or observation equation and the *transition* or state equation, otherwise representing two algorithms in the Kalman filter

(Commandeur and Koopman, 2007).[6] Following Watson (1986), the measurement equation is formulated in equation (1), whereas the transition equations are equations (2) and (3). The measurement equation links the (1 x 1) vector of observed variables $\mathbf{Y_t}$ (actual output) with the (3 x 1) vector of unobserved variables $\mathbf{X_t}$ (potential output, output gap and lagged output gap) through the vector of exogenous variables $\mathbf{d_t}$ (in multivariate representation exogenous variables are represented via exchange rate, interest rate, price indices etc.). In univariate exposition where only the actual output is used, the $\mathbf{d_t}$ is zero.

The respective measurement and transition equations are equations (4) and (5):

The measurement (signal) equation:

$$Y_t = Zx_t + Dd_t + \varepsilon_t , \qquad \varepsilon_t \sim N(0, \sigma^2_\varepsilon) \qquad (4)$$

The transition (state) equation:

$$x_t = Bx_{t-1} + Az_t + \upsilon_t ; \qquad \upsilon_t \sim N(0, \sigma^2_\upsilon) \qquad (5)$$

Or, in the univariate formulation, where exogenous variables are not used ($d_t = 0$), the state space form of the measurement equations is as follows:

$$Y_t = Zx_t \qquad (4.1)$$

$$[y_t] = [1\ 1\ 0] * \begin{bmatrix} \tau t \\ c_t \\ c_{t-1} \end{bmatrix} = \tau_t + c_t \qquad (4.2)$$

And in the case of the transition equation:

$$x_t = Bx_{t-1} + \upsilon_t ; \qquad (5.1)$$

$$\begin{bmatrix} \tau_t \\ 1 \\ c_t \\ c_{t-1} \end{bmatrix} = \begin{bmatrix} 1 & \mu_g & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \phi_1 & \phi_2 \\ 0 & 0 & 1 & 0 \end{bmatrix} * \begin{bmatrix} \tau_{t-1} \\ 1 \\ c_{t-1} \\ c_{t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ 0 \\ \upsilon_t \\ 0 \end{bmatrix} \qquad (5.2)$$

[6] Koopman, Shephard and Doornik (1998) explain that in order to generate samples from the unconditional distributions implied by a statistical model in state space form, or to generate artificial datasets, we use the state space form as a recursive set of equations.

Where:

Table 1. The description of components in the measurement and transition equations

Measurement equation	Description	Transition equation	Description
Yt	vector of observed variables	***B***	matrix of coefficients of unobserved variables
xt	vector of unobserved variables	***A***	matrix of coefficients of exogenous variables
D	matrix of coefficients of exogenous variables	***Zt***	vector of exogenous variables
dt	vector of exogenous variables		
Z	matrix of coefficients of unobserved variables		

In this representation of the UC model, the vector of observed variables Y_t contains only actual output, whereas the vector of unobserved variables contains potential output (τ_t), the cyclical component (c_t) and the first lag of the cyclical component (c_{t-1}). Here, the initial parameters μ_g, ϕ_1, ϕ_2 are treated as unknown, whereas the remaining part needs to derive its statistical properties. In a state space representation we are faced with two groups of unknown parameters that need to be estimated, for a given model specification. The first group represents the trend (τ_t), the cycle (c_t) and the drift (μ_g), whereas the second group are the initial parameters, ϕ_1, ϕ_2 and the error variances (σ^2_ε and σ^2_υ). Hence, there are seven unknown components that need to be estimated, while there is only one piece of information from which to extract them, which is the actual output (real GDP).

The UC modelling in the Watson (1986) form represents a simplified (restricted) version, as it does not include exogenous shocks, dummy variables or any additional explanatory variable such as inflation or unemployment that apply to multivariate techniques. Different authors modify and augment the state space notation by adding various exogenous or dummy variables, depending on the aim of their study.

After being written as a state space form (vectors and matrices), the UC model can be operationalized using the Kalman filter. The UC approach, written in a state space form, represents the structure of the Kalman filter. The Kalman filtering process is implemented conditional on the starting parameter values ($\mu_g, \phi_1, \phi_2, \sigma^2_\varepsilon$ and σ^2_υ), which 'design' the Kalman filter on modelling the desired components of our model. The initial parameter values need to be assumed (e.g. based on economic previous knowledge and judgemental elements one assumes that the initial level of potential output equals the initial level of actual output), estimated (e.g. the initial variance of the error terms of the trend and cycle are estimated via Hodrick-Prescott filter then fed into Kalman filter) or calibrated (the autoregressive coefficients are usually calibrated all over theory as 1.4 and -0.5) before implementing Kalman filter. In our model we implement all abovementioned ways for setting starting values. After being fed into the UC model, the starting parameters then are once more estimated by Kalman filer using the maximum likelihood function. The criteria for determining the value of the initial parameters will be such that they will minimize the difference of the mean squared error E{| y_t - $\hat{y}_t$| }.

5. Kalman filter

The Kalman filter was first developed by Rudolph E. Kalman in 1960 as a system for modelling discrete linear data with random processes. The Kalman filter represents a recursive process that generates *optimal estimates* from indirect, inaccurate and noisy observations (in our case actual output and Phillips curve ecuation).[7] In the case of stochastic processes which involve noisy data, the Kalman filter 'cleans up the noise' through filtering process in order to extract the true value of the desired variable together with its spread (behaviour). If all noise is random (Gaussian distribution of noise), the Kalman filter minimises the mean square error of the estimated parameters, in order to generate the *optimal estimator* (Kleeman, 1995).

In the case of discrete linear data modelling, the filter is always designed as an algorithm.[8] In our case, the filter is designed from two algorithms that are measurement and transition equations. Algorithms serve as a guide to predict the unobserved components, where entering a set of observed, calibrated and otherwise assumed information (y_t, μ_g, ϕ_1, ϕ_2, σ^2_ε and σ^2_υ) in the system will generate an outcome (τ_t and c_t).[9] These parameters, together with other observed variables in the case of multivariate UC model, feed in the system and basically design ('train') the Kalman filter in how to filter or predict the future values of the unobserved variables. The parameters can be changed depending on the needs of the model; however the number of the parameters remains fixed. The Kalman filter is highly sensitive to initial parameter values, which in effect will guide the way to predict unobserved components, thus the starting judgement for them is particularly important. For example, if the series is completely driven by structural shifts, the initial parameter values should be assumed differently compared to the case where the series is assumed to be driven by smooth fluctuations. For example, in transition economies, a higher weight should be assigned to the trend variance $\sigma^2\varepsilon$, as compared to, say, the pre-financial crisis in

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[7] It is a recursive process in the sense that new measurements can be processed as they arrive.

[8] Hamilton (1994) argues that numerical algorithms are usually much better behaved if an 'intelligent' initial guess of parameters is used.

[9] The ratio of $q = \sigma^2_\varepsilon / \sigma^2_\upsilon$ represents the signal-noise ratio, which determines how observations should be weighted for prediction and signal extraction. The higher is q, the more past observations are discounted in forecasting the future. Similarly a smaller q means that the closest observations receive a bigger weight when signal extraction is carried out. Further, a higher q means that most of the variation in the series is allocated to the trend component, whereas smaller q means that most of the variations are allocated to the cyclical component.

the developed countries, where the trend is smooth so the variance of the cyclical component should be assigned for a higher weight.

The lagged terms in the transition equation indicate that the transition algorithm in the Kalman filter will be a recursive process. A recursive process in the discrete data modelling means that each additional observation entered into the algorithm will predict each future values (one-step ahead predicted errors) based on past values at time t, then the following predicted values ($t + 1, t + 2, \ldots t + n$) will be updated (estimated) based on all past values plus the new estimated predicted value and so on. The recursive process runs into every term in the measurement and transition equation, similarly for trend, for cycle and for each parameter in succession.[10] After many iterations, the algorithm will eventually converge into an optimal estimator. Estimating the unobserved components one by one at each point in time, 'allows the data to speak', meaning that the algorithm is able to identify itself the structural breaks in the sample, without having to impose external restrictions.

The estimation procedure using the Kalman filter is as follows. The first step is to write the model in a state space form, as denoted in equations (2.11) to (2.15). Second, it requires setting up the initial parameter values of the model (μ_g, ϕ_1 and ϕ_2), which, in our case, are time invariant and characterize the optimal linear state of estimation, i.e. define the model as filtering or prediction. Also, the filter requires setting the starting values of the unobserved variables (g_t, c_t) and the variances the unobserved variables and their co-variance matrix cov(σ^2_ε, σ^2_υ) which in effect will define the initial *state of the model*. The starting values of the unobserved components (g_t, c_t) and other parameters are generated from other methods, such OLS, calibrated or assumed, thus not generated from the filter itself. In the third step, the transition algorithm (equation (2.14)) generates the current state variables, conditional on the initial parameter values. These are the *predicted* values of the unobserved variables (potential output and output gap), which still contain some noise (error) and uncertainties in them. This stage is also known as the *prediction step* or *a priori* estimate for time t.

In the fourth step, also called the *updating (correcting) step,* the 'cleaning' process continues, where the predicted values of unobserved variables are cast into the measurement algorithm (equation 2.12), to generate the predicted values for the observed variables. The predicting-correcting process in the Kalman filter represents the feedback control process.

After each predicted and updated measurement pair, the process is repeated with the previous estimates used to project or predict new estimates, until the parameter estimates converge (Commandeur and Koopman, 2007). The difference between the observed actual output and the predicted output E{$|y_t - \hat{y}_t|$} is called the measurement innovation or the residual, which quantifies the lack of the

[10] Welch and Bishop (2006, p. 5) explain that the recursive nature of the Kalman filter represents one of the most appealing features, since it makes the practical implementations more feasible, compared to other filters (e.g. Wiener filter) which are designed to operate on all of the data directly for each estimate.

accuracy of the estimated unobserved estimates in predicting the observed values at time t (Welch and Bishop, 2006). Otherwise, the measurement innovation looks like (Hamilton, 1994):

$$E\{|y - \hat{y}_t|\} = \min\{(\sigma^2_{\varepsilon} - \overline{\sigma^2_{\varepsilon}}) + \min(\sigma^2_{\upsilon} - \overline{\sigma^2_{\upsilon}}) \quad (6)$$

Simultaneously, the Kalman filter also calculates the prediction error and the variance terms (σ^2_{ε} and σ^2_{υ}). If the measurement noise vector components (ε_t, and υ_t) are uncorrelated, then the state update can be carried out one measurement at a time. Here, in a recursive manner, the Kalman algorithm updates the predicted values by giving a higher weighted average to the estimates with higher certainty and vice versa (as measured by q, see note 11). The unobserved variables will be estimated using maximum likelihood function (de Brouwer, 1998):

$$\log\Lambda = -\frac{NS}{2} \log 2\pi - \frac{1}{2} \sum_{t=1}^{S} \log |F|_t - \frac{1}{2} \sum_{t=1}^{S} \nu_t' F_{\nu}^{-1}$$

(7)[11]

'...which reflects how likely would have been to have observed the data (potential output and output gap) if the initial parameter values were the true values...'(Hamilton, 1994 p.x).

The value of the maximum likelihood function is maximised by minimizing the prediction errors (ε_t, and υ_t) and their variances (σ^2_{ε} and σ^2_{υ}). If the likelihood function is maximised, conditional on initial parameter values and initial values of g_t and c_t (Hamilton, 1994) :

$$\log (y_t, y_{t-1}, \ldots, y_1 \mid X_t, X_{t-1}, \ldots, X_1; \mu_g, \phi_1, \phi_2, \sigma^2_{\varepsilon}, \sigma^2_{\upsilon}) \quad (8)$$

then the estimated unobserved (g_t and c_t) components and the parameters (μ_g, ϕ_1, ϕ_2, σ^2_{ε} and σ^2_{υ}) are maximum likelihood estimates; if not, then the algorithm will continue a set of iterations and recursive processes by iterating on measurement and transition equations, using new initial parameter values, until it generates the optimal error estimates (Hamilton, 1994).[12] The maximum likelihood function, conditional of the initial parameter values, maximise the log-likelihood function value, by minimising the mean squared error , in order to generate the optimal estimates. The initial values of the parameters are the values that make equation (2.16) as large as possible; nevertheless, any change in the parameter values would imply a different probability distribution.

The Kalman filter may be considered as one of the best linear estimators that outperforms other models, (e.g. ARIMA models), (Koopman et al., 2008). Thus, whenever modelling involves considerable noise, such is the case with

[11] Where, N-number of observed variables, S-sample size, ν- prediction error matrix, F-mean square error matrix for the prediction errors (E-views manual).

[12] Hamilton (1994, p.3050) explains that the mean squared errors are not a function of the data y_t and they can be evaluated without calculating the forecast for the unobserved components.

unobservable components like potential output and output gap, it is usually suggested to use a Kalman filter (Kleeman, 1995).[13]

6. Data

The data used for Kosovo are of quarterly frequency. The time span of the data is relatively short, starting from 2002 to 2011. However, other studies examining the potential output and output gap in transition countries also rely on short time-series (e.g. Darvas and Vadas (2003), Benes and N'Diaye (2004), Tsalinski (2007), El-Ganainy and Weber (2010) etc.)

Only the real GDP data is required for estimation of the univariate UC model.14 Nominal GDP data will be adjusted with GDP deflator, to extract the real GDP data for all three countries. In the multivariate UC model, additional variables will be used, namely the GDP growth rate, Consumer Price Index (CPI), changes in food prices and changes in oil prices. All the changes will be transformed into first differences of the log of the respective variable in order to gain the percentage change for the period. The base year of the CPI index is year 2002. The data for Kosovo are taken from Statistical Agency of Kosovo (SAK), IMF World Economic Outlook (2012) and authors own calculations in the case of GDP quarterly deflator. All the data used in the estimation are seasonally adjusted. [15]

7. Initial parameters of the UC model

As mentioned earlier, before proceeding with estimations, Kalman filter needs the starting values of the parameters (μ_g, ϕ_1, ϕ_2, σ^2_ε and σ^2_v) as well as the starting values of the trend and cycle (y_t and c_t). Unfortunately, the initial parameter values are usually unknown and need to be derived (estimated, assumed or calibrated) from outside the model and then feed into the Kalman filter to estimate the model. The initial model parameters in table 2were set as follows:

[13] Hong (2008) explains that… ''Econometric models usually specify a relationship between economic fundamentals. Economists always hope that econometric models can capture important features of these relationships using a constant structure. Model stability is crucial for statistical inference, out-of-sample forecasts, and any policy implications drawn from the model. Such economic interpretations will be invalid in the presence of structural changes. Therefore, detection and identication of structural changes are important and can be regarded as a first step to build a nonstationary time series model in view of modeling strategy…''

[14]The Statistical Agency of Kosovo provides only yearly data for the GDP series, hence a disaggregated data from yearly into quarterly had to be used. The disaggregation process from yearly GDP into quarterly GDP was conducted by the Central Bank of the Republic of Kosovo, however these data are not publicly available ominal GDP data were adjusted with an estimated quarterly GDP deflator by the author.

[15]Given the relatively poor quality of the data available and the lack of the data for some of the sectors in the economy for disaggregating the annual GDP data into quarterly, the estimations were carried out without years 2000 and 2001.

Table 2. Starting parameter values for the univariate UC model

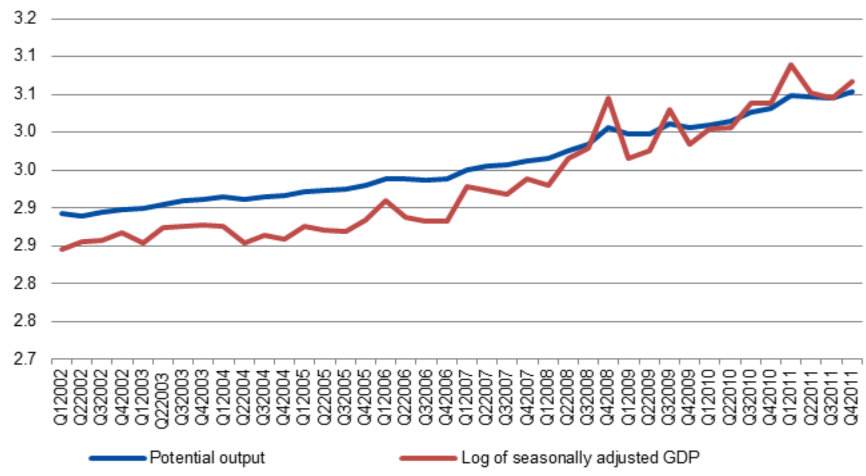
Starting parameter values				
μ_g	σ^2_ε	σ^2_v	ϕ_1	ϕ_2
0.015	0.002	0.02	1.400	-0.500

The drift term μ_g equals the average growth rate of the quarterly GDP, which in Kosovo case is 1.5 percent per quarter; the autoregressive coefficients ϕ_1 and ϕ_2, are set to fulfil the stationarity criteria, that is the sum of the two coefficients should not equal one: $\phi_1 + \phi_2 \neq 1$ (Harvey, 2005) and as suggested from the theory (Clark, 1989 and Kuttner, 1994) are set as $\phi_1 = 1.4$ and $\phi_2 = -0.5$; the error variances σ^2_ε and σ^2_υ were estimated from the OLS regression of the initially Hodrick-Prescott filtered potential output and the output gap. These are the initial parameter values for the univariate UC model, as presented in the following section.

7.1. Results from univariate UC model

As it can be noticed from the figure 2, **t**he estimated output gap generally ranges between -6% of GDP to +4% of GDP, which may be considered as a reasonable magnitude for a transition economy (Darvas and Vadas, 2003; Benes and N'Diaye, 2004).[16]

Figure 1. Potential output in Kosovo, univariate UC model



The highest value of the output gap of +4 percent of GDP is identified in the Q1 2011, whereas the lowest value of -5.8 percent is identified in Q2 2004. During the period 2002 to 2008, Kosovo experienced slow but steady growth rate, however the

[16] The positive values of output gap indicate that the economy is operating above the potential, whereas the negative numbers indicate that the economy is operating below its potential.

results suggest that the economy was performing below its potential (Figure 1).[17] This was the period when many structural reforms, such as the build-up of the institutional setting, the establishment of a market based economy, the development of the banking system, the undergoing privatisation process, encouraging trade and attracting investments, etc. were taking place, meaning that the economy could not have utilized its resources to its full potential.

In addition, this period was characterised with a relatively low and stable inflation rate of 2.2 percent on average. The highest historical inflation rate of 9.4 percent culminated by the end 2008, mainly because of the international oil and flour price jumps at the time. An important factor affecting the negative output gap during this period was the fiscal policy conduct. The period 2002–2008 when Kosovo economy was performing below its potential coincides with a period when the authorities were continuously conducting conservative fiscal policy, and usually concluding the fiscal year with surplus. This was due to the limited monetary policy tools and the inability of authorities to finance budget deficit. By the end of 2008 the government starts expansionary fiscal policy. . The higher budget spending led from surpluses in previous periods into an almost balanced budget in 2008 and low level of budgetary deficit by the end of 2009. The balanced equilibrated budgetary stance once more coincides with the timing when an eventual equilibrium state of the economy happens, i.e. the gap between actual output and the potential output closes somewhere between 2008 and 2009. Additionally to the expansionist fiscal policy, the initial phase of expansion of the business cycle starting from the last quarter of 2008 is also consistent with other economic developments, such is the extensive lending activity. However, on the other side, the indirect impact from the global crisis (decline in exports, slowdown of investments, slowdown in imports etc.) slowed the pace of economic growth. Further, net foreign direct investments in 2008 and 2009 declined consecutively, indicating that the potential output at the time may have been reduced. Further, a lower level of consumption and especially the decline in prices from international markets led to the lowest inflation rate in 2009 of -2.4 percent.

The business cycle of Kosovo experiences a turning point in 2010, where the economy starts performing above its potential. However, the above potential performance of the economy during Q12010 to Q42011 is relatively small (0.7 percent of GDP on average) and with variation. The overheating period is consistent with the growing demand pressures driven by private consumption (CBK, 2011) and substantial increase in the public spending (Ministry of Finance, 2011)[18]. The increase in domestic demand led to two digit increase of imports, therefore in an increase in prices (3.5 percent in 2010, 7.5 percent in 2011). Even though the above potential position of the economy is considered as a state of economy where the pace of production capacity cannot cope with the increasing demand, the Kosovo case represents a different case, as even in the below potential phase or equilibrium, most of the domestic demand was fulfilled via

[17] A one-time dummy was added in the model for Q4 2008, in order to control for an eventual structural break in the series, however, the dummy turned out as insignificant (apparently due to slower economic developments rather than a crisis or a shock), thus it was dropped from the model.
[18]

imports. Hence, the overheating phase was also reflected in terms of increased imports. Further, the raising inflation (which in overheating state is considered as accelerating an unsustainable) is relatively continued to be relatively low (one digit). Despite these developments that led into an above potential performance of the economy, on the other side, the lagged effects of the global crisis mainly via the external sector channels and the uncertainties perceived by the banking sector may have slowed the pace of growth. Moreover, even during 2010-2011 the Kosovo economy was still performing with considerable underutilised resources, such as relatively large unemployment rate. Therefore, the potential output during this period was quite close to the actual output, where the positive output gap comprised only a small proportion of the actual output.

7.2. Results from the multivariate UC model

Multivariate models represent richer structure and utilize additional content form economic theory, for the purpose of increasing the accuracy of the unobserved variables, potential output and the output gap. By incorporating economic content in the structure of the multivariate UC model, the advantage is increasing the accuracy of the estimated unobserved variables. Thus, we enrich the previously presented UC model by adding an additional measurement (signal) equation, that is a Phillips curve equation as in (9):

$$y_t = \tau_t + c_t \qquad (1)$$

$$\pi_t = \mu_\pi + a(L)\pi_{t-1} + b_1 c_t + b_2 c_{t-1} + d_1 \Delta FP + d_2 \Delta OP + d_3 \Delta GDP1 + e_t \qquad e_t \sim iid(o, \sigma^2_\pi) \qquad (9)$$

$$\tau_t = \mu_g + \tau_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim iid(0, \sigma^2_\varepsilon) \qquad (2)$$

$$c_t = \phi_1 c_{t-1} + \phi_2 c_{t-2} + \upsilon_t \qquad \upsilon_t \sim iid(0, \sigma^2_\upsilon) \qquad (3)$$

The Phillips curve represents an essential structural relation that may convey information about the potential output and the output gap in the economy. The modified Phillips curve captures demand and supply side shocks impact on the potential output and the output gap. The demand side pressures are captured by the output gap, whereas exogenous supply side shocks variables are usually proxied through change in food prices and change in oil prices (Gordon, 1997). Food and oil prices may be considered as exogenous, since for the Kosovo case, are mainly imported, hence their prices are given (exogenous).

The π_t term stands for inflation, whereas the lagged inflation stands for the lagged effect during the adjustment process of prices and wages (inertia); L is for the lag polynomial, since each variable can be modelled with a different lag structure. μ_π is the constant term, the a term is the coefficient of the lagged inflation, b_1 and b_2 are the coefficients of the output gap and lagged output gap, respectively, generated with the Hodrick-Prescott filter. The ΔFP, ΔOP and $\Delta GDP1$ stand for the changes in food prices, changes in oil prices and growth rate of the GDP, with their respective coefficients d_1, d_2 and d_3. The GDP growth rate is entered into the equation in order to capture the positive relationship between inflation and the

GDP growth. The e_t is the white noise error term with mean zero and variance σ^2. As argued in theory, changes in demand variables are those that affect the inflation rate, thus need to enter into the equation as first differences or as the first lag of the levels.

Before starting with estimation of the initial parameters of the model and the unobserved variables, first we need to identify an ARIMA process for the lagged terms of inflation, following Box-Jenkins approach. Box-Jenkins approach involves a three step approach: identification, estimation and diagnostic checking and forecasting (Box and Jenkins, 1970).[19]

Following the Box-Jenkins approach, initially each exogenous variable is tested for stationarity (Table 3).

Table 3. Unit root tests, univariate model*

Country	Series	ADF test, intercept	ADF test, intercept + trend	Phillip-Perron test	Decision
Kosovo	Log-levels of quarterly real GDP	Not rejected at any level of significance.	Not rejected at 1%, rejected at 5% level of significance.	Not rejected at any level of significance.	Non-stationary
	∆Log(GDP)	Rejected at all levels of significance.	Rejected at all levels of significance.	Rejected at all levels of significance.	Stationary

*Note: If the trend in ADF (intercept+trend) test turned out as insignificant, the ADF (intercept only) and the Perron-Phillip test were considered to judge the series as stationary or not.

As it can be noticed in table 2, the unit root is present in all of the log levels of the variables (CPI, food prices and oil prices), whereas the first differences of the log-levels are stationary. Thus, inflation variables are will be treated as integrated variables of order one. Second step involves calculating and plotting Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) which are commonly used to identify the ARIMA model. In the case of the geometric progression decline of the ACF and an abrupt decline of the PACF after the lag *p*, an AR(p) model should be considered. Conversely, if the ACF declines abruptly after the lag *p*, whereas the PACF declines with geometric progression after the lag *p*, than an MA(p) model should be considered. However, if both, ACF and PACF tail off, then an ARMA model is suggested to use.

In a pursuit of finding the best tentative inflation model, the ACF and the PACF suggest that a the MA(2) model fits best for Kosovo inflation model.[20] We have

[19] We will deal with the first two stages of choosing the best fitting ARIMA model, whereas the forecasting stage is outside the scope of this paper.

[20] An ARIMA model may be considered as valid when the model is free from residuals and has the smallest information criteria. The Ljung-Box test is commonly used in testing ARIMA modelling for residual correlation using Q(10)-test. Additionally, the smallest Akaike and Schwarz criteria aid in choosing the best fit model. It may be worth noticing that when dealing with small samples, the Schwarz criterion may be more powerful (Verbeek, 2000).

firstly tested a pure autoregressive model of order two, by adding only two autoregressive Log(CPI) variables into the equation; then, as in Kuttner (1994), we have added one by one other independent variables (Table 3):

In table table 4 below, the MA(2) estimated equations are presented:

Table 4. Estimated MA(2) Inflation Models

Equations	Parameter estimates						Diagnostics		
	μ_π	a_1	a_2	d_1	d_2	d_3	Akaike i.c.	Schwarz i.c.	Q(10) p-values
1	0.106 (0.721)	0.683*** (0.149)	-0.370*** (0.094)				4.518	4.699	0.770
2	0.964 (0.283)	0.199** (0.061)	-0.182** (0.058)	0.511*** (0.036)			2.542	2.769	0.553
3	0.081 (0.287)	0.205*** (0.061)	-0.181*** (0.057)	0.503*** -0.039	0.003 (0.004)		2.587	2.859	0.641
4	0.100 (0.298)	0.205*** (0.063)	-0.181*** (0.059)	0.502*** (0.405)	0.002 (0.005)	-0.006 (0.018)	2.643	2.961	0.597

*Note: Standard errors in parenthesis
***Significant at 1% level of significance.
**Significant at 5% level of significance.
*Significant at 10% level of significance.

In the MA(2) model all the equations are correctly specified with regard to serial correlation (Q(10test)). However, the information criteria (Akaike and Schwarz) suggest that the second equation in MA(2) model is the best inflation model fit (Phillips curve specification) for Kosovo case. As the changes in oil prices and lagged growth rate of the GDP turned out as insignificant, we have dropped them from the model specification:

$$\pi_t = \mu_\pi + a_1\pi_{t-1} + a_2\pi_{t-2} + b_1c_t + b_2c_{t-1} + d_1\Delta FP + e_t \quad e_t \sim iid(o, \sigma^2_\pi) \qquad (10)$$

After specifying the inflation equation, as discussed in the univariate unobserved model, we need to set initial parameter values for the multivariate model, also. The initial parameter values for the drift term μ_π, autoregressive coefficients ϕ_1, and ϕ_2 of the output gap and the variances of the potential output and the output gap, σ^2_ε and σ^2_υ, are the same as in the univariate model. Even though we have tried to estimate the initial parameter values with a linear regression, the coefficients from the MA(2) specification yielded better parameter estimates for inflation equation.

Table 4. The starting and estimated parameters for the multivariate model, Kosovo

Starting parameter values, MV model											
Parameters	μ_g	σ^2_ε	σ^2_v	ϕ_1	ϕ_2	a_1	a_2	b_1	b_2	d_1	σ^2_π
Starting parameter values, MV model	0.015	0.002	0.02	1.400	-0.500	0.02	-0.14	0.04	-0.060	0.500	0.800
Estimated coefficient, MV model	0.004***	0.002	0.02	0.0510***	0.004***	0.100	-0.060	-0.060	-0.400	0.500***	-0.400
Standard errors	(0.075)			(0.079)	(0.076)	(0.079)	(0.076)	(0.13)	(0.103)	(0.029)	
Output equation	Ho: No serial correlation Ho: Normality in the residuals								Q(10) = 0.183 Jarque-Berra = 0.072		
Inflation equation	Ho: No serial correlation Ho: Normality in the residuals								Q(10) = 0.814 Jarque-Berra = 0.251		

Note: The log-likelihood function is 148.28. The model converged after 46 iterations.

***Significant at 1% level of significance.

**Significant at 5% level of significance.

*Significant at 10% level of significance.

The diagnostic tests suggest that the multivariate UC model for Kosovo is well specified. The residuals of the model, similar to the univariate model are normally distributed at 5 percent level of significance.

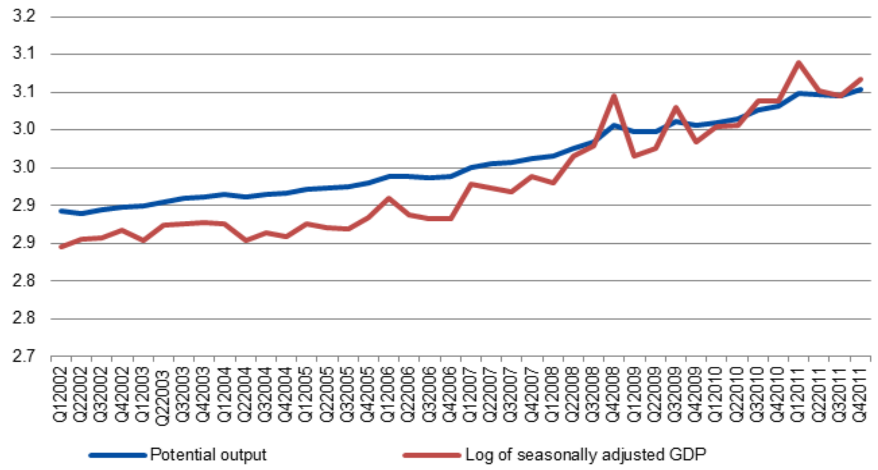
One of the most important relations in the UC multivariate model is the relation of the output gap and the inflation. Contrary to what theory suggests, in Kosovo case 1 percent increase in the output gap of the previous period, on average, will lead to a 0.04 decrease in inflation rate in the current period, ceteris paribus. However, the previous as well as the current value of the output gap turned out as insignificant. An implication of this result may be that when the economy is performing below the potential, it is easier to activate the working force at the same price level. Meanwhile, if the aggregate demand increases, the need for extending productivity increases, too, however the employees may also require higher payment. This in turn may increase the price level. However, the insignificant relationship between output gap and the inflation rate may also reflect the specific labour market in Kosovo, where even though the unemployment rate is considerably high, the reservation wage is also considered to be relatively high (Reference here), whereas wages are not necessarily flexible in short-run. Therefore, the impact of the output gap in the inflation rate may be insignificant. Additionally, nevertheless the presence of a positive or negative output gap, as argued in section 2, Kosovo has a very limited scope of monetary policy at hand to influence the price levels.

Further on, in line with the expectations, food inflation turned out to be an important determinant of the CPI inflation; that is, 1 percent increase in food inflation, on average leads to 0.5 percent increase in the overall CPI, ceteris

paribus. This finding is expected in the case of Kosovo, given that the foodstuff represents around 60 percent of the CPI basket.
Further, the potential output growth rate is 0.4 percent quarterly, which is lower than the actual output growth rate. Both autoregressive coefficients turned out as highly significant, confirming that the output gap follows and AR(2) process, as in the univariate model.

In the following we will examine the estimated potential output for Kosovo (Figure 2).

Figure 2. Potential output in Kosovo, multivariate UC model



The fact that the lagged terms of the output gap in Kosovo turned out to have an insignificant impact in inflationary pressures, were reflected in the generated unobserved series, also. As it can be noticed, despite including economic theory in it the multivariate model generated slightly different results from the univariate model, since the estimated UC are quite similar in both models. In most of the quarters, the output gap is the same, in some others the output gap differs only in the decimals. For example, during 2006, the output gap in the multivariate model is larger for 0.00017 percent of the GDP, whereas during 2010 and 2011 for only 0.0002 percent of the GDP.
As argued in the univariate model, the period from Q12002 to Q32008 represents a period where Kosovo economy was performing below its potential. From 2008 onwards, Kosovo business cycle experiences two turning points: the first being between 2008 and 2009 where the economy, after around ten years performing below its potential reaches the equilibrium and the second turning point during 2010, where the economy starts performing above its potential, even though the potential output is quite close to the actual output. To conclude, the business cycle in Kosovo, despite other important developments in other sectors of the economy, throughout the period under examination closely mimics the fiscal policy developments. Therefore, the fiscal policy in Kosovo economy appears to have played a predominant role in the business cycle of Kosovo.
Overall, developments like the declaration of independence in 2008 and later on the moderate effect of the global financial crisis had only a transitory impact in

the potential output (trend), whereas the output gap (cycle) turned from negative into a positive one. This is in line with the main assumption of the UC model, indicating that shocks affecting trend and cycle are not correlated.

8. Conclusion

Potential output identifies the maximum level of output produced in an economy without generating inflationary pressures, whereas the output gap identifies the cyclical position in the economy, indicating whether an economy is performing below or above its potential. Both indicators are relevant for the conduct of monetary and fiscal policy. Further, information on potential output and the output gap increases the viability of the decision making in maintaining a stable macroeconomic environment.

Both variables are unobservable. Among many techniques derived in the theory, which all encompass their own advantages and disadvantages, we have decided to employ an unobserved components method implemented via the Kalman filter. This approach is considered to be a more appropriate technique as it yields more robust results, especially in the case of transition economies that have undergone considerable structural changes and have short time-series.

During the period of investigation, univariate and multivariate models generate similar results, where the highest value of the output gap of +4 percent of GDP is identified in the Q12011, whereas the lowest value of -5.8 percent is identified in Q22004. From 2002 to 2008 we find that the Kosovo economy was performing below its potential with an average of -4% of GDP. This development is consistent with the beginning of a recuperating process after the crisis in 1999, the construction of the institutional setting and particularly is consistent with the conservative fiscal policy conduct. During 2008 and 2009, the budgetary spending starts to increase, for the first time leading into a balanced state of budget. This development coincides with an eventual equilibrium state of the economy, i.e. a closed gap between actual and potential output. From 2010 onwards, the economy seems to be performing above its potential. The overheating period is consistent with the growing demand pressures driven by private consumption, but most of all due to a substantial increase in the public spending on the building of the national highway. However, the impact of the financial crisis expressed via the external sector channels and the increased uncertainties perceived from the banking system slowed the pace of growth from 2009 onwards, by keeping the potential output above yet close to the actual output.

In the multivariate specification, an output gap versus inflation relationship was established. However, this relationship turned out insignificant, most probably due to structural problems in Kosovo economy, such as relatively high unemployment rate as well as sticky prices and wages.

To conclude, the fiscal policy appears to be the predominant factor impacting the business cycle development in Kosovo. Fiscal policy, even though had counter-cyclical effects during 2009 when the impact of the global financial crisis started to show in Kosovo, during the period of investigation has continuously been pro-cyclical.

REFERENCES

Antonicova, Z. and Hucek, J. (2005) “Multivariate Filter with Unobserved Components” *Biatec*, Vol. 13, No. 6, pp. 13-18.

Benes, J.and Ndiaye, P. (2004) “A Multivariate Filter for Measuring Potential Output and the NAIRU: Application to the Czech Republic”, *IMF Working Paper* No. 04/45.

Beveridge, S. and Nelson, C. (1981) “A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the Business Cycle” *Journal of Monetary Economics* Vol.7 pp.151-174.

Carvalho, V. and Harvey, A. and Trimbur, T. (2007) “A Note on Common Cycles, Common Trends, and Convergence” *Journal of Business & Economic Statistics, American Statistical Association* Vol. 25 pp. 12-20

CBK (2011): Annual Report, Central Bank of the Republic of Kosovo, Prishtina

Cerra, V. and Saxena, S. (2000) “Alternative Methods of Estimating Potential Output and the Output Gap - An Application to Sweden“, *IMF Working Papers* No. 00/59

Clark, P. (1987) “The Cyclical Component of U.S. Economic Activity”, *Quarterly Journal of Economics,* Vol. 102 pp. 797-814

Clark, Peter K. (1989) “Trend Reversion in Real Output and Unemployment,” *Journal of Econometrics* 40 pp. 15-32

Commandeur, J. and Koopman, S. (2007) “*Practical Econometrics: An Introduction to State Space Time Series Analysis*” New York: Oxford University Press

Darvas, Z. and Vadas, V. (2003) “Univariate Potential Output Estimations for Hungary” *MNB Working Papers* No.8, Magyar Nemzeti Bank (The Central Bank of Hungary)

Durbin, J. and Koopman, S. (2001) “Time Series Analysis by State Space Methods” *Oxford University Press,* Oxford

Fuentes, R. and Gredig, F. andMauricio, L. (2007), “Estimating the Output Gap for Chile”, *Central Bank of Chile Working Paper* No. 455

Gerlach, S. and F. Smets (1997) “Output Gaps and Inflation: Unobservable-Components
Estimates for the G-7 countries” *Bank for International Settlements,* Draft version

Harvey, Andrew C. (1989), “Forecasting, Structural Time Series Models and the Kalman Filter” *Cambridge University Press,* Cambridge

Harvey, A.C. and Todd, P.H.J. (1983) “Forecasting Economic Time Series with Structural and Box Jenkins Models. A case Study” *Journal of Business and Economic Statistics* Vol. 4 pp. 299-306

Hodrick, R. and Prescott, E. (1997) “Postwar U.S. Business Cycles: An Empirical Investigation” *Journal of Money, Credit & Banking* Vol. 29

Kalman, R. E. (1960) “A new approach to linear filtering and prediction problems” Transaction of the ASME – *Journal of Basic Engineering*, Vol. 82 (Series D) pp. 35-45

Kichian, M. (1999) “Measuring potential output within a state-space framework”, *Bank of Canada Working Paper* No.9

Kleeman, L. (1995) Understanding and applying Kalman filtering. Department of Electrical and Computer Systems Engineering Monash University, Clayton (mimeo)

Koopman, S. and Marcellino, M. and Wong, Y. (2008) “Forecasting Macroeconomic Time Series using Unobserved Components Models”, 5th *Eurostat Colloquium on Modern Tools for Business Cycle Analysis*

Kuttner, K. (1994) “Estimating Potential Output as a Latent Variable,” *Journal of Business & Economic Statistics* Vol. 12 No. 3 pp. 361-68

Magud, N. and Medina, L.(2011) “The Chilean Output Gap”, *IMF Working Papers* No. 2

Mishkin, F. (2004) Can Central Bank transparency Go Too Far? RBA Annual Conference Volume Christofer Kent and Simon Guttanmann (ed.) *The Future of Inflation Targeting,* Reserve Bank of Australia

Nelson, C. and C. Plosser (1982)”Trends and Random Walks in Macroeconomics Time Series: Some Evidence and Implications” *Journal of Monetary Economics* Vol. 10 pp. 139-162

SAK (2009): The Workforce Questionnaire, Statistical Agency of Kosovo, Prishtina

SAK (2012): The Workforce Questionnaire, Statistical Agency of Kosovo, Prishtina

Sramkova, L. and Kobilicova, M. and Krajcir, Z. (2010) "Output Gap and NAIRU Estimates within State-Space Framework: An Application to Slovakia" *Financial Policy Institute, Ministry of Finance*

Tsalinski, T. (2007) "Two approaches to estimating the potential output of Bulgaria" *Bulgarian National Bank Discussion Paper* 57/2007

Watson, M. (1986) "Univariate detrending methods with stochastic trends," *Journal of*
Monetary Economics Vol.18 pp. 49-75

Welch, G. and Bishop, G. (2001) "An Introduction to the Kalman Filter" SIGGRAPH 2001 course 8, In Computer Graphics, Annual Conference on Computer Graphics & Interactive Techniques *ACM Press,* Addison-Wesley, Los Angeles, CA, USA (August 12–17)

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