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Estimating Production Gap and NAIRU in Iran's Economy by Using State-Space Model

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Abstract

The purpose of this paper is to estimate the output gap and NAIRU for Iran's economy, both of which are among the most important variables in determining the economic status. Since these variables are unobservable, to estimate them, one needs modern econometric techniques rather than conventional tools. For this reason, this paper uses the Kalman filter tool in the form of a state-space model. Since there are several different specifications for a state-space structure, seven different models are tested by using seasonal data from 1989 to 2014. Results show that only two specifications have suitable estimation results. The first one is a structural model consisting of output and unemployment rate decomposition, plus the relationship between the inflation rate and the output gap in the form of the Phillips curve, and the second is a system that only includes unemployment rate decomposition. The early model can show the periods of inflationary recession between 1992 and 1995, and a severe economic recession during the period of 2010–2013 due to economic sanctions imposed on Iran. The latter model can depict NAIRU gap fluctuations following the inflation fluctuations. In addition to the compatibility of these results with what is observed in reality, the parameters are also statistically significant.

Keywords: Kalman Filter Method, NAIRU, Production Gap, State Space Model.
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1. Introduction

Business cycles have always been one of the most important issues in economic literature, and are considered as one of the main

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prerequisites to guide economic policies. The business cycle refers to production fluctuations around its long-run trend. Therefore, the production gap is the difference between potential production and actual production. Accordingly, the business cycle is obtained by removing the long-run trend of the data (Lucas, 1977). Finding the production gap is useful in determining the business periods so that the negative production gap indicates a recession period, but a positive production gap shows a boom period. Therefore, the rate of production gap is considered as one of the economic fluctuation indicators. In addition to the production gap, the unemployment rate can also be an indicator of the business cycle. The criterion-related to the unemployment rate, which can show the structure of business cycles, is NAIRU[1]. NAIRU indicates the business cycle status, in which there is no pressure on inflation to change that reflects the economy equilibrium state because macro variables are constant in the equilibrium state. Therefore, the NAIRU unemployment rate is expected when the production gap is zero. Otherwise, unlike the business cycle, unemployment will change according to NAIRU. Thus, it can be stated that NAIRU is a long-run equilibrium unemployment rate, and its difference from current unemployment reflects the unemployment cycle. Accordingly, the production fluctuations and unemployment can be important criteria in determining the state of economic equilibrium and the business cycle. The relationship between inflation and unemployment rate is usually expressed through the Phillips curve. Gordon (1998), Stuck and Watson (1999), and Fiver (1995) are among the studies conducted in this regard, where the effect of unemployment rate fluctuations on inflation has been studied, which is considered the source of inflation acceleration. In other words, any periodic changes in the unemployment rate are reflected by the inflation rate.

On the other hand, unemployment rate fluctuations are a function of the production amount, and thus the demand for the labor force. Thus, there is a significant relationship between the unemployment rate and the production gap known as Okun’s law, which refers to the relationship between the unemployment rate and the business cycle.

1. non-accelerating inflation rate of unemployment

The question is that how to cycle amount can be separated from the long-run trend with the production time series. Economists are confronted with the question of whether time series represent a long-run trend. If so, it’s important to know how the cycling term can be separated from the data. To achieve that, there are two problems: First, the economic theory does not provide more information on the long-run trend and its relation to the cycling term. Second, only time series related to production can be observed, and there are unobservable the long-run trend and thus the cycle amount. In their extraction, they make traditional econometric methods unusable. So, the separation of two terms of the trend and the cycle requires new hypotheses and modern methods. Canova (2007) refers to three different methods for extracting a cyclic term as follows:

1. Statistical method: It has a statistical process, where the cyclic term extraction is performed using time series characteristics of the variable.
2. Economic method: It is based on economic theory. In this method, given the process of data generation, the relationship between the cycle, the trend, the considered variable, and the business cycle is extracted.
3. Combined method: In this method, a process is used which has a statistical nature; yet it has a kind of economic justification.

One of the existing combined methods, widely used in various sciences including economics, is the state space and Kalman filter models, which its goal is eliminating the trend term and finding the cyclic term of real data. The Kalman filter is an algorithm, which is employed to create the minimum mean squared prediction error in a state-space model. Since this filter can be used for cases such as the unobservable variable and a variable parameter over time, it will be a powerful tool for extracting the business cycle and NAIRU. The main innovation of this paper is that it has seven different specifications for the simultaneous relationship between the inflation rate, the output gap, and the NAIRU, where the validity of each model has been verified by comparing the generated series for unobservable variables and what expected from the theory, and also statistical inference on the estimated parameters.

The remainder of this paper is organized as follows. Section 2 provides a literature review. Section 3 elaborates on the theoretical foundation. Section 4 provides an estimation of the NAIRU and production gap for the Iranian economy and Section 5 concludes the paper.

2. Literature Review

As stated by Canova (2007), estimating the cyclic term is possible with three different methods. Accordingly, various studies conducted in the field of production gap estimation and NAIRU have used different theoretical principles and foundations.

Some studies, e.g. Falahati et al. (2016), have used both statistical (*Hodrick–Prescott filter*) and economic (production function) methods. Their results indicated that there were production fluctuations in the specific periods of the Iranian economy i.e. oil shocks, Islamic revolution, and imposed war. The main difference between this article and our paper is that these authors employed a fundamental function (production function) to estimate the output gap that is generally neglected any relation between output and other macro variables, such as inflation and unemployment. In other words, we try to include such relations in the form of the Phillips curve and unemployment rate decomposition.

Using different methods can make different results. Hence, comparing the results of different methods can be a criterion to evaluate if a method is efficient or not. For example, Kavand et al. (2007), after estimating the production gap using Kalman filter and Hodrick-Prescott methods, compared their results. They found that the production gap calculated through the state space method had a lower fluctuation domain than that of the Hodrick-Prescott method. Since the economic approach requires modeling, its result depends on the system of equations, the initial point, and the data used; while the statistical methods are not very exposed to the initial conditions. Compared with our model, they used a system had introduced by Harvey (1989) but we primarily stand on a broader structure which includes flexibility in model specification, though, general features of their model are similar to us.

But, the results of economic methods may not be the same in different studies. For example, Rajaei et al. (2017) found results different from Kavand et al. (2007). Using the *Hodrick–Prescott,* and Band-Pass methods, the scholars concluded that the Hodrick-Prescott filter method more efficiently estimated the production gap. Although, we think that *Hodrick–Prescott can estimate the gap, however, the value of the gap may not derive efficiently. So, from our view, Kavand results may be stronger and more trustable than Rajaei.*

In a comprehensive review, Kiani et al. (2012) proposed the two classes of parametric and nonparametric methods to estimate the production gap. Their results indicated that in the parametric method, the space state and Kalman filter were more efficient; while in the non-parametric method, the Hodrick-Prescott and Rotemberg showed more efficiency. In other words, they confirmed that the Kalman method, using the state-space model, could provide an appropriate estimation of the production gap in Iran. Although Kiani's study is different from us in its details, their overall finding is very similar to our paper and in other words, our findings are in line with these results.

Akbari et al. (2004) estimated potential gross output in the Iranian economy, using Hodorick–Prescott filter. Their results showed that the inflation rate and the exchange rate appreciation could lead to an increase in Iran’s output gap, but the liquidity growth had little impact on it. This study is merely used as one of the major statistical methods and among the first studies that estimated the output gap for Iran.

As stated, the Kalman filter method and the state-space model can be used to extract the cycle of each economic variable, e.g. NAIRU. Ace (2014) calculated the NAIRU rate for Turkey’s economy based on the simultaneous equations model, by using the Kalman filter method. In this study, there was used a two-equation system based on the unemployment rate, the production gap, and the relative linear trend model. Since the NAIRU rate and the production gap are the two identical concepts of business cycle state, they have been estimated simultaneously in some studies, for example, Ramkova et al. (2010), to estimate the production gap and NAIRU for Slovakia. According to Ace (2014), they play an important role in determining the dynamics of the inflation rate, the unemployment rate, and real production. Finally, given the causal relationship between the mentioned variables, the time series trend of the production gap and NAIRU was calculated. Fabiani et al. (2001) used a partial linear trend for estimating NAIRU in the euro area using the Kalman filter approach. They employed the equations related to the Phillips curve, the Okun's relation, and the first-order auto-correlation relations. They somehow confirmed the system of equations used by Ramkova et al. (2010), in which the model used for the estimation of NAIRU and the production gap was based on the simultaneous correlation between inflation, unemployment, and production; because NAIRU is the rate of unemployment, on which there is no inflationary pressure.

3. Theoretical Foundation

3.1 State Space Model

The state-space form representation is a mathematical model. It includes state and signal variables, between which the relationships are determined using random differential equations. The state variable is used to describe the system state. In other words, this variable determines its future behavior. The signal is a variable whose status in each period is a function of the state variable and exogenous shocks. The differential equations representing the dynamic path of state and signal variables are known as state and measurement (signal) equations, respectively. One of the most important benefits of this modeling is that it facilitates the estimation of unobservable economic variables, which lack data over a while and cannot be estimated using conventional techniques. Yet, the state-space model makes it possible to consider the non-observable variables in the form of the state variable, and then estimate the coefficients by providing the Kalman filter algorithm. Accordingly, in this section, we briefly examine the mathematical and statistical form of the state-space model to find out its mechanism for modeling the space, based on state and signal variables. Then, we describe the Kalman algorithm filter, which is an attempt to estimate non-observable variables. As mentioned above, the first equation in a state-space model is the equation related to the state variable, known as the measurement equation which is calculated in this way:

$$y_t = H_t\beta_t + A_tZ_t + \varepsilon_t \quad (1)$$

where, y_t is the vector n×1 of the observable variables, Ht is the matrix n×m , Zt is the matrix n×k of the exogenous variables, βt is the vector m×1 of the observable state variables, A_t is the matrix k×n of the parameters, ε_t is the error with mean of zero, and the variance-covariance Rt with dimensions of n×n. To complete the system of equations, it is necessary to determine the process of change in the state variable (unobservable) over time, which its form is considered as follows:

$$\beta_t = \mu_t + F_t\beta_{t-1} + S_t v_t \tag{2}$$

where F_t is a matrix of m×m, μ_t is the vector of m×1, S_t is the matrix of m×g , and v_t is the vector of non-correlated shocks with dimensions of g×1, which their mean is zero and their variances are equal to Q_t, where Q_t is a given matrix with dimensions of g×g. Kalman filter is an algorithm, which estimates the unobservable variables by using observations and shocks. This algorithm has a two-stage process. In the prediction stage, the Kalman filter provides an initial estimate of the constant variables. In the second stage, by observing the next period value of the observable variable, the predicted value in the previous stage is reviewed. This algorithm is repeated recursively. As the production gap and NAIRU are considered unobservable variables, the Kalman filter technique will be a useful tool in the cycle- trend decomposition. In this state, it is first necessary to divide the time series as sum of its constituents, which for the variable of yt, its decomposition is as follows:

$$y_t = \tau_t + c_t + \gamma_t + \varepsilon_t \tag{3}$$

where τ is the trend term, c_t is the cyclic term, γ_t is an unobservable seasonal term, and ε_t is an unobservable error term. Some of the terms in Equation (3) are optional, which can be omitted, due to the variable nature. The terms of Equation (3) typically follow a random process, which Kalman filter is used for their estimation because they are unobservable. For example, if y_t oscillates around a constant trend, it can be modeled as $y_t = \tau + \varepsilon_t$, in which$\varepsilon_t \sim iid\ N(0.\sigma_\varepsilon^2)$, and if the trend term changes over time as a random step process, it can be expressed as below:

$$y_t = \tau_t + \varepsilon_t. \quad \varepsilon_t \sim iid\ N(0.\sigma_\varepsilon^2 \tag{4}$$
$$\tau_t = \tau_{t-1} + \eta_t. \quad \eta_t \sim iid\ N(0.\sigma_\eta^2) \tag{5}$$
$$E(\varepsilon_t \eta_t) = 0$$

In this case, τ_t is a relative or mean level of the process and its oscillation rate in each period is equal to η_t. We can generalize the above equation to a model in which the trend term has a variable slope (β_t) over time. The above model is expressed as follows:

$$y_t = \tau_t + \varepsilon_t. \quad \varepsilon_t \sim iid\ N(0.\sigma_\varepsilon^2) \tag{6}$$
$$\tau_t = \tau_{t-1} + \beta_{t-1} + \eta_t. \quad \eta_t \sim iid\ N(0.\sigma_\eta^2) \tag{7}$$
$$\beta_t = \beta_{t-1} + \zeta_t. \quad \zeta_t \sim iid\ N(0.\sigma_\zeta^2) \tag{8}$$

4. Estimation of NAIRU and Production Gap for the Iranian Economy

The used data are related to the inflation rate, real production, and unemployment rate in the seasonal period from 1989–2014[1]. These data were extracted from the central bank time-series information system and were used after seasonal adjustment. As mentioned, the state-space model can be specified and estimated in different ways. So, the dynamic path of the production gap and NAIRU variables can be calculated using a set of different models. Therefore, in this section, seven different models of the relationship between inflation, production, and unemployment will be presented, based on which production gap and NAIRU are estimated. Finally, examining the model results and the estimated values, just two models present acceptable values for NAIRU and the production gap and we only show the structure of these two models.

4.1 Results of the First Model Estimation

Since the two previous models have not been able to obtain the correct and acceptable estimates of NAIRU and the production gap, in the third model, the dynamic process of variables is modeled differently, shown in the following:

1. Due to the lack of information for the seasonal unemployment rate, our data has been limited up to 2014.

$$y_t = y_t^T + y_t^c$$
$$\pi_t = \alpha_1 \pi_{t-1} + \alpha_2 \pi_{t-2} + \alpha_3 y_t^c + \alpha_4 y_{t-1}^c + \alpha_5 y_{t-2}^c + \varepsilon_t^\pi$$

$$y_t^T = y_{t-1}^T + \beta_{t-1} \qquad (9)$$
$$\beta_t = \beta_{t-1} + \varepsilon_t^\beta$$
$$y_t^c = \alpha_2 y_{t-1}^c + \varepsilon_t^c$$
$$u_t = nairu_t + s_t$$
$$nairu_t = nairu_{t-1} + \varepsilon_t^n$$
$$s_t = \alpha_6 s_{t-1} + \alpha_7 y_{t-1}^c + \varepsilon_t^s$$

The difference seen in the third model is that the unemployment rate fluctuations are expressed in terms of the production cycle. Thus, the relationship between production and unemployment rate has been included in the model. Results of the estimation of the above model is shown in Table (2).

Table 1: Results of the Third Model Parameters Estimation

PARAMETER	ESTIMATED VALUE	SD	Z STATISTIC	PROBABILITY VALUE
$\boldsymbol{\alpha_1}$	1.38	0.01	114	0
$\boldsymbol{\alpha_2}$	-0.39	0.006	-65	0
$\boldsymbol{\alpha_3}$	0.37	0.005	72	0
$\boldsymbol{\alpha_4}$	-0.16	0.01	-10	0
$\boldsymbol{\alpha_5}$	-0.6	0.045	-13	0
$\boldsymbol{\alpha_6}$	0.002	0	11	0
$\boldsymbol{\alpha_7}$	-0.006	0.001	-4.89	0

Source: Research Findings.

The results of Table (1) indicate that the estimated parameters are significant and acceptable. Thus, the time series of the NAIRU and production gap can be estimated and reported based on the above model. As can be seen in Table (1), the current business cycle coefficient is positive and 0.37 for inflation, which is exactly consistent with the theory. In other words, with increasing cycle rate, the inflation rate will increase, too.

On the other hand, the coefficient of the previous cycle to unemployment fluctuations has a negative value. In other words, by increasing the production relative to potential production and reducing the production gap, demand for labor force increases, and the unemployment rate approaches the NAIRU. Accordingly, Tables (2) and (3) show the NAIRU and the production gap derived from this model.

Table 2: The NAIRU Rate (Percent) Derived from the Third Model

Year	NAIRU	Year	NAIRU	Year	NAIRU	Year	NAIRU
1989:1	0	3	8.7	2002:1	14.7	3	10.2
2	6	4	8.5	2	12.5	4	9.5
3	19.3	1996:1	8	3	12.2	2009:1	12.5
4	13.6	2	7.3	4	12.7	2	11.1
1990:1	12.9	3	6.3	2003:1	12.2	3	11.2
2	11.7	4	6.6	2	11.6	4	11.2
3	11.5	1997:1	7.8	3	11.1	2010:1	14
4	11.1	2	8.8	4	11.8	2	13.5
1991:1	10.4	3	9.6	2004:1	11.3	3	13.5
2	9.8	4	10.3	2	10.3	4	12.1
3	9	1998:1	10.5	3	10.4	2011:1	14.6
4	8.8	2	10.9	4	10.3	2	12.3
1992:1	8.8	3	11.1	2005:1	11	3	11.1
2	8.8	4	11.7	2	11.9	4	11.8
3	8.5	1999:1	12.3	3	10.9	2012:1	14.1
4	8.4	2	13	4	10.8	2	12.9
1993:1	8.8	3	13.9	2006:1	12	3	12.2
2	8.9	4	14.1	2	11	4	11.1
3	9.2	2000:1	14	3	10.1	2013:1	12.3
4	9.2	2	13.9	4	11.6	2	10.6
1994:1	9.1	3	14.1	2007:1	12.1	3	10.4
2	8.9	4	14	2	10.7	4	10.3
3	9	2001:1	14.1	3	9.9	2014:1	10.4
4	8.9	2	13.8	4	9.8	2	107
1995:1	8.8	3	14	2008:1	11.9	3	9.4
2	8.7	4	14.2	2	9.6	4	10.4

Source: Research Findings.

From the NAIRU definition, there is a negative relationship between NAIRU gap[1] variations and inflation: whenever inflation is raised, it is accompanied by a reduction in unemployment concerning

1. By definition, NAIRU gap is the difference between NAIRU from unemployment rate. Positive gap means unemployment rate is above NAIRU.

NAIRU and vice versa. From table (2), in periods such as 1994- 1995, 2008, 2012 – 2013, where the inflation rate increased, the unemployment rate is below NAIRU. So based on this comparison, estimated NAIRU can bring information on inflation variations.

Table 3: Production Gap Derived from the Third Model

Year	Production gap	Year	Production gap	Year	Production gap	Year	Production gap
1989:1	0	3	-0.007	2002:1	0	3	-0.005
2	-6.5	4	-0.005	2	-0.004	4	-0.004
3	1.3	1996:1	0.001	3	0	2009:1	0.001
4	0.003	2	0.01	4	-0.004	2	0.005
1990:1	0.006	3	0.004	2003:1	-0.003	3	0.005
2	0.01	4	0.01	2	0	4	0.008
3	0.002	1997:1	0.005	3	-0.001	2010:1	0
4	0	2	0.004	4	0	2	0.003
1991:1	-0.005	3	0	2004:1	0.002	3	-0.001
2	0	4	0.002	2	-0.001	4	-0.001
3	-0.01	1998:1	-0.002	3	0	2011:1	-0.004
4	0	2	0.001	4	0	2	-0.006
1992:1	-0.007	3	-0.002	2005:1	-0.001	3	-0.003
2	-0.007	4	0	2	0	4	-0.004
3	0.003	1999:1	-0.001	3	0.003	2012:1	-0.0002
4	-0.003	2	-0.003	4	0.001	2	-0.0006
1993:1	0.004	3	0.002	2006:1	0.001	3	-0.003
2	-0.003	4	-0.004	2	0.004	4	-0.007
3	0.007	2000:1	0.002	3	-0.004	2013:1	-0.009
4	-0.006	2	0.001	4	-0.001	2	-0.008
1994:1	0	3	0.003	2007:1	-0.003	3	-0.009
2	-0.008	4	0	2	-0.004	4	0.004
3	-0.005	2001:1	0.003	3	-0.002	2014:1	0.005
4	-0.004	2	-0.001	4	-0.003	2	0.01
1995:1	-0.008	3	0	2008:1	-0.002	3	0.006
2	-0.01	4	0	2	-0.004	4	0.004

Source: Research Findings.

According to Table (3), the third model can show the periods of recession and boom, close to reality. For instance, between 1992 and 1995, the production declined, and Iran experienced a period of inflationary recession. According to Table (3), the estimated production gap is negative in this period. On the other hand, in 1998, the world oil price declined significantly, which, in turn, harmed production, and caused Iran to experience a period of economic recession in those years. The third model, inconsistent with the characteristics of this period, shows the production gap as negative. Another fact which indicates the consistency of the production gaps to the observations is the beginning of a severe economic recession between 2010 and 2013. Since the half of 2010, the economic sanctions were imposed on Iran, and peaked in the late 2011 and early 2012. In this period, along with the sanctions pressure on the Iranian economic system, Iran experienced severe economic recession associated with high inflation rates, indicated in Table (2). By the way, this system is suitable in deriving output gap and NAIRU for Iranian economy for three reasons: firstly, the estimated parameters are statistically significant; secondly, the produced numbers for output gap and the NAIRU has placed in a range compatible with economic theory; and thirdly, the derived time series for our unobservable variables are matched with the stylized facts during the data period. The significance of parameters along with defendable derived series for unobservable variables leads us to opt this model.

In this section, a new form of the Philips curve is used for better estimating the production gap and NAIRU. This form, which is based on the New Keynesian theory, argues that the inflation expectations as well play an important role in inflationary dynamics, and in addition to the inflation of the previous period, the expected inflation should be included in the model specification. Therefore, the above model is estimated with two other Phillips curves as follows:

$$\pi_t = \alpha_1 E\pi_{t+1} + \alpha_2 \pi_{t-1} + \alpha_3 y_t^c + \alpha_4 y_{t-1}^c + \alpha_5 y_{t-2}^c + \varepsilon_t^\pi$$

$$\pi_t = \alpha_1 E\pi_{t+1} + \alpha_2 \pi_{t-1} + \alpha_3 y_t^c + \varepsilon_t^\pi$$

Yet, even the production gap and NAIRU extracted from the two new models with the Phillips curves mentioned above do not provide acceptable results, and cannot be considered as an appropriate model.

4.2 Results of the Second Model Estimation

The sixth model in the developed form of the fifth one, which contains a dynamic random variable:

$$u_t = nairu_t + \varepsilon_t^u \quad (10)$$

$$nairu_t = nairu_{t-1} + \gamma_{t-1}$$

$$\gamma_t = \gamma_{t-1} + \varepsilon_t^\gamma$$

Accordingly, the NAIRU estimated in this model is in the form of Table (4).

Table 4: NAIRU Derived from the Sixth Model

Year	NAIRU	Year	NAIRU	Year	NAIRU	Year	NAIRU
1989:1	0	3	8.7	2002:1	14.5	3	10.1
2	13.5	4	8.5	2	13	4	9.6
3	13.7	1996:1	8.1	3	12.3	2009:1	11.8
4	13.6	2	7.4	4	12.7	2	11.2
1990:1	13	3	6.6	2003:1	12.3	3	11.3
2	12	4	6.6	2	11.7	4	11.3
3	11.6	1997:1	7.6	3	11.3	2010:1	13.4
4	11.3	2	8.5	4	11.6	2	13.5
1991:1	10.6	3	9.4	2004:1	11.3	3	13.5
2	10	4	10.1	2	10.6	4	12.4
3	9.3	1998:1	10.4	3	10.4	2011:1	14
4	8.9	2	10.8	4	10.3	2	12.7
1992:1	8.9	3	11.1	2005:1	10.9	3	11.4
2	8.8	4	11.5	2	11.6	4	11.7
3	8.5	1999:1	12.2	3	11	2012:1	13.5
4	8.5	2	12.8	4	10.9	2	13
1993:1	8.7	3	13.6	2006:1	11.8	3	12.4
2	8.9	4	14	2	11.1	4	11.4
3	9.1	2000:1	14	3	10.4	2013:1	12.1
4	9.2	2	14	4	11.3	2	10.9
1994:1	9.1	3	14	2007:1	11.9	3	10.5
2	9	4	14	2	10.9	4	10.3
3	9	2001:1	14	3	10.1	2014:1	10.4
4	8.9	2	13.9	4	9.8	2	10.6
1995:1	8.8	3	13.9	2008:1	11.4	3	9.7
2	8.7	4	14.1	2	10	4	10.3

Source: Research Findings.

As we told, one of the criteria in evaluating NAIRU results is a negative relationship between its gap and inflation variations; like Table (2), Table (4) also show this negative relationship, especially for the years Iran experienced high inflation rates.

5. Conclusion

This study investigated and estimated the production gap and NAIRU in Iran for the period of 1989–2014. These two are among the important variables, which can be used to provide views on the business cycle and economic equilibrium. Estimating these two economic indicators is conducted using various methods, including time-series filtering methods and state-space methods. In this study, the Kalman method in a state-space model was used to estimate the time series. For this purpose, seven different models with different structures were specified, and then the production gap and NAIRU were estimated based on the models' results. In this structure, the models were divided into three classes. In the first class, it was examined the simultaneous relationship between the inflation rate, the unemployment rate, and real production. In the second class, models were merely related to the unemployment rate dynamics. Using seasonal data for the period 1989 to 2014, the parameters of the models were estimated, and NAIRU and the production gap were extracted.

We test the estimated results based on statistical methods and compared them with real data. On the behalf of statistical methods, all estimated parameters in the two models are meaningful. Another test of verifying the results is comparing the estimated output gap and NAIRU with what was observed from reality during the period we have used.

Estimated output gap from the first model, shows a recession from 2010: Q3 till 2013: Q3; this period coincided with an imposed sanction on Iran that led to a great reduction in output with a high negative growth rate. By the end of 2013, the Iran economy has experienced a positive growth rate and recovers itself and our estimated output gap also shows positive values. Such recessionary periods have been captured by our estimated output gap such as a recession in the year 2008, and in 1994 – 1995 (due to implementing adjustment policies). Thereby, the estimated cycles are consistent with some facts on the Iran economy during 1989–2014.

Moreover, the Estimated NAIRU from the model is somewhat consistent with inflation fluctuations during this period. Variations in NAIRU have negative movement with inflation variations and thereby if the estimated result be correct, one expects during a rise in inflation, NAIRU has damped and vice versa. For example, during 2012 – 2013, 2008, 1994 - 1995 were inflation had increased, NAIRU has dropped; such a negative relationship between inflation and NAIRU could be found during the estimated period.

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