An examination of hysteresis hypothesis on natural rate of unemployment in the case of Turkey

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ABSTRACT

In this study, the Hysteresis Hypothesis that assumes the natural rate of unemployment follows the last period's realised unemployment was examined for the Turkish case by using annual data for the period of 1950-1995. The technique used in this study is the Kalman – Filter that is using as an influential technique to estimate the parameters of time varying regressions. Obtaining results show that the hypothesis is valid for the Turkish case in sample period. But, this quite weak validity needs additional explanatory variables to prove hypothesis completely.

Keywords: Hysteresis, Kalman-Filter, and Unemployment

Introduction

A Keynesian account which asserts the long-run equilibrium level of an economical variable is determined by a time path that is built by the short-run equilibrium levels of major economical variables driven the economy (i.e. money supply or interest rates) is known as "Hysteresis Hypothesis"[1]. Tobin (1972) argued that unemployment rate is one of the influenced variables by the short-run equilibrium levels of economy driven variables.

Tobin's present note has been examined by a numerous applied studies. The studies of Nelson and Plosser (1982), Campbell and Mankiw (1986) and Hall (1986) show that unemployment rate does not return to a given or initial equilibrium level after a temporary disturbance. According to authors, a simple random walk model included intercept is sufficient to simulate this argument.

$$U_t = \alpha + \beta T + \varepsilon_t . \qquad (1)$$

In equation (1), U_t is the unemployment rate at time t, T is a time trend , and ε_t is the white noise residual term which are distributed serially uncorrelated and with mean zero at time t. Authors argued that the short-run unemployment rate would not return the long-run stable trend level after a temporary disturbance, if the estimated parameter of trend ($\hat{\beta}$) was statistically insignificant.

Blanchard and Summers (1986) constructed somewhat different models to estimate the *hysteria* in unemployment rate. The simplest model among those (insiders-outsiders hypothesis) is based on the idea that the employed members of labour unions (insiders) are more efficient than the unemployed union members (outsiders) on wage settings, because insiders do not give a turn to outsiders to put forward on idea on wage setting negotiations. On the other hand, insiders negotiate to set a wage level that can be sufficient to protect their positions ignoring outsiders. In other word, insiders make an effort to keep equal this period's employment level to the last period's realised employment, unawares. In this case, the current period's expected employment level, $E(N_t)$, must be equal to the last period's realised employment, N_{t-1}. According to authors, the current period's expected employment level seems to be evaluated by clarifying labour demand function. Considering constant scale returns, employers demand labour when a labour has unit marginal productivity. So, $Y_t = N_t$ and $P_t = W_t$. Where, Y_t, P_t , and W_t denotes output, prices and nominal wages, respectively. If output is described as $Y_t = c(M_t – P_t)$, then employment level becomes $N_t = c(M_t – W_t)$. Where, M_t denotes money supply. By finding the expected value of this equation and subtracting from itself, Blanchard and Summers (1986) achieved the formulation $E(N_t) = N_t – c[M_t – E(M_t)]$. Because nominal wage is predetermined by wage setting negotiations, the expected wage is equal to realised nominal wage, and therefore, it has been dropped from the equation. Finally, taking one period lag of the left hand side employment level produces a time path of employment as seen in equation (2).

$$N_t = N_{t-1} + c[M_t - E(M_t)] \quad (2)$$

Equation (2) shows that unexpected changes in aggregate demand affect employment level and there is not any effect that obtains to return old equilibrium level of employment. Equation (2) is also an evidence for the Tobin (1972)'s argument that asserts employment level or unemployment rate is *hysteric*. Blanchard and Summers has constructed a numerous different and more complex models which outsiders can be affect the wage setting negotiations in.

In this study, the Tobin (1972)'s argument that asserts the long-run unemployment rate is affected by the short-run level of unemployment or political variables (i.e. money supply or interest rate) has been tested for Turkish economy for the period of 1950-1995. The rest of this study is organised as follows. Section 1 illustrates the econometric methods that were used in this study. In Section 2, the empirical findings are summarised and discussed. And the latest section will draw conclusions.

Methodology and Data

"The Natural Rate of Unemployment" which is commonly known as "Long – run Unemployment Rate" can be formulated as seen in equation (3),

$$U_t = U^* - \Psi(M_t - P_t) + \eta_t . \quad (3)$$

Where; U_t is unemployment rate at time t, U^* is the natural rate of unemployment, M_t is money supply at time t, π_t is inflation rate at time t, and η_t is the residual term distributed normally at time t. There would not be any problem to solve the equation (3) by using Ordinary Least Squares (hereafter OLS), if we consider the equation (3) as classical issue. Because classical economists claim that there is only one natural rate in the long run. If this equation, however, is considered as Keynesian issue, we should solve it by using a technique that supplies us a constant term for each year in sample period. Because Keynesian economists claim that there is not only one natural rate in the long run. In this study, the equation (3) was estimated by using “Kalman-Filter Technique” which commonly uses to estimate the time varying regressions efficiently. By using this technique, we are going to take an intercept term for each year in sample period.

The structural model that was used to test the hysteresis hypothesis has been constructed as seen in equation (4),

$$U^*_t = U^*_{t-1} + a\left(U_{t-1} - U^*_{t-1}\right) + e_t \,. \tag{4}$$

Equation (4) shows that this period’s natural rate of unemployment is affected by the last period’s natural rate of unemployment and some portion (*a*) of difference between the last period’s realised unemployment and the last period’s natural rate of unemployment. But, equation (4) can not be estimated by using available data. Because, the last period’s natural rate of unemployment is seen as intercept term, while the natural rate of unemployment is used as dependent variable. In a linear regression model, a variable which has different values for different periods can not be used an intercept term. So, this equation should modify as a difference equation by subtracting the intercept term from dependent variable. Obtained difference equation is as seen in equation (5).

$$\begin{aligned} &\Delta U^*_t = \alpha X_t + \varepsilon_t \,, \\ &\alpha > 0 \end{aligned} \tag{5}$$

Where, $\Delta U^*_t = U^*_t - U^*_{t-1}$ and $X_t = U_{t-1} - U^*_{t-1}$. If the Keynesian inference that was come into existence in Tobin (1972)’s argument was true, when $U_{t-1} > U^*_{t-1}$, the natural rate of unemployment would increase, and the current period’s natural rate of unemployment would be greater than the last period's natural rate of unemployment. Because of this assumption, α is expected as positive.

Equation (5) was estimated by using the Kalman-Filter Technique. The general state space form applies to a multivariate time series, y_t, containing N elements [2]. These observable variables are related to an $m\times1$ vector, α_t, known as the *state vector*, via a *measurement equation*.

$$y_t = Z_t\alpha_t + d_t + \varepsilon_t , \qquad t = 1,........,T \tag{6}$$

Where Z_t is an $N\times m$ matrix, d_t is an $N\times1$ vector and ε_t is an $N\times1$ vector of serially uncorrelated disturbances with mean zero and covariance matrix H_t, that is

$$E(\varepsilon_t) = 0 \qquad and \qquad Var(\varepsilon_t) = H_t \tag{6a}$$

In general the elements of α_t are not observable. However, they are known to be generated by a first-order Markov process,

$$\alpha_t = T_t\alpha_{t-1} + c_t + R_t\eta_t , \qquad t = 1,........,T \tag{7}$$

Where T_t is an $m\times m$ matrix, c_t is an $m\times1$ vector, R_t is an $m\times g$ matrix and η_t is a $g\times1$ vector of serially uncorrelated disturbances with mean zero and covariance matrix, Q_t, that is

$$E(\eta_t) = 0 \qquad and \qquad Var(\eta_t) = Q_t \tag{7a}$$

Equation (7) is the *transition equation*. The specification of the state space is completed by two further assumptions:

- The initial state vector, α_0, has a mean of a_0 and a covariance matrix P_0, that is

$$E(\alpha_0) = a_0 \qquad and \qquad Var(\alpha_0) = P_0$$

- The disturbances ε_t and η_t are uncorrelated with each other in all time periods, and uncorrelated with the initial state, that is

$$E(\varepsilon_t \eta_s^{'}) = 0 \qquad E(\varepsilon_t \alpha_0^{'}) = 0 \qquad and \qquad E(\eta_t \alpha_0^{'}) = 0$$

The matrices Z_t, d_t and H_t in the *measurement equation* and the matrices T_t, c_t, R_t and Q_t in the *transition equation* will be referred to as the *system matrices*. Unless otherwise stated, it will be assumed that they are non-stochastic. As a result the system is *linear* and for any value of *t*, y_t can be expressed as a linear combination of present and past ε_t's and η_t's and the initial state vector, α_0. If the system matrices do not change over time, the model is said to be *time-invariant* or *time-homogeneous*.

As indicated in Harvey (1991), once a model has been put in a state space form, the way is opened for the application of a number of important algorithms. The Kalman-Filter is a recursive procedure for computing the optimal estimator of the state vector at time *t*, based on the information available at time *t*. This information consists of the observations up to and including y_t. The system matrices together with a_0 and P_0 are assumed to be known in all time periods and so do not need to be explicitly included in the information set.

Consider the state space model of (6) and (7). Let a_{t-1} denote the optimal estimator of α_{t-1} based on the observations up to and including y_{t-1}. Let P_{t-1} denote the $m \times m$ covariance matrix of the estimation error, i.e.

$$P_{t-1} = E\left[(\alpha_{t-1} - a_{t-1})(\alpha_{t-1} - a_{t-1})'\right] \qquad (8)$$

Given a_{t-1} and P_{t-1}, the optimal estimator of α_t is given by

$$a_{t|t-1} = T_t a_{t-1} + c_t \tag{9}$$

while the covariance matrix of the estimation error is

$$P_{t|t-1} = T_t P_{t-1} T'_t + R_t Q_t R'_t , \qquad t = 1,........., T \tag{10}$$

These two equations are known as the *prediction equations*.

Once the new observation, y_t, becomes available, the estimator of α_t, $a_{t|t-1}$, can be updated. The *updating equations* are

$$a_t = a_{t|t-1} + P_{t|t-1} Z'_t F_t^{-1} \left(y_t - Z_t a_{t|t-1} - d_t \right) \tag{11}$$

$$P_t = P_{t|t-1} - P_{t|t-1} Z'_t F_t^{-1} Z_t P_{t|t-1} \tag{12}$$

where [3],

$$F_t = Z_t P_{t|t-1} Z'_t + H_t , \qquad t = 1,........, T \tag{13}$$

The starting values for the Kalman-Filter may be specified in terms of a_0 and P_0 or $a_{1|0}$ and $P_{1|0}$. Given these initial conditions, the Kalman-Filter delivers the optimal estimator of the state vector as each new observation becomes available. When all T observations have been processed, the Filter yields the optimal estimator of the current state vector, and/or the state vector in the next time period, based on the full information set. This estimator contains all the information needed to make optimal predictions of future values of both the state and the observations.

There are two groups of unknown parameters in the Kalman-Filter procedure. Among those, the initial values of the measurement equation parameters and their covariance matrixes, and the variance of the residuals of measurement equation are in the first group. Parameters of the transition equation and their covariance matrixes, and the variance of the residuals of transition equation are in the second group. Unknowns in the first group can be handled by estimating the measurement equation by using OLS for full sample period. But, the second group unknowns can not be initialised by running the same procedure. In order to handle the second group unknowns, it must be used a maximum-likelihood equation that can be maximised by *Symplex Algorithm*. The estimated values that were obtained by using this optimisation procedure are used the second group initial values of the Kalman-Filter System. The maximum-likelihood equation that was maximised in this study is as seen in equation (14).

$$\log L = -\frac{NT}{2}\log 2\pi - \frac{1}{2}\sum_{t=1}^{T}\log|F_t| - \frac{1}{2}\sum_{t=1}^{T} v'_t \, F_t^{-1} v_t \qquad (14)$$

We have used M2 for money supply and WPI for inflation in equation (3). Both series have been collected from "The Central Bank of Turkey, Monthly Statistical Bulletins". Unemployment data has come from "The National Employment Bureau, Job Application Statistics". Because the lack of data, unemployment for 1960 has been estimated by using a linear trend equation. Each variable is in logarithms and the annual data covers the period of 1950-1995.

Empirical Findings

Hysteresis Hypothesis has been built on the idea that there is a relationship between the natural rate of unemployment and the last period's realised unemployment. So, we have to examine the line graphs of both series, at first. If the hypothesis is valid, we can roughly see the visual relation in this way. Both series' line graphs are as seen in Figure 1[4].

"TAKE IN FIGURE 1"

According to time series in Figure 1, there is a quite weak visual relationship between unemployment and the natural rate of unemployment for the Turkish case in sample period. The natural rate of unemployment has a floating increasing trend following unemployment in 1950s. But, the volatility in the natural rate is greater than unemployment for this period. In early 1960s unemployment rate has sharply decreased, the natural rate has sharply decreased too. The natural rate of unemployment in 1970s has again started to increase like unemployment has done in the same period. A similar volatility to the observed in unemployment in the second half of 1960s can be seen in the natural rate of unemployment. The natural rate has continued to increase till the middle of 1980s, like unemployment has done. At the end of the 1980s, each of the series has decreasing trends. These obtaining visual impressions can be interpreted as the first evidence on the validity of the hysteresis hypothesis for the Turkish case, but there is a need the empirical findings more than visual impressions to set a certain conclusion. The parameter estimates of the equation (5) were presented in Table 1 as an evidence about the quite weak relationship between two relevant variables.

"TAKE IN TABLE 1"

Summarised test results in Table 1 has drawn a conclusion that proves the validity of the hypothesis. α has estimated as positive and statistically significant as much we expected. However, the empirical findings indicate that the relation between unemployment and the natural rate of unemployment is quite weak by straighten out the findings obtaining visual impressions. Finding the adoption parameter (α) quite less exposes that the natural rate of unemployment has not affected by realised unemployment rate as much we expected for the Turkish case. There should not be any doubt to explain this conclusion. It needs to look over the other policy implications in sample period. It is impossible to explain the natural rate's changing by regressing only the last period's realised unemployment rate on the natural rate of unemployment, and to think the changing the natural rate is abstract from the changing of the other economical variables.

Conclusions

Keynesyen economists assert that the long run equilibrium level of some economical variables are not constant, and the long run equilibrium level of some variables are changing by changing the economy driven variables' equilibrium levels. Tobin (1972) argued that employment or unemployment rate are the influenced variables by economy driven variables' (i.e. money supply or interest rates) long run levels. In this study, the hypothesis mentioned above has examined for the Turkish case by using the annual data for the period of 1950-1995. Obtaining results show that the hypothesis is valid for the Turkish case, but the relationship between unemployment and the natural rate of unemployment is quite weak. In this case, we can conclude that explaining the relation between these two variables needs to look over the other policy implications addition to the relation predetermined by the hypothesis.

Notes

1. "Hysteresis" has a meaning in old Greece as "come from behind". It is used in physics in order to define "the effect of magnet", too.

2. The state space form is an enormously powerful tool that opens the way to handling a wide range of time series models. Once a model has been put in state space form, the Kalman-Filter may be applied and this in turn leads to algorithms for prediction and smoothing.

3. It is assumed that the inverse of F_t exists. It can be replaced by a pseudo-inverse.

4. In Figure 1, both series are logarithmic. The intercept term in equation (3) that supplies us the natural rate of unemployment has been estimated in logarithms, because this equation has been constructed in logarithmic form.

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Figure 1: Unemployment and the Natural Rate of Unemployment

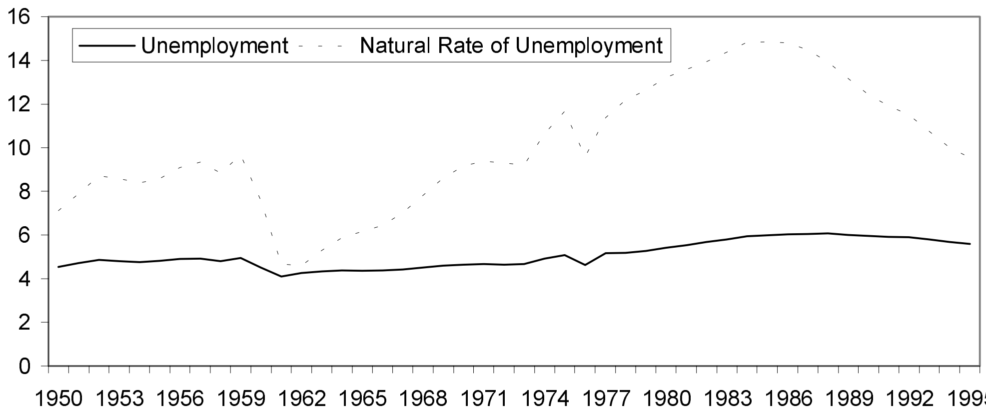

Table 1: Parameter Estimates of the Equation (5).

Variable	Coefficient	t-statistics
α	0.0000058298*	3.76437
ρ	0.9968179598*	70.48403
$R^2 = 0.93$ DW = 1.38		

Note: Equation (5) has been estimated by using the Cochrane-Orcutt Iterative Method to eliminate the auto-correlation problem in residuals. ρ denotes auto-regression parameter. "*" indicates that the relevant parameter is statistically significant at %1 level.