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INFLATION AND OUTPUT GAPS RECONSIDERED: ASSYMETRIES AND NONLINEAR PHILLIPS CURVE EVIDENCE FOR THE TURKISH ECONOMY

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Abstract

In this paper, the relationship between the inflation gap and output gap is investigated by adopting the Markov switching model and using monthly data between 1990:1 and 2008:5. To the findings, the relationship between inflation gap and output gap is nonlinear. The major contribution of this study is that regime probabilities are computed in the context of Markov switching model by following Chen (2006).

Keywords: *1. Phillips curve, 2. Monetary policy asymmetry, 3. Taylor rule, 4. Markov switching models. 5. Regime probabilities*.

ENFLASYON VE ÇIKTI AÇIKLARININ DEĞERLENDİRİLMESİ: ASİMETRİLER VE TÜRKİYE EKONOMİSİ İÇİN DOĞRUSAL OLMAYAN PHILLIPS EĞRİSİ KANITI

Özet

Bu çalışmada, 1990:1 – 2008:5 dönemi aylık verileri kullanılarak, Türkiye ekonomisi açısından enflasyon farkı ile çıktı açığı arasındaki ilişki araştırılmış ve Markov rejim değişim modeli yardımıyla, söz konusu ilişkinin doğrusal olmadığı yönünde bulgulara ulaşılmıştır. Çalışmanın temel katkısı, Markov rejim değişim modeli çerçevesinde, Chen (2006) tarafından önerilen geçiş olasılıklarının hesaplanmış olmasıdır.

Anahtar Sözcükler: *(1) Phillips eğrisi, (2) Para politikası asimetrisi, (3) Taylor kuralı, (4) Markov rejim değişim modeli, (5) Rejim olasılıkları.*

1 This paper is based on the findings of Aslı Seda Bilman's master thesis named "Phillips Eğrisi'nin Politika Önerisi ve Asimetrik Etkiler".

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1. Introduction

Phillips curve initially introduced by A. W. Phillips that sheds light on the trade-off between unemployment rate and the rate of change in the nominal wages is one of the most popular issues when it comes to empirical research in economics. The trade-off between inflation and nominal wages has been mentioned prior to A.W. Phillips by I. Fisher (1926), however it has drawn a great deal of attention after Keynes (1936). The analysis of this relationship has been founded theoretically by the contributions of economists such as R. Lipsey (1960), M. Friedman (1968), and R. Lucas and L. Rapping (1969). A prominent figure in economics E. S. Phelps has been awarded by the Nobel Prize in Economics due to his research on that issue.

Phillips curve has important aspects in terms of monetary policy applications. The relationship between inflation gap and output gap is considered appropriate for a Phillips curve (or an aggregate supply) analysis in the context of the Taylor Rule[2]. The same variables can be used to investigate the optimal monetary policy due to the reason that central banks do have tendency to control the inflation rates or income levels. For such reasons, using these two variables would give the opportunity to understand whether the central banks are successful in terms of their monetary policy applications.

The literature on Phillips curve includes vast amount of theoretical and empirical studies. Examples which deal with the mathematical specification of the curve may be given as follows: Clark and Laxton (1997), Eliasson (1999), Laxton, Rose and Tambakis (1999), Beaudry and Doyle (2000), Collard and Julliard (2001), Kichian (2001), Gagnon and Khan (2001), Fauvel, Guay and Paquet (2002), Mankiw and Reis (2002), Farés (2002), Khan and Zhu (2002), Jondeau and Bihan (2003), Ewing and Seyfried (2003), Clements and Sensier (2003), Demers (2003), McNelis (2003), Khalaf and Kichian (2004), Guay and Pelgrin (2004), Dupuis (2004), Dufour, Khalaf and Kichian (2005), Zhu (2005), Arghyrou, Martin, and Milas (2005), Tillman (2005), Zhang, Osborn and Kim (2006), De Veirman (2006), Boug, Cappelen and Swensen (2006), Sanchez (2006), Gaiotti (2008). Studies that consider the issue in the context of inflation targeting, monetary policy, and nonlinearity may be listed as follows: Schalling (1998), Gomez and Julio (2000), Meyer, Swanson and Wieland (2001), Dolado, Dolores and Naveira (2003), Tambakis (2004), Kuzin and Tober (2004), Kesriyeli, Osborn and Sensier (2004), Huh (2005), Nason and Smith (2005), Minford and Srinivasan (2005), Goodhart and Hofmann (2005), Gomes, Mendes and Mendes (2006a, 2006b), Nell (2006), Davig (2007), Woodford (2007), Martin and Milas (2007). Some examples for the studies that place greater emphasis on unemployment, inflation, and wages are: Wredin and Warne (2000), Flaschel and Krolzig (2003), Semler and Zhang (2004), Swanson (2005), Lundborg and Sacklén (2006), Ashley and Verbrugge (2006). Studies that consider sectoral and regional Phillips curves may be listed as follows: Hallet (2000), Mayes and Virén (2004), Aguiar and Martins (2005). And finally, Tambakis (1999) gives special importance to social welfare in the context of the Phillips curve.

The literature on Phillips curve concerning the Turkish Economy has grown especially during the last couple of decades. Phillips curve is analyzed in different settings due to lack of relevant data or new theoretical contributions. Some researchers considered the trade-off between inflation and growth rates while others investigated the relationship between growth and unemployment rates. Nas and Perry (2000) investigate inflation, inflation uncertainty, and monetary policy applications in Turkey for the period 1960-1980 by using GARCH modelling and Granger causality tests. The main finding of the study is that increasing rates of inflation enhances the uncertainty of inflation in Turkey. Çetinkaya and Yavuz (2002) made a similar research by using Hodrick-Prescott filtering method and the procedures suggested by Ball (1994) and Zhang (2001). They put forward that disinflationary policies do not lead to a considerable amount of loss of output in Turkey and that these kinds of policies are generally determined by positive supply shocks. Berber and Artan (2004) investigated the relationship between economic growth and inflation rates by using Granger causality tests. They used the quarterly data of the period 1987-2003. Their findings suggest that high inflation in Turkey affects economic growth negatively. Yazgan and Yılmazkuday (2005) investigated the inflationary dynamics in Turkey in the context of the Neo Keynesian Phillips curve by using the GMM approach. They found strong evidence for the Neo Keynesian Phillips curve. A study that reached an opposite finding is Kuştepeli (2005). She adopted linear and nonlinear approaches to analyze the annual data between 1980-2001 and monthly data between 1988-2003. She did not find any evidence of the Phillips curve for the Turkish economy. She concluded that the most significant point in the struggle against inflation is that Turkey needs new policies to cope with the expectations for high inflation rates. Önder (2006) analyzed the stability of the Phillips curve for Turkey by adopting Markov switching and multiple structural break models and using annual data for the period 1987-2004. The findings suggest that there is evidence for a nonlinear Phillips curve. He found no evidence that the response of the inflation to the output gap is symmetric. In addition to these, he concluded that the persistence of inflation has decreased substantially after 2001. Yaşar (2008) found a positive relationship between the rate of change in the output gap and inflation. Eren and Çiçek (2009) evaluated the Phillips curve in a setting of the global output gap hypothesis and concluded that the Phillips curve in Turkey is getting flatter. In addition to the literature on the Turkish economy, this study investigates the relationship between inflation gap and output gap by using a Markov switching model. Data is monthly and covers the period 1990-2008. The reason why the aforementioned variables are used is that they enable us to model expectations and deviations from the expectations. Markov regime switching models make it possible to investigate the relationship between inflation gap and output gap by modelling two distinct periods (i.e. the periods of low and high inflation) separately.

2. Data and Econometric Procedure

2.1. Data

Data which is gathered from the official web site of the Central Bank of Turkey is monthly and comprises the period 1990:1-2008:5. CPI and industrial production index (IPE) (1992 as base year) is used as a proxy for the output level. The reason why the abovementioned period has been chosen is that monthly data is available only after the year 1998. The base years are equivalent for each index series.

2.2. Econometric Procedure

Before implementing the test procedures, IPE series has been seasonally adjusted and each series have been filtered by using Hodrick-Prescott filtering method in order to determine the inflation gap and output gap. Having established that the series are seasonally adjusted, one may proceed with constructing Markov regime switching models initially introduced by Hamilton (1989).

2.2.1. Seasonal Adjustment

There are plenty of methods to remove the trend from the series. In this study, TRAMO (Time Series Regression with ARIMA noise, Missing Observations, and Outliers) SEATS (Signal Extraction in ARIMA Time Series) procedure developed by Gomez and Maravall (1997a, 1997b) is adopted so as to understand whether each series include seasonal properties and remove these effects. The findings suggest that IPE includes seasonal effects which make it necessary to remove these effects from the series. IPE and seasonally adjusted IPE series are presented in Figure 1 and 2 respectively.

2.2.2. Hodrick-Prescott (HP) Filtering Procedure

This method is often used in empirical macroeconomics to determine the long run trend components of the series. Hodrick and Prescott (1997) developed this procedure to analyze the cyclical movements of the US macroeconomic data series in the post-war period. HP procedure makes it possible to remove the short run variations in a time series and obtain a long run nonlinear trend. This type of filtering enables the researcher to predict a smoothed trend (s) from the main series (y). For this reason, the variance of the main series around the trend is minimized and a constraint (λ) is used to eliminate the effects of persistent shocks in the main series. The formulation of the HP filter is written as follows:

$$\sum_1^T (y_t - s_t)^2 + \lambda \sum_2^{T+1} [(s_{t+1} - s_t) - (s_t - s_{t-1})]^2 \qquad (1)$$

The smoothness of the trend depends on the value of the parameter λ. Trend gets smoother as the value of λ gets greater. In other words, as the parameter λ converges infinity, the trend gains a linear type as well. The determination of this parameter is of vital importance. Hodrick and Prescott gave an answer to that particular question. The parameter λ would be 100, 1600, and 14400 for annual, quarterly, and monthly data series respectively as far as their study is concerned.

HP filter is used in order to derive the expected inflation or the trend inflation rates from the main inflation rate series. Similarly, potential level of output is determined by using the same procedure. By subtracting the potential values from the real ones, inflation gap and output gap are created. Since monthly data has been used in this study, parameter λ has been given the value 14400. Figure 3 and Figure 4 show the potential inflation rates and output levels respectively.

2.2.3. Markov Switching Models

The studies made during the last two decades have focused mainly on the issue that the real world may be modelled more precisely by using nonlinear approaches. These techniques enable the researchers to combine different trends on a series to build a specific regime. Two important approaches have been put forward in this context. The first is the ARCH modelling procedure initially introduced by Engle (1982). This procedure is used to model the volatility of the high frequency data. Due to these properties of this procedure, it is generally applied to model the behaviour of financial data series. Another procedure developed by Hamilton (1989) is referred to as the Markov Regime Switching Model which captures the asymmetric relationships in a nonlinear context. The reason why the issue of asymmetry in economic theory is of great importance is that the periods of expansion and contraction in a national economy are not equivalent in span. For this reason, the cyclical upward and downward movements in a data series do not continue symmetrically (Akgül, Koç, and Koç, 2007, 5). Ignoring nonlinearity in the studies would lead to biased results and misleading economic policy recommendations. Hamilton (1989) applied the regime switching models to interest rate series. Engle and Hamilton (1990) used the exchange rate series to construct Markov switching models. Following the studies like Hamilton (1994, 1996) switching models have drawn the attention of vast number of economists.

A Markov switching model is a stochastic process in which the probabilities are explained by preceding ones (Bildirici and Bozoklu, 2007, 3). These models explain the relationship between the regimes for the periods *t* and *t-1*. Such a relationship may be formulated as follows where s_t is the regime variable.

$$P\{s_t = j | s_{t-1} = i\} = P\{s_t = j | s_{t-1} = i, s_{t-2} = k, \dots\} = p_{ij} \qquad (2)$$

The expression above shows the probability of switching from regime *i* to regime *j*. The probabilities for regime switches would be as follows as long as there are two regimes.

$$Prob(s_t = 1 | s_{t-1}) = p_{11} = p \qquad (3)$$

$$Prob(s_t = 0 | s_{t-1}) = p_{12} = 1 - p$$

$$Prob(s_t = 0 | s_{t-1}) = p_{22} = q$$

$$Prob(s_t = 1 | s_{t-1}) = p_{21} = 1 - q$$

In the above equations, p_{11} indicates the probability of remaining in the first regime when the first regime prevails. p_{12} shows the probability of passing from the first regime to the second when the first regime prevails. Similarly, p_{22} and p_{21} imply the probabilities of remaining in the second regime and skipping to the first regime respectively, when the second regime prevails. These regime switching probabilities have two important properties: (i) they are nonnegative and, (ii) the summation of them should make unity.

The regime variable, s_t, cannot be observed directly whereas the economic and/or financial data series, y_t, are observable. The characteristic of these series depend on the regime variable. In other words, the statistical properties of a series depend highly on the regime and they may vary as the regime varies.

$$E\left[\frac{y_t}{s_t}\right] = \mu_{s_t} \tag{4}$$

$s_t=0$ is a state that the inflation rate decreases and μ_0 is the corresponding mean when y_t indicates the inflation rate. Similarly, $s_t=1$ shows an inflationary process and μ_1 is the corresponding mean. In this case, the first mean would be greater than the latter ($\mu_1 > \mu_0$). This relationship between the means would be expressed as follows.

$$\mu_{s_t} = \begin{cases} if\ s_t = 1, then\ \mu_1 > 0 \\ if\ s_t = 0, then\ \mu_0 < 0 \end{cases} \tag{5}$$

For this reason, the means of the expansionary and contractionary periods would be exactly distinct due to asymmetry. By taking this into consideration, one may write a regime change model as follows.

$$y_t = \mu_{s_t} + \varepsilon_t, \varepsilon_t \sim N(0, \sigma^2) \tag{6}$$

One may write the following equation for AR(p) by relying on the fact that y_t is an autoregressive process.

$$y_t = \delta_{s_t} + \varphi_1 y_{t-1} + \cdots + \varphi_p y_{t-p} + \varepsilon_t, \varepsilon_t \sim N(0, \sigma^2) \tag{7}$$

2.2.4. Identifying the Probability of Remaining at the Same Regime: Chen's Contribution to Markov Switching Models

Chen (2006) improved the model introduced by Hamilton (1989) by computing the time varying regime switching probabilities and investigated the relationship between interest rates and exchange rates. He used weekly data for six developing countries (Indonesia, South Korea, Philippines, Thailand, Mexico, and Turkey) and concluded that the rise in nominal interest rates increases the probability of switching to the regime where there is high volatility in exchange rates. Chen (2006) initially developed the following model.

$$x_t = \mu_{s_t} + \varepsilon_t, \varepsilon_t \sim N(0, \sigma^2) \tag{8}$$

x_t shows the percentage change in exchange rates. μ_{s_t} and σ^2 indicate the mean and variance for x_t, respectively. As mentioned earlier, s_t is the regime variable. Chen (2006) suggested the following time varying switching probabilities matrix (P_t).

$$P_t = \begin{bmatrix} p_t^{11}(x_t) & 1 - p_t^{22}(x_t) \\ 1 - p_t^{11}(x_t) & p_t^{22}(x_t) \end{bmatrix} \tag{9}$$

In the above matrix, x_t represents an explanatory variable which affects an independent variable. $p_t^{11}(x_t)$ is the contribution of x_t to the probability of remaining in the first regime when first regime holds. Similarly, $p_t^{22}(x_t)$ is the contribution of x_t to the probability of remaining in the second regime when second regime holds (İspir, Ersoy, and Yılmazer, 2008, 6). These probabilities are computed by the formulas below.

$$p_t^{11}(x_t) = \frac{\exp(\phi_{0,1} + \phi_{1,1} x_t)}{1 + \exp(\phi_{0,1} + \phi_{1,1} x_t)} \tag{10}$$
$$p_t^{11}(x_t) = \frac{\exp(\phi_{0,2} + \phi_{1,2} x_t)}{1 + \exp(\phi_{0,2} + \phi_{1,2} x_t)}$$

In this study, the variables (inflation gap and output gap which is derived from the seasonally adjusted industrial production index series) are optimized by using a software and the time varying switching probabilities are obtained by using the parameters calculated in the previous step following Chen (2006). Thus, a regime switching model has been estimated for the inflation gap and an investigation has been made to understand to what extent the output gap affects the probability for inflation gap to remain at the same regime.

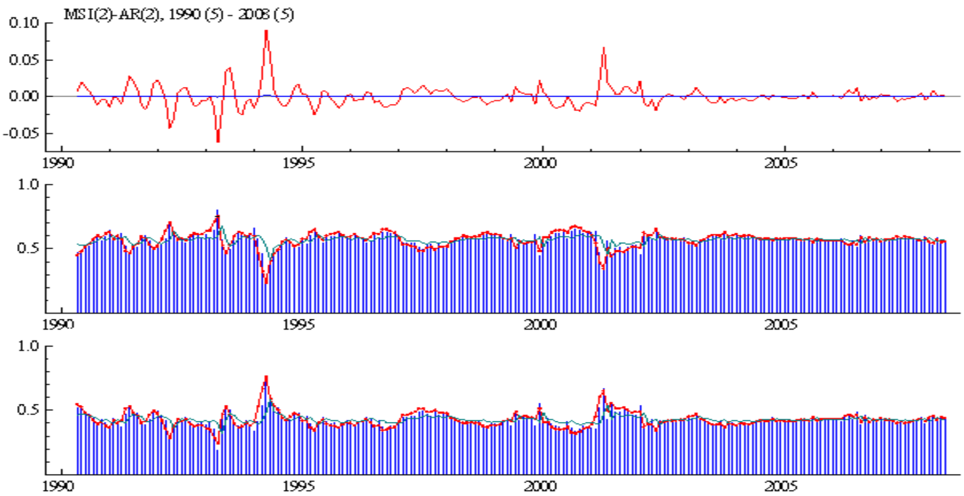
3. Findings

The relationship between the inflation gap and output gap can be expressed as follows.

$$\pi - \pi^* = f(y - y^*) \tag{12}$$

In the above equation, π and π* show the actual and expected (potential, trend) inflation rates, respectively. y indicates the actual industrial production index (seasonally adjusted) and y* shows the potential output level. Smoothed and filtered regime probabilities for inflation gap series (π-π*) are shown at the diagram below. The upper panel of diagram 5 illustrates the monthly inflation gap series for the period 1990:1-2008:5. In the middle panel of the diagram one may find the smoothed and filtered probabilities of inflation gap series for the first regime. In the lower panel, smoothed and filtered probabilities of inflation gap series for the second regime are shown.

Diagram 1: Regime Probabilities



According to the diagram, for the periods when the actual inflation rate is lower than the trend rate (i.e. for the periods of low inflation) the first regime has a probability higher than .05. Similarly, for the periods when the actual inflation rate is higher than the trend rate (i.e. for the periods of high inflation) the second regime has a probability higher than .05. In other words, the first regime implies a period where the actual inflation rate is below the expected rate whereas the second regime depicts a period where the actual rate exceeds the expectations. It complies with our expectations that the second regime corresponds to the years 1994, 2000, and 2001 when the effects of the crises dominated the whole economy.

The probabilities of remaining on the same regime or switching to a different regime are calculated following Chen (2006). In diagram 2, one may see the contribution of output gap in remaining on the first regime when the first regime holds in the Turkish economy. According to this diagram, if the output gap increases (i.e. if the actual output exceeds the potential level) so does the probability of staying in the first regime. In other words, as the output gap increases, the probability of remaining in the low inflation regime increases for the Turkish economy. In diagram 3, the contribution of output gap in remaining on the second regime may be observed when the second regime holds in the Turkish economy. In such a period where the actual inflation rates exceed the expectations, there is no stable relationship between inflation rates and output level.

Diagram 2: The probability of p_{11}

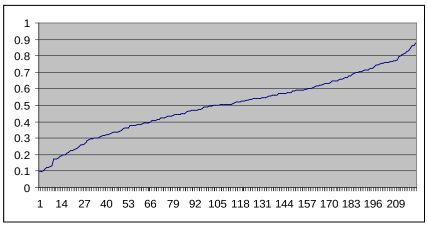
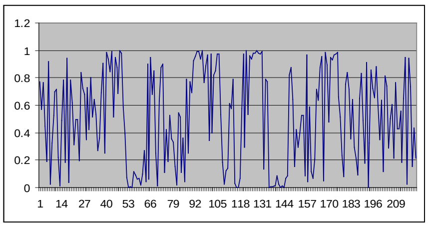


Diagram 3: The probability of p_{22}



Similarly, diagram 4 shows the contribution of the output gap in the probability of switching from the first regime to the second. Since the summation of the regime probabilities should make unity, deducting the probability of remaining on the first regime from unity when the first regime prevails will yield the probability of switching to the second regime as long as the economy is characterized by two distinct regimes. Finally, diagram 5 illustrates the effect of the output gap on the probability of switching from the second regime to the first. This probability value would be calculated by subtracting the probability of remaining on the second regime from unity which is identical to the probability of switching to the first regime.

Diagram 4: The probability of p_{12}

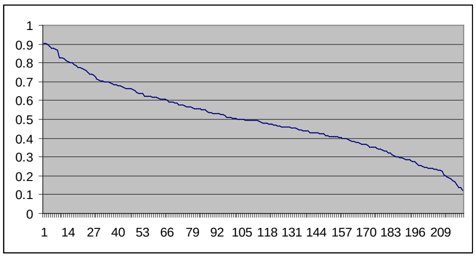
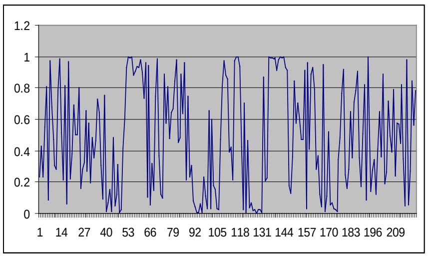


Diagram 5: The probability of p_{21}



By relying on these probabilities one may argue that two different regimes can be used to model the relationship between inflation gap and output gap. Besides, this relationship is nonlinear due to the fact that the combination of these two regimes would lead to a nonlinear process even though each regime is linear.

4. Conclusion and Implications

This study adopts the Markov switching model proposed by Hamilton (1989). Investigations conducted in a regime switching context have led to the conclusion that the relationship between inflation gap and output gap is characterized by two distinct regimes. This means that the relationship is nonlinear. The first regime represents a low inflation period where the actual inflation rate is below the expected rate. The second regime is the regime of high inflation where the actual rate exceeds the expected rate. It is not surprising that the second regime in Turkey corresponds to the years when the effects of the crises eroded the economic dynamism.

The main contribution of this study is that the role of the explanatory variable in the transition to a different regime is considered in addition to the calculations of the switching probabilities for Turkish data. According to these probability values the following interpretations can be made.

(i) The probability of remaining in the first regime increases as the output gap increases. The implication of this finding is that when output level increases, the inflationary process is likely to slow down in Turkey.

(ii) There is not a stable relationship between the output gap and the probability of remaining in the second regime. This finding implies that the relationship between the two has broken off in the second regime which corresponds to the financial crises.

The nonlinear relationship between inflation rate and output level entails that the monetary policy applications would lead to asymmetric effects. The new approaches to the Phillips curve suggest that when inflation rates and output level exceed the expectations the rise in the interest rates would be sharper than the fall when inflation rates and output level remain below the expected values. This situation is the source of the asymmetry. Further research is needed to determine the effect of this nonlinear relationship between inflation rate and output level on the interest rates.

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