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IMPACT OF INFLATION GAP TO NOMINAL INTEREST RATES: CASE OF TURKEY

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ABSTRACT: The objective of this paper is to examine the impact of inflation gap from target to nominal interest rate decision of Central Bank of Republic of Turkey (CBRT). CBRT has begun to implement IT regime explicitly as late as after January 2006, when the country could able to reduce its inflation rate below 30 percent between 2002 and 2005. We apply VAR technique to series between 2002-2011, in which CBRT has implemented IT implicitly and explicitly. Empirical findings indicate that the impact of inflation gap to nominal interest rate is insignificant.

Keywords: Inflation targeting, Turkish Economy, inflation gap.

JEL Classification: C32, E31, E58

1. Introduction

The purpose of this paper is to give decision about monetary policy strategy of the Central Bank of Republic of Turkey (CBRT) by estimating the coefficient and degree of relation between the central bank's nominal interest rate policy and inflation gap from target which is log consumer price index minus the log of the target inflation rate (Mishkin, 2001), and the macroeconomic variables by estimating a system of simultaneous equations. The coefficient of inflation gap from target to the nominal interest rate is accommodating or used systematically for monetary control, because CBRT announces that its first aim is to provide price stability, and The central banks may "look at every other thing" but are focused on inflation (Svensson, 2000) or in the words of Bernanke et al. (1999): IT is constrained discretion which keeps the economic ship in the desired area in the long run, while permitting central bank to respond in the short run." (Saleem,2010:53). This paper applies previously developed methodologies to study monetary policy in Turkey for period of 2002-2011 in which CBRT decides to use inflation target as a new intermediate target implicitly and then explicitly to lower inflation rates and makes it stabilized. This period also includes global financial crisis, which hit whole the economies over the world.

Examining the monetary policies of the Central Bank around a model dates back to the recent past. Starting from the 1970s when the monetarist school emerged, the effect of the policies on the product and inflation based on various assumptions has been examined by many economists. Milton Friedman (1968), Sargent and Wallace (1975), Robert J. Barro (1976) have made scientific studies on the optimal monetary policy covering the rational expectations theory.[1] Following Friedman (1968) and Lucas (1973), Barro puts forward the effect of monetary expansion on the output and the prices in mathematical terms and thus he moves the debate to new variants "within the frame of the shape that Philips Curve should take" (Barro, 1976).

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[1] For detailed information, see Milton Friedman 1968; Sargent, T. and N. Wallace, 'Rational' expectations, the optimal monetary instrument, and the optimal money supply rule**, Journal of Political Economy**, April, 241-54, 1975, p. 5; Robert J. Barro, "Rational Expectations and The Role of Monetary Policy**", Journal of Monetary Economics** 2 (1976) l-32, North Holland Publishing Company, 1976, p. 1.

Under different intermediate target regimes, determining the coefficient of inflation gap from target has discussed in the literature by several authors. They all concentrated on price stability goal within the framework of loss function, and used nominal interest rate with output gap in loss function models to find an optimum interest rate for central bank, following Taylor (1993) rules. In Svensson (1999), Mishkin (2000 and 2004), and Aızenman,Hutchison and Noy (2010), IT regime was modelled and estimated to measure the degree of price stability goal and the performance of the central banks. On the other hand in Altınkemer (1998), Celasun-Denizer (1999), and Olcay, Karasoy and Kunter (2000) monetary policy reaction function for Turkey was investigated.

In those studies mentioned above, monetary reaction functions were estimated by Ordinary Least Square (OLS) method separately. While, Saleem (2010) and Soderstorm (1999) made their estimations by a VAR technique with a simultaneous equation system. In this paper we use VAR method too, because in endogenous and exogenous models the residuals of the equations indirectly affect each other.

This paper investigates an optimal monetary policy of a central bank over its deviation from intermediate targets. When we consider inflation targeting (IT) regime as intermediate target, an optimum policy becomes zero deviation from targeted inflation rate. Central Bank of Republic of Turkey (CBRT) has adopted this intermediate regime for price stability explicitly or implicitly since 2002. This study accounts whether deviation from targeted inflation rate is a determinant of optimal nominal interest rate or not on the basis of empirical evidence. As we know Until 2002, Turkey has not become a potential candidate for IT regime. So this reason, firstly CBRT has begun to apply IT regime implicitly, and then after january 2006, the the Central Bank announced IT regime explicitly after reduction of inflation rate below 30 percent.

2.The Conventional Theory for Optimum Monetary Policy: Loss Function

The loss function means expressing the inflation gap and the output gap in the quadratic form in a weighted order. As small deviation is expected, the central bank aims to minimize the loss function given below. This is because if not the structural unemployment but the cyclical unemployment concerns the central bank and so the monetary policy. Hence, the monetary policy behaves like a central bank in the

modern sense considering the flexible policy and the real output rather than ignoring the business cycle and making a strict targeting considering only inflation. From this perspective the monetary policy affects both output and inflation. However, control of inflation continues to be the primary purpose of the monetary policy (Oktar,1998;9). Yet, the equal distribution of the responsibility for the control of inflation by the institution conducting the government and the monetary policy leads to nobody taking responsibility in real terms (Fischer,1996;5). And the possible outcome of this is the loss of confidence in the public opinion on the monetary policy and the predominance of uncertainty (Oktar, 1998;3).The central bank's expected loss function can be expressed as follows (Leitemo,2008;2):

$$E_{t0}\sum_{t=t0}^{\infty}\beta^{t-t0}L_t \qquad (1)$$

In the equation, β indicates the discount factor of the consumer; L indicates loss function, t indicates time and E indicates the forward looking expectation operator in the course of t=0. The equation shows the deviations in the targeted levels of the targeted variations to occur in the future (Svensson, 2003;14). We can take that the discount factor approaches the unit value by making abstraction in terms of convenience ($\beta \to 1$).

The expression below is written for the loss function L_t $(\text{Svensson}, 2003; 7)$;

$$L_t = \frac{1}{2}((p_t - p^*)^2 + \lambda x_t^2) \qquad (2)$$

p_t, shows the percent value of the difference between the targeted inflation and the inflation outturn, and y_t shows the percent of the variation made in/from the output amount. $\lambda \in (0,1)$is a coefficient and economically it shows the value relatively attributed to the variability/instability in the output gap by the central bank (This coefficient also includes the political pressures affecting the distribution of the monetary policy (Lohmann, 1992;274)). p^* shows the targeted inflation level. If noted, the equation numbered (2) being the objective function consists of two terms. The first states the variance of the output gap and the other states the variance of the inflation rate. This is because one is the square of $(p - \bar{p})$ and the

other is the square of $(y - \bar{y})$ when written more clearly. In this case, if we state the objective function in terms of variances as shown by many authors (Svensson, 2003;7); we get:

$$L_t = \frac{1}{2}[Var(p_t) + \lambda Var(y_t)] \quad (3)$$

"Var" represents the variances here. Sargent and Walace (1975) have also made similar calculations by connecting the monetary policy to the loss function within the framework of the rational expectations (Sargent and Wallace, 1975; 5)

2.1. Application of Loss Function for Turkey.

The Turkish economy made a drastic switch from export-push growth model to market-based policies and outward orientation since 1980. After excellent far-reaching structural adjustment starting in 1980, including increase the central bank independence, aiming to cope with inefficiencies and balance of payment difficulties, CBRT became interested in monetary programming as early as 1985, and then announced its first monetary programming in January 1990 (Ersel and İskenderdeoğlu, 1990:1-2). Monetary programming brought a new approach to the central banking in terms of announcing monetary quantities to the public and adapt their plans to the targets (Tacal, 1993; Yıldırım 1995). After monetary programmings, CBRT decided to reduce inflation in a short time and very quickly. For this reason, CBRT tried to satisfy conditions for IT regime until 2006, and can implement IT in 2006 explicitly. İn a very short time period (4 years) average yearly inflation reduces from 28,8 percent to 8,3 percent. However, the standart deviation of inflation has rose (see table 1). To sum up, Central Bank of Turkey (CBT) has been making inflation targeting openly or implicitly since 2002 in theory and practice.

Table 1. Intermediate Regimes and Average Annual Inflation, Growth Rate: 1990-2011

Variable	Monetary targeting	Exchange-rate targeting	Monetary targeting and implicit inflation tageting	Explicit inflation targeting
Period applied	1990-1999	2000-2001	2002-2005	2006-2011*
Avr. Growth (%)	4,1	5,82	7,63	4,32
Avr.Inflation (%)	77,6	55,6	28,8	8,3

Std. Deviation of Growth	6,41	2,7	2,9	6,6
Std.Deviation of Inflation	17,5	11,9	17,4	2

*: Datas belonging 2011 is up to September.

we know that the loss function is an indicator of optimum monetary policy for central banks. Even though 9-year data does not make sense to test the central bank loss function, we can find the deviations by regarding the difference between the inflation targeting and the inflation outturn as 12-month periods for CBRT and see the application results this way from equation (2) for Turkey. It is easy to find the deviations as the inflation target is known in this period. We are going to apply Hodrick-Prescott to the industrial production index to calculate the output gap.

Let us make a drawing for Turkey by considering the inflation and output gap variances of L_t function coming up from equation (3). And let us assign three different values to λvalue between (1-0) representing the range of significance attributed to the output by the central bank.

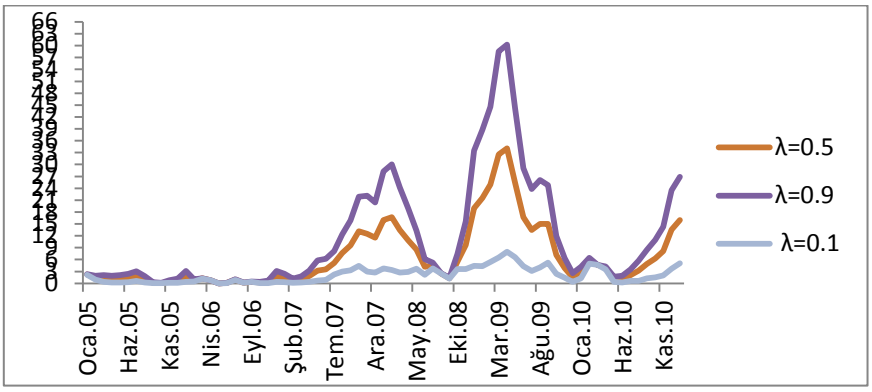
$\boldsymbol{\lambda = 0.1}$ means central bank conducts a policy close to strict inflation targeting

$\boldsymbol{\lambda = 0.5}$ means central bank regards the output deviation no less than the inflation,

$\boldsymbol{\lambda = 0.9}$ means central bank regards the output deviation more than the inflation.

Figure 2 shows the results of the central bank loss function expressed theoretically and formed by the values between 0-1 for each λ in the light of the data in Turkey. When looked closely to Figure 2, it is seen that making the loss function minimum formed by the data belonging to the time periods when the CBT makes open and implicit inflation targeting causes the function to follow a fluctuating course in general except λ=0.1 which is close to full targeting. It is also seen that the deviation from the target is severe in open-targeting periods, especially in 2007 and 2009.

Graph 1. The Central Bank Loss Function Under Inflation Targeting Regime

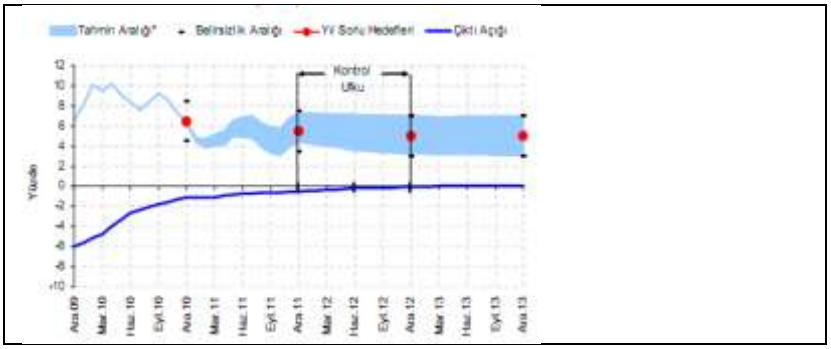


Source: Bülent Doğru, "Merkez Bankası Politikalarının Fiyat İstikrarı ve Diğer İktisadi Olgular Açısından Değerlendirilmesi ve Türkiye'de Enflasyon Hedeflemesi Örneği", (İstanbul Üniversitesi Sosyal Bilimler Enstitüsü Basılmamış Doktora Tezi), İstanbul, 2012.

The result revealing here is that the central bank should carry out the inflation policy without considering the output. Only then, L is able to make the loss function minimum.

When we look at Figure 1 reflecting the views of the CBT in this issue, it is easily seen that the CBT prefers to give probability space target from the point target acquisition by keeping the inflation control horizon (the difference between the highest and the lowest expected value) wide (Yılmaz, 2011;7). The deviation of the output gap is estimated to converge to zero over time.

Graph 2: Deviation from the Target Value in the Output Gap and Inflation Targeting



Source: CBT, Inflation Report - January 2011, January 25, 2011, Ankara, p. 17

3. Optimal Monetary Policy Model Including Inflation Gap

Recently inflation gap from target becomes a crucial indicatior for the central bank's confidence gap. Following Mishkin (1998 and 2001), Kadıoğlu, Özdemir and Yılmaz (2000), and Amato and Gerlach (2002), we have added inflation gap from target to loss function, and make a modified model to estimate. The main model, we are modifying belongs to Soderstorm (1999).

We are analyzing the effects of the CBT's policy decisions to keep the inflation under control considering Soderstorm's (1999) model for open economies. Soderstrom's model is the advanced version of Svensson and Rudebusch's (1998) model that does not include the interest rates explicitly. In addition to this model, Svensson and Soderstorm models are taken a step further by attributing a new variable named the success criteria of the central bank in the study.

Central banks do not follow a rigid aggressive interest policy to keep inflation under control because there is a negative relationship between the interest rate and investment. The central bank should also consider the potential production losses. Taking these into consideration, the relationship between the output gap, inflation rates and interest rates can be formulated as follows (Saleem, 2010;65):

$$y_{t+1} = \alpha(L)y_t + \beta(L)(i_t - p_t) + \varepsilon_{t+1} \qquad (4)$$

y_t is output gap between potential and actual GDP values. Equation (16) shows the linkages between aggregate demand,its lagged values and output gap. Inflation rate can be expressed with a total supply-type function in accordance with rational expectations hypothesis. The inflation rate in the next period is explained by the inflation rates in the current and deferred period and the output gap. δ ve γbeing the coefficients of the parameters, the equation of inflation can be expressed as follows:[2]

$$p_{t+1} = \delta(L)p_t + \gamma(L)y_t + \mu_{t+1} \qquad (5)$$

The central bank considers both the output and inflation together when deciding the interest rate (Saleem, 2010;66). It uses the output of a simultaneous equation system to do this. Then we need a third equation. The output gap and the lagged values of inflation and interest rates take part as the independent variables in this equation affecting the central bank's interest rate decisions. Additionally, we

[2] We assume that it does not make rigid targeting (Svensson, 1998)

think whether the central bank is able to achieve the inflation rates it has declared in the inflation targeting regime also affects the policy interest rate decisions of the bank. In other words, the success/or failure of the bank affects the policy interest rate. And thus, we add to the model, established by Saleem (2010), Sodestorm (1999) and Svensson (1998) an explanatory variable defined as " absolutely efficient", an explanation of how much central bank has deviated from target or range point it announced before. Providing E is the absolute active term, E is found as follows:

$$E = 100\left|\frac{\pi - \pi^*}{\pi^*}\right| \tag{6}$$

Where, $\pi^*$is target inflation rate of the Central Bank and π is the actual inflation rate. According to our observation, E decreases when central bank reaches its target inflation rate and vice versa. This is true because under IT regime, rational expectation of people converges to a point with rising of central bank's credibility over time. Then we can write the central bank's interest equation as follows:

$$\mathrm{i_{t+1}} = \theta(\mathrm{L})\mathrm{i_t} + \varphi(\mathrm{L})\mathrm{y_t} + \vartheta(\mathrm{L})\mathrm{p_t} + \partial(\mathrm{L})\mathrm{E_t} + \omega_{t+1} \tag{7}$$

Where (L) denotes the lag structure of variables and ω is a white noise variable. It relates the nominal interest rate to output gap, lagged inflation, absolute efficient term, and its lagged interest rate. It is assumed as an accelerationist type of Philips Curve relationship (Svensson and Rudebusch, 1998).

After these pre-workings, we can represent a standard VAR model to express how the central bank has to set the optimum interest rate with adjusting output and inflation under given E values, considering Soderstorm and Saleem models.

$$y_{t+1} = \sum_{j=1}^{L} A_s^y y_{t-j} + \sum_{j=1}^{L} B_s^y p_{t-j} + \sum_{j=1}^{L} C_s^y i_{t-j} + \sum_{j=1}^{L} D_s^y E_{t-j} + \varepsilon_t^y$$

$$p_{t+1} = \sum_{j=1}^{L} A_s^p y_{t-j} + \sum_{j=1}^{L} B_s^p \pi_{t-j} + \sum_{j=1}^{L} C_s^p i_{t-j} + \sum_{j=1}^{L} D_s^p E_{t-j} + \varepsilon_t^p$$

$$i_{t+1} = \sum_{j=1}^{L} A_s^i y_{t-j} + \sum_{j=1}^{L} B_s^i p_{t-j} + \sum_{j=1}^{L} C_s^i i_{t-j} + \sum_{j=1}^{L} D_s^i E_{t-j} + \varepsilon_t^i$$

Here p_t is the annual CPI inflation rate, i_t is the call money rate, y_t is output gap, and E_t is the absolute efficient term. This VAR model will show us behavior of central bank; whether it is moderate or aggressive. It also suggests that the central bank is both responsible for price stability and maintaining financial stability with the help of a compatible macroeconomic situation. Therefore, the modified VAR model concerns with the demand and supply side equations in the open economy and gets an optimum interest rate from simultaneous equation system above. The reason why we use VAR model for our empirical estimation is that these three variables have indirect impact on each other.

4.Data and Empirical Results

Our monthly time series for period 2002:01-2011:06 are, taken from Central Bank of Turkish Republic electronic data service (EVDS). Eviews 6 is used in this article for empirical results.

Our empirical analysis begins by testing the time series properties of the variables concerned. Firstly, we analyze the stability of variables we concern. The Augmented Dickey-Fuller (ADF) and Philips Perron unit root tests are used for this purpose as necessary (Harris,1995). According to table 1 all variables, except the monthly inflation variable, appear to have a unit root, and must be differenced once to achieve stationarity before vector autoregressive (VAR) analysis. The exception one have an order of integration of zero (Günçavdı and Mckay, 2003;6). This provides us to measure the impact of interest rate to the output gap, to variable E, which measures inflation gap form target, and its impact on inflation. The maximum lag length is found 1, determined on the basis of Akaike Information Criterion.

Table 1: ADF and PP Unit Root Tests

Variable	**Definition**	**Unit root test**		**Unit root test**	
		Level		1st difference	
		ADF*	PP*	ADF	PP
y	Output gap	-2.49(0.32)	-2.17(0.49)	-6.94(0.00)	-7.01(0.00)
i	CBT policy interest	-1.84(0.35)	-2.18(0.21)	-2.55(0.10)	-7.31(0.00)
P	Monthly consumer inflation	-4.48(0.00)	-6.22(0.00)	-	-
E	Central bank success criteria	-1.83(0.36)	-4.29(0.00)	-6.84(0.00)	-13.60(0.00)

-* ADF test is Augmented Dickey Fuller unit root test and PP Philips Perron unit root test. Tested equations include trends and coefficients. Values in parentheses are probabilities, and tested period is 2002:01-2010:03.

The estimation result of VAR is summarized in table 2. Each column represents the equation in simultaneous equation system above. Y, İ, P are endogenous variables of VAR, While E is exogenous variable of the system.

Table 3: VAR results 2002:01-2011:06

	(1)	(2)	(3)
	lp_t	dli_t	dly_t
lp_{t-1}	0.868*	0.001**	0.001
dli_{t-1}	0.061**	0.962*	0.053*
dly_{t-1}	-0.095	0.045	0.736*
dE_{t-1}	0.003	-0.001	-0.004**
intercept	-8.440	4.332	-24.072*
Adj. R-squared	0.06	0.80	0.55
AIC	3.69	3.03	2.90
SIC	3.82	3.15	3.02
F-statistic	1.0	23.5	106.4
Log likelihood	-198.4	-161.3	-154.3
Num.of obs.	110	110	110

*Indicates significance at 1 percent, ** indicates significance at 5 percent level.

Definition of regression variables:

lp	Log of inflation
dli	First difference of log of nominal interest rate
dly	First difference of log of output gap
dlE	First difference of log of absolute efficient value

The result of unrestricted VAR model, equation 2, explain the relationship between interest rate and its one lagged value, output gap, inflation, and E value. According to its estimation output, interest rate is determined by its previous value and inflation. The value E is negatively related to interest rate but is insignificant and less effective on interest rate. We can conclude that in Turkey, output gap and absolute efficient term have no impact on interest rate. In another saying, Central Bank of Republic of Turkey (CBRT) gives its optimum policy interest rate decision regardless of inflation gap from target inflation, announced under the inflation target regime (implicit or explicit) during 2002-2011. Equation 3 measures the relationship between the output gap, inflation rate, nominal interest rate, and value E. The output gap is positively related to the lagged value of inflation rate, nominal interest rate and lagged value of output gap, and

negatively related to the lagged value of E. But inflation rate fails to explain the output gap in the economy.

All estimation results consistently show that in Turkey nominal interest rate variable appears to be related with the logarithm of consumer price index (inflation) and its lagged value in the short-run. The results also shows that the difference between actual inflation and targeted inflation level, which is definition of value E, has negatively related to nominal interest rate, but is insignificant. In other words, the value E has no impact on base interest rate decision of the central bank. The statistical evidence of the estimation results of VAR analysis is provided by the significant coefficients of the lagged levels of these variables in their first difference. This means that the central bank has played a discretion policy rather than rules in the conduct of monetary policy from an analytic perspective during the period.

5.Conclusion

This paper has examined the role of deviation from targeted inflation rate on nominal interest rate decision of CBRT. It also considered whether for price stability goal CBRT has implemented its implicit and explicit inflation targeting regime by rule or by discretionary measures during 2002-2011.

The results indicated that the variable E, deviation from targeted inflation, has no impact on nominal interest rate. On the basis of empirical evidence, we can conclude that optimum inflation rate decision in Turkey is only explained by lagged value of inflation and its previous value, and that CBRT can not control inflation in Turkey using interest rate as a nominal anchor, because relationship between inflation an ineterest rate is positive.

The empirical results also showed that although CBRT has implemented inflation targeting regime since 2002 (explicitly since 2006), its monetary policy strategy depends on discretionary policies instead policies by rule, because explanation power of coefficient of interest rate is less than expected (0.061). This means that interest rate does not play a critical role in determining inflation in Turkey.

We also find that output gap is negatively and significantly related to the performance criterion variable E of the central bank. If CBRT

deviates 1 unit from its inflation target level, the logarithmic difference of output gap reduces 0.004. The fact that this estimation output suggests is that when the central bank keeps its promise and can achieve to equal targeted and actual inflations, Turkish economy has a potential to reach high growth rates under inflation target regime.

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