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TÜRKİYE'DE ENFLASYON HEDEFLEMESİ: VAR ANALİZİ

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ÖZET

Enflsyon, 20 yüzyılın ikinci yarısından bu yana tüm ekonomilerin temel problemlerinden birini oluşturmaktadır. 90'lı yılların başında bazı yükselen ekonomiler enflasyon hedeflemesini kullanarak enflasyon oranını düşürdü ve durağan hale getirdiler. Bir diğer yükselen ekonomi olan Türkiye 80'lerden bu yana kronik enflasyon problemi yaşamaktadır ve birçok ekonomik kriz bunu kalıcı hale getirmiştir. Birçok ekonomik istikrar programı uygulanmasına rağmen kronik enflasyon sorunu 21. yüzyılın son 10 yılının ilk birkaç yılına kadar devam etmiştir. 2001 yılında, hükümet ve Türkiye Cumhuriyeti Merkez Bankası (TCMB) enflasyon hedeflemesi programı uygulamaya başlamıştır. Bu çalışmada açık bir ekonomi modelinde Taylor kuralı kullanarak enflasyon hedeflemesi programının test edilmesi amaçlanmaktadır. Bu anlamda çalışmada, Türkiye ekonomisi için 2002:M1-2009:M11 yılları arasındaki aylık verilere VAR analizi uygulanmıştır.

Sonuçlar, Türkiye'de uygulanan enflasyon hedeflemesi programı için Taylor tipi para politikası reaksiyon fonksiyonun uygun olduğunu göstermektedir.

Anahtar Kelimeler: Tylor Kuralı, Enflsyon Hedeflemesi, Var

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INFLATION TARGETING IN TURKEY: A VAR ANALYSIS

ABSTRACT

Inflation has been one of the main problem for whole economies since the second half of 20th century. At the beginning of 90's some of emerging economies have choosed to target inflation rate to reduce inflation and to stabilise economy. Another emerging economy, Turkey has also lived chronical inflation problem since 80's and many economical crises made it permanent. In spite of several economical stabilization programs practiced, chronical inflation problem have continued several years until first decade of 21th century. In 2001, government and the CBRT have started to practice inflation targeting program for Turkish economy also.

In this study we aimed to examine such a program by using Taylor rule in an open economy model. In this context, we applied VAR analysis by using monthly data belonging Turkish economy which includes period between January of 2002 and November of 2009.

We found that Taylor type monetary policy reaction function fits for inflation targeting program which has been practiced for the Turkish economy in an open economy model.

Keywords: Taylor Rule, Inflation Targeting, VAR.
Jel Classification: E52

1. Introduction

Haberler (1966) took inflation to mean a condition of rising prices in his book named "Inflation Its Causes and Cures". Although there are some different definitions, Wilson (1982) defined it as a persistent rise in the general level of prices and emphasized importance of two terms in his definition. One of them was "persistent"; a temporary increase does not mean any sight for an economist who interested in inflation. Another term was "general price level" that an individual increase in any good does not mean exactly to an increase in inflation. Because general level of prices depends on a series of individual price changes and their relative importance (Wilson: 1982: 2).

The causes of inflation are popularly discussed in terms of "demand-pull" or "cost-push". Demand-pull characterizes inflation when total demand exceeds total supply (Friedman: 1980: 23). According to Haberler (1966) rising demand faster than supply pulls up prices and wages and causes demand-pull inflation. In this situation general level of prices will rise until new equilibrium point is composed by intersection of supply and demand curves.

Haberler (1966) mentioned about another reason of demand-pull inflation called "government inflation". A rise in government deficit can

cause an increase in demand and rise in inflation follows it. Also an expansion of bank credit for private investment, rising demand from abroad (imported inflation) or an increase in gold production (gold inflation) are another sources of demand-pull inflation (Haberler: 1966: 61).

Second main factor is named cost-push that characterizes inflation when costs particularly wages, but also other factors like rent and interest loans rise, pushing up the sales price of products to meet rising costs (Friedman: 1980: 23).

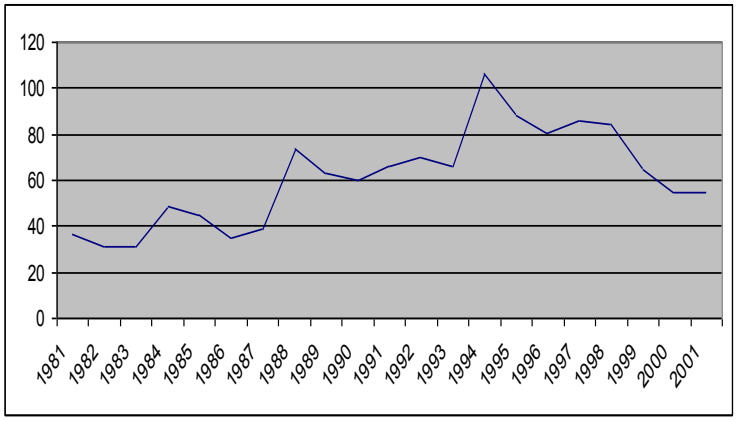
By the first half of 70's, increasing in the general level of prices arised all over the world and inflation rate increased permanently. While inflation was 4,7% per year, it increased up to 10% per year in OECD countries. Increasing has continued for several years especially in developing countries. One of the main motivation for rising in inflation was collapse of Bretton Woods system in 1971. After collapsing of the system, there was no standart with money supply, so arbitrary applications in the supplement of money caused increasing in the level of general prices. Another important motivation of the rising in inflation rate is petroleum shocks lived in 1973 and 1979. Instantaneous and appreciable increasing in the price of petroleum that is one of the most important energy source moved production costs directly and caused cost-push inflation. Share of governments in the world economy had been arised because of Keynesian economical concept after post-war period. Because of this situation, efficiency in production had reduced despite of increasing demand and so some kind of demand-pull inflation rised in the following years.

As a result of these factors, reducing inflation has become one of the main intention of governments. When the time comes to 90's, liberally governments and central banks have choosed inflation targeting practice. Central banks of Australia, Canada, Finland, Israel, New Zaeland, Spain, Sweden and England are examples of countries have inflation oriented central banks. As can be seen, most of them are emerging economies and but some of them are industrialised economies.

Turkey also lived energy and exchange crisis at the end of 70's and economical instability in the same era. Inflation rate reached 52,6% level in 1978 and it went beyond 100% level in 1980. Through the agency of economical crisis, inflation rate increased over 100% level in

1994 again. Because of full-fledged recessions, high inflation rates had become permanent for the Turkish economy. Movements of inflation in this period, between 1981 – 2001, can be seen in the following graphic number 1.

Graphic 1. Inflation Rate 1981-2001 Period



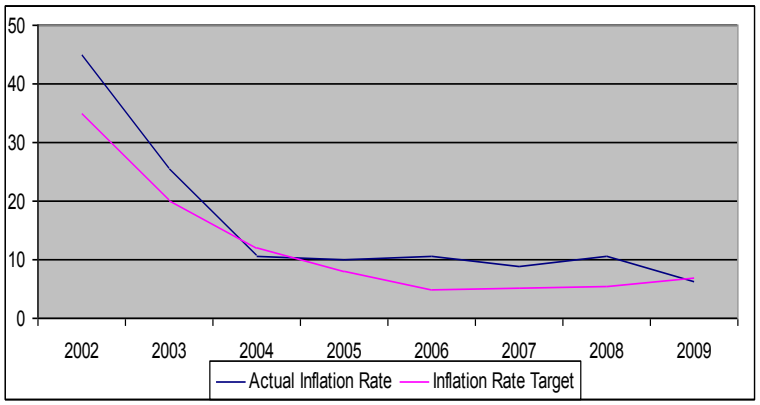
Source: IMF, International Financial Statistics 2009 Date(15.03.2010)

Turkish economy was hit hard by financial crisis in November 2000 and February 2001 again. Then in April 2001, current government prepared a stabilization program named "A Transition Program into a Powerful Economy" to make some radical structural changes in the economy as a whole. Program also included some structural changes in the financial system and the Central Bank of the Republic of Turkey (CBRT) in particular. The most important changes were to define the CBRT legaly, to determine the primary purpose of the bank as 'price stability' and to begin inflation targeting program. In this context exchange rates would be determined by competitive exchange market anyway.

After a short period from the beginning of stabilization program, early general elections was called and another government has came to office in november 2002. Although change in government and management of economy, present government announced that it would continue to practice stabilization program as strong as past government. So inflation targeting program has continued in the same path also.

Inflation rate started to run low and it was only one digit rate after several decades in Turkish economy in 2004.

Graphic 2. Actual Inflation Rate and Inflation Target Period 2002-2009



Source: IMF, International Financial Statistics 2009 Date(15.03.2010)

The main goal of our paper is to understand whether short term interest rate which is used as an instrument of monetary policy, is effective instrument to success price stabilization during economical stabilization program and to examine importance of output in the program by using Taylor type monetary policy reaction function. Because studies about developed countries have had some suggestions about usefulness of short term interest rate, if it is used together with inflation targeting policy to achieve price stability and to establish stable production level and about that it is more effective than other monetary policy instruments (Money supply, exchange rate, etc.) (Kesriyeli; 1998).

We examine inflation targeting period to understand behaviour of short term interest. So time interval considered in this study differs from other studies about Turkish economy. Another important difference in this study that we take into account extended monetary policy reaction function by including exchange rate into the reaction function. Lastly although there are plenty of studies about Taylor rule, a few of them used VAR methodolgy to examine Taylor rule. By using VAR analysis, we will be able to consider possible simultaneous relationship among the endogenous variables and to avoid simultaneity bias.

In the second part of the study Taylor rule will be introduced in a nutshell. National and international literature will be overwieved in the third part. Information about data used in this study and model established through econometrical analysis will be investigated in the fourth part of the paper. Fifth part is about empirical results and at the end of our study we give useful insight about Turkish inflation targeting program and compare monetary policy reaction derived by econometrical application with original monetary policy reaction of Taylor represented his announcement in 1993.

2. Taylor Rule

John B. Taylor (1993a) offered a different monetary policy rule has dynamic pattern and put in a plan to practice monetary policy rules. That is why starting by examining his proposals about characteristics of a rule and about how it might be practiced will be plausible explanation, before we describe his monetary policy reaction function. According to Taylor monetary authority does not need to follow mechanically any algebraic formula to practice monetary policy rule. Also authority does not need to install a constant rule. It means instrumental variable does not cost certain value. Taylor (1993b) emphasized to not to confuse discretionary policy practice and his proposal because of these ideas. Because practicing a policy rule needs responsibility and judgement, so computers can not achieve it and so weigh of variables can change according to situation of economy. Last point is that if a policy rule is to have any meaning, it must be in place for a reasonably long period of time. For a policy rule, several business cycles would certainly be sufficient, but, for many purposes, several years would do just as well (Taylor; 1993b; 5).

According to Taylor, the term "policy rule" connotes either a fixed setting for the policy instruments or a simplistic mechanical procedure (Taylor; 1993a; 198). So an alternative terminology "systematic policy" was offered by Taylor has better explanation power which he try to imply.

Policy rule proposal of Taylor is that short term nominal interest rate react according to change in inflation rate from its target introduced by policy makers and actual GDP from potential GDP. If inflation rate deviates higher than target or GDP gap rises positively, short term nominal interest rates will increase and it will decrease if actual inflation

rate is below its target or actual GDP falls under its potential. So in equilibrium short term nominal interest rate inflation will be on target and all of sources possible for production in economy will be material in process of production. We can express relationship between variables by developing an equation. We can note variables as follows:

$i =$ Short term interest rate

$i^f =$ Real interest rate

$\pi =$ Actual inflation rate

$\pi^* =$ Target inflation rate

$h =$ Inflation rate reaction coefficient

$y =$ Actual GDP or GDP growth rate

$y^* =$ Potantial GDP or potential GDP growth rate

$g =$ GDP gap reaction coefficient

After notation of variables used in policy reaction function, we can write equation as follows:

$$i = i^f + \pi + h\left(\pi - \pi^*\right) + \frac{g\left(y - y^*\right)}{y^*} \qquad (1)$$

As can be seen in this equation, while actual inflation is equal to inflation target and output level is equal to its potential, short term nominal interest rate will be equal to sum of real interest rate and actual inflation. So there will be no importance of values of coefficients g and h. If actual inflation rate rises, short term inflation rate will increase vice versa. Effect of increase in inflation will be determined according to size of coefficient h. If it is between 0 and 1, increase in interest rate will be less than change in inflation and if it is more than 1, increase will be bigger than inflation change. g coefficient size will determine reaction size of interest rate when output differs from its potential like coefficient h.

Sizes of coefficients h and g show preferences of policy makers about which goal is important for them. This is because they represent Monetarist and Keynesian policy proposals those contrast entirely. Namely if coefficient g is valued zero and coefficient h is valued high, it can named as pure Monetarist rule. So monetary authority takes only on

board deviations in inflation and neglect output gap. If coefficient h is zero and coefficient g is valued high, it can be named as pure Keynesian rule. In such a case monetary authority only consider unemployment and neglects deviations in inflation (Akat; 2004; 7).

Taylor's original analysis in his original paper in 1993 does not include exchange rate. Because he analysed U.S.A. economy in a closed economy model and Taylor (2001) pointed out that there are some indirect effects of exchange rate on interest rate. Because of this reason to determine response of interest rate to a shock in exchange rate is hard (Taylor; 2001; 264). But it is useful to include exchange rate into the reaction function especially for emerging economies which exchange rate has high pass through into prices. Ball (1999), Svensson (2000) and Taylor (2001) placed exchange rate into policy reaction function and found that exchange rate has significant coefficient. So it would be useful to include exchange rate variable for Turkey that has open economy and where exchange rates float into competitive market.

3. Literature

Taylor rule and estimating Taylor-type monetary policy reaction function were research bases for several studies for last decade and most of them took into account industrialized economies specially U.S.A., European Union and Japan. These studies estimated monetary policy reaction function by using different econometrical methodologies in different time periods and they added different variables into reaction function. Although there is a vast literature about Taylor rule, we mention some basic studies estimating Taylor-type monetary policy reaction function for industrialized economies in our study.

One of them belongs to Judd and Rudebusch (1998). They examined U.S.A. economy and parted period, between 1970 and 1997, according to chairmenship of Federal Reserve System and followed error correction model (ECM) for econometric analysis. At the end of the study they implied that behaviour of FED differs according to chairman of it. So, while Greenspan followed Taylor-type monetary policy, Volker and Burns did not consider Taylor rule.

Bernanke and Gertler (1999) added asset prices into Taylor's policy rule reaction function and examined U.S.A. and Japanese economies between 1979 and 1997. They built up Bernanke, Getrler and Gilchrist model and simulate economy by using the generalized methods

of moments (GMM) with correction for MA(12) autocorrelation. They implied useful framework for explaining U.S.A. monetary policy actions at the end of their studies.

Clarida, Gali and Gertler (1997) examined six countries into two different groups to estimate monetary policy reaction function for each group. First group consisted of Germany, Japan and U.S.A., another group consisted of United Kingdom, France and Italy. They estimated monetary policy reaction function for post-79 era by using the generalized methods of moments (GMM) and they concluded that first group countries take into account anticipated inflation in their monetary policy reaction function instead of lagged inflation like original study of Taylor. In another study of Clarida, Gali and Gertler (2000) modified Taylor rule by smoothing interest rate and estimate forward looking monetary policy reaction function for Volcker-Greenspan period. They used same methodology and they concluded that interest rate policy is more sensitive to changes in expected inflation than before Volcker period.

Levin, Wieland and Williams (1998) estimated monetary policy reaction function for U.S.A. economy also by using four different structural macroeconometric model and compared results of each model. They examined U.S.A. data belonging years between 1980-1996 by using a combination of OLS, 2SLS and GMM methodologies. They concluded that models include first difference of the federal fund rate work better. Because first difference of the rate responds to the current output gap and the deviation of the one year avarage inflation rate from target.

Florens, Jondeau and Bihan (2001) estimated monetary policy reaction function for Federal Reserve of U.S.A. (FED) in a different methodology. They estimated forward looking reaction function period including years between 1979 and 1998 and they used the maximum likelihood (ML) method instead of the generalized methods of moments (GMM) different from Clarida, Gali and Gertler (1998). Then, they compared results with GMM and two step GMM method results and implied that ML methodology gives more robust results than GMM methodology to estimate policy reaction function of FED.

Jamal and Hsing (2007) estimated policy reaction function for FED by using quarterly data belonging years between 1987 and 2005 including Greenspan period as a chairman of FED. They put real interest

rate, inflation target, output gap, inflation rate and federal fund rate into function and estimated by Newey-West methodology. They got results supporting significancy of Taylor rule and implying that coefficients of rule differ from Taylor's original rule. As a result they concluded that constant term and inflation term is not different from Taylor's original study and but coefficient of output gap is different from Taylor's finding. According to them FED gave less importance to changes in output gap.

Mehra and Minton (2007) estimated policy reaction function for Greenspan also. They estimated policy reacition function in a forward looking structure and assumed bank was smoothing interest rate. They took into account core inflation and estimated function by using the generalized methods of moments (GMM). They also compared data whether real time data gives more robust results rather than revised data. According to results of their analyse, Greenspan followed Taylor rule and reaction function responded changes in inflation strongly and weakly to output gap compare to inflation.

Leigh (2008) estimated Taylor type policy reaction function by using the maximum likelihood (ML) method to analyse 1979-2004 period including Volcker and Greenspan. They relaxed assumption that the inflation target is constant over the time and they assumed variation in implicit inflation target by using Kalman filter. He concluded that FED followed time varying implicit inflation targeting procedure significantly.

Cote et. al (2004) analysed Canada economy to examine performance and robustness of simple policy rules for the Canadian economy. They compared performances of seven different policy rule by using the vector autoregression (VAR) methodology. They found that adding exchange rate term to a simple policy rule often increases the value of policymaker's loss function and open economy rules do not perform well in many models. Although it was not robust, they found that a simple nominal Taylor type rule that has a coefficient of 2 on the inflation gap and 0,5 on the output gap performs better.

Carstensen (2006) put nominal and real exchange rates into original function of Taylor rule to examine behaviour European Central Bank (ECB) period between 1996 and 2006. He concluded that bank does not take into account inflation in its policy decisions and so it is not possible to construct Taylor type policy reaction function for it in these years. Gorter, Hacobs and de Haan (2008) included inflation and output

gap expectations into model and analysed period between 1991 and 2003. They applied the non-linear least squares and generalized methods of moments (GMM) and they compared results of each methodology. They found that ECB uses expected inflation and expected output growth in its interest rate decisions, also coefficient of realized inflation is not significant in conventional reaction function model.

Hsing (2004) estimated monetary policy reaction function of Bank of Japan in his study. He used overnight call rate as short term interest rate. Then he added financial variables, stock prices and exchange rate, into reaction function and used quarterly data belonging 1979 and 2002. He estimated policy reaction function by using the vector autoregressive (VAR) methodology. At the end of his empirical analysis he implied that overnight call rate reacts positively to a shock to the output gap, the inflation gap, yen depreciation, stock prices. The response of the overnight call rate to yen depreciation on stock prices lasts longer. Lastly, the reaction of the call rate to the inflation gap goes on longer than that of the overnight call rate to the output gap.

Although there is a vast literature concerning industrialized countries, number of studies investigating emerging countries were limited. But the number of these studies have started to rise in recent years. Turkish economy has been subject to studies about Taylor rule and estimating monetary policy reaction function also. In one of them Kesriyeli and Cihan (1998) estimated backward and forward looking monetary policy reaction function by using two stage least squares methodology. They took into account years between 1987 and 1998 and concluded that Taylor type policy reaction function is a useful guide for countries which has stable and low inflation rate instead of emerging countries have unstable economies and high inflation.

Us (2004) examined Turkish monetarial transmission mechanism in a small structural model and compared Taylor rule and monetary condition index (MCI) in her study. She estimated impulse response functions for each rule by the vector autoregressive (VAR) methodology. At the end of her study, she found that monetary condition index is effective to stabilize economy and reduce fluctuations in economy and so policymakers ought to use MCI while they decide policy actions.

Caglayan (2005) used the multinominal logit model to examine whether inflation rate and output gap are important indicator of short term interest

rate decisions. She used data belonging years between 1990 and 2004. As a result of this analysis, she implied that inflation rate is an important indicator and but output gap is not important for policymakers. Caglayan also suggested that lagged output gap might be used as an alternative component of interest rate decisions.

Aklan and Nargelecekenler (2008a) analysed period between 2002 and 2006 to see whether the CBRT followed Taylor rule in these years as a monetary policy benchmark. They estimated policy reaction function by using the generalized methods of moments (GMM). At the end of their study they implied that interest rate reacts inflation rate, output gap and also exchange rate in the context of Taylor rule. They examine the Turkish economy in another article (2008b) with the data belonging 2001-2006 years. They estimated Taylor type policy reaction function as backward and forward by using same methodology. At the end of their study, they found that Taylor rule is current for the Turkish economy and they implied that after 2001 crisis, coefficients of inflation rate and output gap are bigger than before.

4. Data, Model and Methodology

4.1. Data

Stabilization program has been started in april 2001 in Turkey and the CBRT has started to announce inflation targeting by 2002. Also positive results of program appeared in the first month of 2002 on inflation and other macroeconomic variables. For these reasons we started to examine inflation targeting era by the first month of 2002 and we used data covering the period 2002:01-2009:11 in order to see results of program.

All of data used in analysis were obtained from publication of the International Money Fund named International Financial Statistics. We used interbank interest rate as short term nominal interest rate. Inflation rate was measured as the first difference of CPI (2005=100) and deseasonalized by using TRAMO/SEATS program. Then inflation gap was calculated as the difference between actual inflation and backward inflation target announcement of the CBRT's webiste. Inflation targets for each year can be seen in table 1.

Table 1. Inflation Target per year

	2002	2003	2004	2005	2006	2007	2008	2009
Inf. Target	35%	20%	12%	8%	5%	4%	4%	7,50%

Source: The CBRT. www.tcmb.gov.tr Date: 25.03.2010

We deseasonalized industrial production index by using TRAMO/SEATS program to derive potential output by HP filtre and we obtained output gap by calculating difference between potential output and actual output. We used SDR to measure exchange rate where the SDR is an international reserve asset, created by the IMF in 1969 to supplement its member countries' official reserves. Its value is based on a basket of four key international currencies are euro, U.S. Dollar, Pound Sterling and Japanese Yen, and SDRs can be exchanged for freely usable currencies (IMF; 2010; 1). Inflation rate and SDR data were used in logharitmic forms.

Table 2: The Data Set

Variables	Explanations	Resources
INT	Interbank Interest Rate	IFS
INFGAP	Inflation Rate Gap Derived from CPI (2005=100)	IFS
GAP	Output Gap (Derived by HP filtering process)	IFS
SDR	Special Drawing Right	IFS

4.2. Model and Methodology

We can write original Taylor rule function as below:

INT=f(INF, GAP, GAP) (2)

We extend function as an open economy analysis by including SDR into function,

INT=f(INF, GAP, SDR) (3)

Some of these variables might have relationships. For instance, after the CBRT lowers on interest rates, consumption and investment would increase, thus aggregate demand would shift higher level and so GDP would increase. So it would change output gap positively. At the same time an increase in output would cause a decrease unemployment rates and inflation rate would increase. Because of the practicing VAR

methodology and all the right hand side variables are identical and lagged, simultaneity bias is not concerned. It is essentially a system of equations whose dependent variables are regressed on lagged observations of all the variables in the system (Ford: 1986: 2).

In VAR framework, there are no exogenous variables and no identifying restrictions. The only role for economic theory is in specifying the variables to be included (McCoy: 1997: 2). In VAR methodology, each time serie has to be stationary to include into analysis. Therefore, before including a variable into system, it is important to control stationarity.

We can write system of simultaneous equations in a vector form as follows.

$$Ay_t = B(L)y_{t-1} + C\varepsilon_t \qquad (4)$$

This is a general representation where y_t is a vector of endogenous variables, y_{t-1} is a vector of their lagged values, and ε_t is a white noise vector of the disturbance terms for each variable. A is a $n \times n$ square matrix and n is the number of variables that contains the structural parameters of the contemporaneus endogenous variables. $B(L)$ is a pth degree matrix polynomial in the lag operator L, where p is the number of lagged periods used in the model. C is a square matrix sized $n \times n$, contains the contemporaneous response of the variables to the disturbances or innovations.

McCoy (1997) mentioned that there is a problem with presentation in eq 1., because the coefficients in the matrices are unknown and variables have contemporaneous effects on each other. So it is not possible to determine the values of the parameters in the model. To fully identify model, it is possible to transform into a reduced-form model to derive the standart VAR representation in the following equation.

$$y_t = D(L)y_{t-1} + e_t \qquad (5)$$

In this form, $D(L)$ equals to $A^{-1}B(L)$ and e_t equals to $A^{-1}C\varepsilon_t$. The last term in equation is serially uncorrelated (Ioannidis: 1995: 256). The matrix Σ is the variance/covariance of the estimated residuals, e_t, of the standart VAR.

$$\Sigma = \begin{vmatrix} \sigma_1^2 & \sigma_{12} & \cdots & \cdots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^2 & \cdots & \cdots & \sigma_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \sigma_{n1} & \sigma_{n2} & \cdots & \cdots & \sigma_n^2 \end{vmatrix}$$

In this matrix Σ,there are $(n^2 - n)/2$ number of restrictions requried to identify to system. Traditional VAR methodology proposes the identification restrictions based upon on a recursive structure known as Cholesky decomposition (Ioannidis: 1995: 256). Cholesky decomposition seperates the residuals e_t into orthogonal shocks by restrictions imposed on the basis of arbitrary ordering of the variables and implies that first variable responds only to its own exogenous shocks, second responds to first variable ‘s and its own exogenous shocks. So the structure of matrix will be lower triangular, where all elements above the principial diagonal are zero (McCoy: 1997: 5).

After the identification of restrictions impulse response function (IRF) is employeed to reflect the dynamic effect of each exogenous variable response to the individual unitary impulse from other variables. The IRF can explain the current and lagged effect over time of shocks in the error term (Liu: 2008: 243).

The variance decomposition is another test in the VAR analysis. Variance decomposition gives information about dynamic structure of system. The main pupose of variance decomposition is to introduce effects of each random shock on prediction error variance for future periods (Ozgen and Guloglu: 2004: 9).

5. Empirical Results

A stationary time serie is significant to a regression analysis based on time series. A nonstationary time serie would lead to a spurious regression. For this reason series must be stationary to include into VAR analysis. To determine whether the series are stationary, the augmented Dickey-Fuller (1979) unit root tests are applied. Table below summarizes the results of ADF test for all the variables.

Table 3. ADF Unit Root Test of Results

	INT		**INFGAP**		**GAP**		**SDR**		**Critical Values**
	***I*(0)**	***I*(1)**	***I*(0)**	***I*(1)**	***I*(0)**	***I*(1)**	***I*(0)**	***I*(1)**	
1	-0.85	-4.64	-6.41	-6.30	-2.78	-6.64	-3.19	-8.81	0.01= -3.50 0.05= -2.89 0.10= -2.58
2	-1.71	-4.62	-5.86	-6.53	-2.76	-6.61	-3.22	-8.76	0.01= -4.06 0.05= -3.45 0.10= -3.15

[1] Intercept (c) term; [2] Trend (t) and intercept (c) term.

Note: MacKinnon (1996) critical values was used. All variables was made ADF test according to Schwarz information criterion.

Table 3 shows the unit root test results of variables by using the ADF unit root test. The null hypothesis of non-stationary was performed at the 1% significance levels. Results show that inflation gap variable is stationary at level. But interest rate, output gap rate and exchange rate variables have unit roots at level. These variables are found to be stationary only when tested at first difference. Output gap rate, interest rate and exchange rate variables are included into model with their first differences I(1), while inflation gap variable is included into model with its level I(0).

One of the important question in the VAR models is to select the optimal lag length. The most common and simple approach in selecting exact lag length is to re-estimate VAR model until the smallest Akaike Information criterion (AIC) value is found. Because comparing two or more models, the model with the lowest AIC is preffered (Gujarati: 2004: 537). According to Asteriou (2005) the judgement of the optimal length should still take other factors into account: For example autocorrelation, heteroskedasticity, possible ARCH effects and normality of residuals. In this study we choosed two lags based on Akaike information criterion and results can be seen in appendice A.

Another important question is the stability of the VAR model in order to get valid results from impulse response analysis. Stability would be achieved if the characteristic roots of the matrix coefficients have a modulus less than one. So we tested lag structure and stability of the number of lag length with autocorrelation test and had a look at unit root

graph. Graph showed that all roots are less than one and no roots are out of the unit circle. In autocorrelation test results imply that there is no autocorrelation. Autocorrelation test results and unit root graph are given in appendice B.

We practiced Johansen cointegration analysis to check long term relationship between variables. We found that there are four cointegrating relationship between variables according to Trace test and four cointegrating relationship according to maximum eigenvalue test. So the test rejected null hypothesis suggests there is no cointegrating relationship among variables at level 5%. This means VAR analysis fits best to analysis. Test results can be seen in table 4.

Impulse response function derived from the VAR analysis is useful to trace out response of one variable to a shock in the error term of another variable. It can explain current and lagged effect over time of shocks in the error term (Liu et. al: 2008: 243). For this reason impulse response function is one of the important element of the VAR analysis.

Table 4. Johansen Cointegration Analysis (Trace and Maximum Eigenvalue Tests)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.316544	91.53935	47.85613	0.0000
At most 1 *	0.263862	56.90539	29.79707	0.0000
At most 2 *	0.202742	29.02864	15.49471	0.0003
At most 3 *	0.088277	8.410161	3.841466	0.0037
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.316544	34.63396	27.58434	0.0002
At most 1	0.263862	27.87676	21.13162	0.0635
At most 2	0.202742	20.61848	14.26460	0.0737
At most 3 *	0.088277	8.410161	3.841466	0.0047
Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

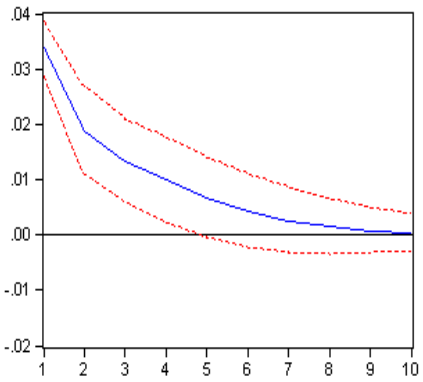
Graphic 1 presents the impulse response functions of the interest rate for a year. Within 95% confidence interval, INT has positive response to a shock to INFGAP, SDF and lagged INT significantly and negative response to a shock to OUTGAP significantly. This result can be interpreted as the CBRT would increase short term nominal interest rate if inflation rate goes beyond target level or exchange rate increases and would decrease it if actual output passes output target at the begining of the shock.

There are a number of point to deliberate. First of all short term nominal interest rate responses inflation gap positively in first three months, then effect turns negative and dies out in five months. Response of short term nominal interest rate to output gap rate is negative in first three months and then it turns to positive. It continues untill the end of the period examined. Response of short term nominal interest rate to exchange rate is positive and effective for more than six months. These mean that the CBRT reacts, if actual inflation passes inflation target and the bank increases short term nominal interest rate appropriately with the rule. Meanwhile a positive shock in output gap rate would affect interest rate negatively in first months and but it would turn to positive later. Behaviours of the CBRT differs from the rule at this point. This means short term nominal interest rate is more concerned with inflation targeting and less concerned with output gap rate. Positive response of the CBRT to SDR can be interpreted as fear of floating effect. Increasing exchange rate would cause an increase in actual inflation and it would affect inflation targeting regime.

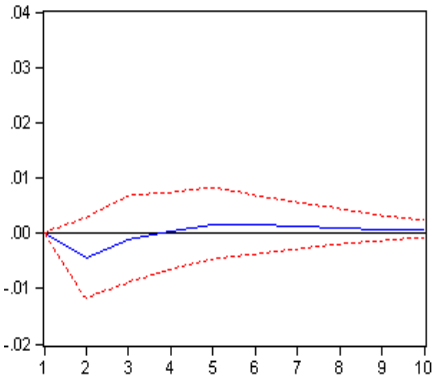
In order to extract effects of each variable on short term nominal interest rate, variance decomposition method was used. As can be seen in the table 6, lagged values of interbank interest rate are the most influental variable, it can explain more than 90% at the end of a year. Inflation gap can explain variation in interbank interest rate just a little portion of it and it is not more than1%. Output gap rate can explain up to 1,5% of variance. SDR's explanation capability is up to 6,5% also.

Graphic 3. Impulse – Response Table for INT

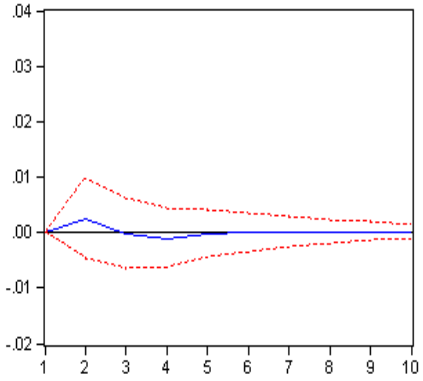
Response of INT to INT Shock



Response of INT to OUTGAP Shock



Response of INT to INFGAP Shock



Response of INT to REAL Shock

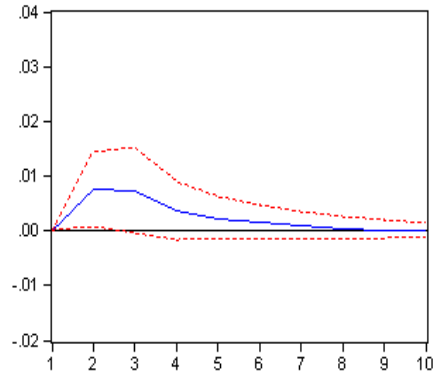


Table 5. Variance Decomposition of Overnight Interest Rate

Variance Decomposition of INT:					
Period	**S.E.**	**INT**	**INFGAP**	**OUTGAP**	**SDR**
1	0.033706	100.0000	0.000000	0.000000	0.000000
2	0.039655	94.75883	0.368679	1.306382	3.566105
3	0.042468	92.40971	0.324077	1.205777	6.060438
4	0.043763	92.12164	0.365936	1.141248	6.371174
5	0.044348	91.92989	0.360469	1.245306	6.464339
6	0.044611	91.78929	0.356403	1.339917	6.514390
7	0.044711	91.70531	0.354813	1.415512	6.524370
8	0.044749	91.65421	0.354358	1.469307	6.522120
9	0.044763	91.62724	0.354457	1.498666	6.519640
10	0.044767	91.61417	0.354668	1.512760	6.518402
11	0.044769	91.60843	0.354809	1.518800	6.517965
12	0.044770	91.60610	0.354883	1.521126	6.517895

6. Conclusion

In this study, we aim to extend Taylor rule and applied VAR methodology to examine the monetary policy reaction function of the CBRT. Results can be interpreted as follows. Short term nominal interest rate responses significantly to inflation gap, output gap rate and exchange rate. Response of short term nominal interest rate to exchange rate is positive and expected as in Taylor (2001), Ball (1999) and Svensson (2000) findings.

Response of short term interest rate to inflation gap is positive and but it continues for a little while. Direction of the response is as expected in original rule. Response of short term nominal interest rate to output gap rate is negative. It is in the opposite direction with the original rule. Although interest rate responses to shocks in these variables, variables could explain only a little portion of variance in interest rate. ıt is not more than 10% at the end of year.

According to impulse response analysis and variance decomposition process, monetary policy reaction function differs from Taylor's monetary policy reaction function and emphasizes on inflation gap. Output gap rate does not takes place in function as expected. This

also consistent with remarks and actions of the CBRT. Because the CBRT has announced its first goal as price stabilization after the beginning of stabilization program and made some regulations to provide bank's freedom and to prevent government's effects on price stabilization goal.

According to results captured from impulse response analysis and variance decomposition process, interbank interest rate responses shocks in inflation gap, exchange rate and output gap rate significantly. Also inflation gap, exchange rate and output gap rate can explain a little part of variance on interest rate. So we imply that Taylor type monetary policy reaction function might be a part of decision making process of the CBRT to adjust short term nominal interest rate. Also there might be some other instruments help inflation targeting. This implications support John B. Taylor's first advice about practicing systematic monetary policy that we have mentioned in introduction. Extending monetary policy reaction function might be research topic for further economic analysis.

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Appendices A

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	333.1390	NA	3.83e-09	-8.027781	-7.910380	-7.980646
1	442.9204	206.1749	3.90e-10*	-10.31513	-9.728128*	-10.07946*
2	458.9931	28.61724*	3.90e-10	**-10.31691***	-9.260297	-9.892694
3	465.8706	11.57422	4.91e-10	-10.09440	-8.568192	-9.481653
4	475.8950	15.89236	5.76e-10	-9.948658	-7.952842	-9.147369
5	481.8730	8.894063	7.51e-10	-9.704219	-7.238799	-8.714390
6	497.4992	21.72425	7.84e-10	-9.695102	-6.760078	-8.516735
7	509.7756	15.86949	9.00e-10	-9.604282	-6.199655	-8.237376
8	520.0157	12.23824	1.11e-09	-9.463798	-5.589567	-7.908354
9	526.1741	6.759173	1.53e-09	-9.223758	-4.879924	-7.479775
10	543.8882	17.71412	1.65e-09	-9.265566	-4.452128	-7.333044
11	558.3747	13.07316	1.99e-09	-9.228651	-3.945609	-7.107590
12	579.5279	17.02577	2.12e-09	-9.354339	-3.601693	-7.044740

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

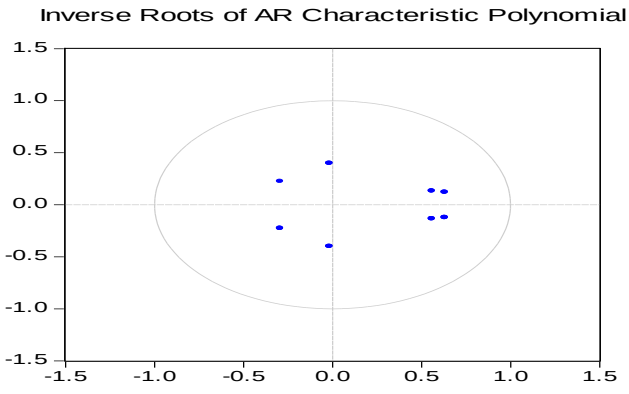
FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Appendices B



Autocorrelation Test

Lag 1		Lag 2		Lag 3		Lag 4	
LM-Stat	**Prob**	LM-Stat	**Prob**	LM-Stat	**Prob**	LM-Stat	**Prob**
30.774	0.0144	15.787	0.4679	13.738	0.6182	7.6273	0.9592
19.262	0.2553	18.035	0.3218	15.326	0.5009	13.460	0.6388
14.392	0.5695	14.010	0.5979	10.622	0.8321	8.1459	0.9444
16.013	0.4520	17.137	0.3768	16.747	0.4021	9.4075	0.8957
7.5218	0.9618	10.930	0.8138	12.490	0.7096	10.838	0.8193
17.035	0.3833	22.781	0.1197	21.757	0.1512	19.023	0.2675
12.928	0.6780	12.358	0.7190	15.865	0.4624	13.915	0.6050
4.5219	0.9977	4.4828	0.9978	2.8436	0.9999	4.7516	0.9969
19.170	0.2599	16.523	0.4171	8.1613	0.9439	11.242	0.7943
14.620	0.5526	9.5601	0.8886	11.910	0.7501	14.385	0.5700
11.330	0.7887	12.163	0.7326	10.108	0.8609	12.235	0.7276
39.083	0.0011	34.345	0.0049	34.029	0.0054	33.215	0.0069

*Autocorrelation test was made according to Lagrange Multiplier (LM).