Can Central Banks Lead Market Interest Rates? Evidence from Turkey

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Abstract

This study examines the validity of pass-through effect of interest rate and efficiency of monetary policy in Turkey by using monthly data belonging 01:2002 - 08:2015 period. The study benefits from the recent advance in the time and frequency domain causality tests and employs both conventional and bootstrap process based Toda Yamamoto, frequency domain and rolling windows causality methods. The econometric investigation provides strong evidence of long-run interest rate pass-through in Turkey.

Keywords: Interest rate pass-through, monetary transmission mechanism, causality, central banking

1. Introduction

The existence of interest rate pass-through or/and the speed of pass-through are among the most debated topics in the literature of economics. If it is, the policy makers would be able to affect real side of the economy by practicing monetary policy actions. Besides, the existence of pass-through is important to talk about efficiency of financial system in influencing real side of the economy. The interest rate as a monetary policy instrument, affect the real side of the economy in three different ways: substitution effect, income effect and wealth effect. Substitution effect implies that changes in interest rate tend to substitution between the monetary policy interest rate and the credit instruments like as cash, vehicle, housing and commercial credits (Petrevski and Bogoev, 2012: 127).

The aim of this study is to investigate the validity of pass-through effect via substitution effect in the context of monetary policy applied in inflation targeting regime. The validity of interest pass-through effect means that interest rate channel of monetary transmission mechanism works and this would imply that monetary policy actions of the Central Bank of Republic of Turkey (hereafter, CBRT) influence the real side of the Turkish economy. We analyze the post 2001 crisis period where inflation targeting regime implemented by the CBRT and interest rate is the main policy instrument of the bank. By investigating the validity interest rate pass-through, this study finds whether the interest rate decisions of the CBRT would also affect real side of the economy or not. In that respect, findings of the study present the effect of inflation targeting regime on the Turkish economy. Results of this study also would give insight about if the inflation targeting regime takes the real side of the economy into account although the CBRT declares that the single target of the regime is price stability. To our knowledge, although there is a number of studies analyzing various economies by employing time domain techniques, there is no study where investigate the interest rate pass-through effect by employing frequency domain technique. The time domain causality tests produce a single test statistic for the interaction amongst the variables in concern. The frequency domain methodology generates tests statistics at different frequencies across spectra and thereby it provides flexibility to examine the direction of causality between indicative policy interest rate and different interest rates in different time periods. We also employ conventional and bootstrap process based Toda Yamamoto causality

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test in order to compare results. By incorporating the recent developments in the causality analysis, this study contributes to the literature and provides new and fresh evidences that can be utilized in monetary policy decisions.

The rest of paper is organized as follows. Theoretical framework and literature review is outlined in Section 2. The econometric methodology is outlined in Section 3. Then the data and the empirical findings are discussed in Section 4. Finally some concluding remarks and policy implications are offered in Section 5.

2. Theoretical Background and Literature Review

In this section, we will examine both international empirical literature and empirical literature investigating the Turkish economy. To sum up, most of the studies investigating the validity of interest rate pass-through effect employ variables bill rates, deposit rates, retail lending rates as a policy interest rate and mortgage rates, cash rates, vehicle rates and commercial rates to measure the effects of interest rate changes. Besides, the empirical literature analyzing interest rate pass-through effect employs different econometric methodologies such as ordinary least squares (OLS), linear, panel and threshold cointegration (VEC, Panel VEC, TVEC), linear and nonlinear vector auto regression (VAR and TVAR) models.

Sander and Kleimer (2004) analyzes Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain in order to find whether pass through effect is valid in the period between 01:1993 and 10:2002 by employing threshold cointegration and structural breaks methods. Hovart et al. (2004) analyze the existence of the effect for the Hungarian economy between years 01:1997 and 08:2004 and employ ECM and TAR models. Jovanovski et al. (2005) employ linear cointegration method in order to test the Macedonian economy between years 2002-2004. In latter studies, Gambacorta (2008) and Chionis and Leon (2006) investigate the existence of the effect for Italy and Greece, respectively. While Gambacorta (2008) employs balanced panel technique for 73 commercial banks in Italy, Chionis and Leon (2006) use bivariate cointegration and ECM techniques in their study. Egert et al. (2006) applies multi-country analysis and take Czech Republic, Hungary, Poland, Slovakia and Slovenia into account. In recent studies, Becker et al. (2012) analyze the UK economy for the period between years 01:1995 and 08:2008 by employing threshold cointegration method. Finally Petrevski and Bogoev (2012) employ dynamic OLS and ARDL methods in order to find the validity of effect in Macedonia between year 2002 and 2010. The studies listed above all find positive clues about the existence of interest rate pass-through effect in the countries examined. Another important finding from the international literature is that in the short run banking rates are rigid and in the long run the pass-through effect is more effective than short run.

There is a number of studies investigating the Turkish economy. One of them belongs to Inal (2006). Inal (2006) analyzes the effects of policy interest rate on government borrowing interest rate between years 07:2001 and 03:2006. Aydin (2007) analyzes the effect of policy interest rate on commercial banking credit instruments between years 06:2001 and 10:2005 and employs panel vector error correction model. Ozdemir (2009) analyzes the Turkish economy by employing threshold vector error correction model (TVEC) in order to find the validity of effect in 04:2001-07:2007 period. Cavusoglu (2010) tests the Turkish economy for the 01:2002-12:2009 period by using VAR and VEC methods. Finally Yildirim (2012) investigate the interaction between monetary policy interest rate and credit and deposit rate between years 11:2002 and 10:2011 by using TAR and momentum TAR models. All the studies summarized above implies long run effect in the Turkish economy. Another important finding obtained from the studies is that speed of interest rate pass-through is very high in the economy.

A theoretically possible alternative would be to apply the Toda and Yamamoto (1995), Hacker and Hatemi-J (2005, 2006) bootstrap process-based Toda-Yamamoto (1995) linear Granger causality and frequency domain causality to understand the possible relation between policy rate and different interest rates. By doing so, it would be possible to examine the relation in different perspectives. This paper has to build vector auto regressive (VAR) models. The pass-through process has been investigated via VAR process which the generated for relationship between policy rate (i_{IR}) and cash rate (i_{CA}) and VAR(p) can be written as follows (Sander and Kleimeier, 2004:464);

$$i_{IR} = \sum_{i=1}^{p} \alpha_{1i} i_{IR_{ti}} + \sum_{i=1}^{p} \beta_{1i} i_{CA_{ti}} + \varepsilon_{1t} \tag{1}$$

$$i_{CA} = \sum_{i=1}^{p} \alpha_{2i} i_{CA_{ti}} + \sum_{i=1}^{p} \beta_{2i} i_{IR_{ti}} + \varepsilon_{2t} \tag{2}$$

3. Methodology

3.1. Toda-Yamamoto (1995) Linear Granger Type Causality Test

Toda-Yamamoto (1995) applies VAR model due to number of the delay and also take into account the degree of integration of the series with $\chi 2$ distribution of the Wald test. Toda-Yamamoto causality analysis of the values β of the variables so that the level of the series by creating a standard VAR model eliminates the problems of determining the rank of cointegration (Zapata and Rambaldi, 1997:289-292, Duasa, 2007:85-87). The relationship between policy rate (i_{IR}) and cash rate (i_{CA}) VAR(p) process can be expressed as ;

$$i_{IR} = \sum_{i=1}^{p+d_{\max}} \alpha_{1i} i_{IR_{ti}} + \sum_{i=1}^{p+d_{\max}} \beta_{1i} i_{CA_{ti}} + \varepsilon_{1t} \tag{3}$$

$$i_{CA} = \sum_{i=1}^{p+d_{\max}} \alpha_{2i} i_{CA_{ti}} + \sum_{i=1}^{p+d_{\max}} \beta_{2i} i_{IR_{ti}} + \varepsilon_{2t} \tag{4}$$

where $d_{\max}$ is the maximum degree of integration of the variables in the model, p is the optimal lag length obtained from the VAR model and ε_t is the term refers to the error correction based on the assumption of white noise. The null hypothesis is tested as $\beta_{1i} = 0$ for i≤k in equation 3. If the alternative hypothesis is accepted, it means that causal relationship running from cash rate (i_{IR}) to policy rate (i_{CA}). The null hypothesis is tested as $\beta_{2i} = 0$ and i≤k in equation 4 again and if the alternative hypothesis accepted, it means that there is a causality between variables running from policy rate (i_{CA}) to cash rate (i_{IR}).

3.2. Hacker and Hatemi-J (2005, 2006) Bootstrap Process-Based Toda-Yamamoto (1995) Linear Granger Causality

Toda-Yamamoto (1995) causality test, applying a number of sampling is less, and if you have autoregressive conditional heteroscedasticity (ARCH) effect in error terms, based on the results of causality is wrong to make comments. Therefore, Hacker and Hatemi-J (2006) and also Hatemi-J (2005) developed a new methodology by using Efron (1979) bootstrap process based on the causality test. The vector autoregressive model of order p VAR(p) can be expressed as where y_t is the number of variables in the VAR model, v is an vector of intercepts and A_r is matrix of parameters for lag r (r=1,…,p) ;

$$y_t = v + A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + \varepsilon_t \tag{5}$$

If the variables are cointegration equation 3 and 4 in the VAR ($p + d_{\max}$) model with a simple expression;

$$y_t = v + A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + A_{p+d_{\max}} y_{t-p-d_{\max}} + \varepsilon_t \tag{6}$$

(Hatemi-J and Roca, 2007:830, Hacker and Hatemi-J, 2006:1490).[4] The estimated VAR(p+d_{max}) model in Equation 6 can be written compactly as: $Y = (y_1,..., y_T)$,

$$\hat{D} = (\hat{v}, \hat{A}_1,..., \hat{A}_p,..., \hat{A}_{p+d_{\max}}), \hat{\delta} = (\hat{\varepsilon}_1,..., \hat{\varepsilon}_T) \text{ and } Z_t = \begin{bmatrix} 1 \\ y_t \\ y_{t-1} \\ \vdots \\ y_{t-p-d+1} \end{bmatrix};$$

can be written as,

$$Y = \hat{D}Z + \hat{\delta} \tag{7}$$

Null hypothesis that the there is no Granger causality (causality non Granger) Todo-Yamamoto (1995) developed by the modified Wald test (Modified WALD);

$$MWALD = (C\hat{\beta})'[C((Z'Z)^{-1} \otimes S_U)C']^{-1}(C\hat{\beta}) \sim \chi_p^2 \tag{8}$$

where $\otimes$ is the Kronecker product, and C is a $pxn(1+(p+d_{\max}))$ selector matrix, S_U is variance-covariance matrix of residuals and $\hat{\beta} = vec(D)$ is vec signifies the column-stacking operator. The error terms are normally and the MWALD test statistic is asymptotically χ^2 distributed (Hatemi-J and Roca, 2007:831, Hacker and Hatemi-J, 2006:1491, Hatemi-J and Morgan, 2009:441). Hatemi-J (2005) Monte Carlo experiments testing the error terms in the normal zero smudge MWALD (nonnormality) and ARCH effect is rejected because of the null hypothesis leads to excessive. This is why Hatemi-J (2005), Efron (1979) developed by the leveraged bootstrap developed simulations. We generate the distribution for the MWALD test statistics by running the bootstrap simulation 10.000 times and calculating the MWALD test statistics for each run. We then find bootstrap critical values pertaining to 1%, 5% and

4 For choice of optimal lag order Hatemi-J (2003) are developed new information criteria. For the details of Hatemi-J criterion can be read the study of Hacker and Hatemi-J (2006).

10% significance levels. Afterwards, we calculate the MWALD statistics using original data. We reject the null hypothesis of no causality in the Granger sense at the α level of significance, if the actual MWALD is greater than. The Monte Carlo simulations are conducted using programme procedure written by Hacker and Hatemi-J (2005, 2006)

3.3. Frequency domain causality test

While conventional time domain causality tests produce a single test statistic for the interaction between variables in concern, frequency domain methodology generates tests statistics at different frequencies across spectra. Frequency domain approach to causality thereby permits to investigate causality dynamics at different frequencies rather than relying on a single statistics as is the case with the conventional time domain analysis (Ciner, 2011). Hence, it seems to be very meaningful to carry out frequency domain causality to better understand temporary and permanent linkages between policy rate and credit rates. To test for causality based on frequency domain, Geweke (1982) and Hosoya (1991) defined two-dimensional vector of time series $z_t = [x_t, y_t]'$ and z_t has a finite-order VAR;

$$\Theta(L)z_t = \varepsilon_t \tag{9}$$

where $\Theta(L) = I - \Theta_1 L - ... - \Theta_p L_p$ and lag polynomial with $L^k z_t = z_{t-1}$. Then Granger causality at different frequencies is defined as;

$$M_{y\to x} = \log\left[\frac{2\pi f_x(\omega)}{\left|\psi_{11}(e^{-i\omega})\right|^2}\right] = \left[1 + \frac{\left|\psi_{12}(e^{-i\omega})\right|^2}{\left|\psi_{11}(e^{-i\omega})\right|^2}\right] \tag{10}$$

if $\left|\psi_{12}(e^{-i\omega})\right|^2 = 0$ that y does not cause x at frequency ω. If components of z_t are I(1) and co-integrated, then the autoregressive polynomial $\Theta(L)$ has a unit root. The remaining roots are outside the unit circle. Extracting z_{t-1} from both sides of equation 9 gives;

$$\Delta z_t = (\Theta_1 - I)z_{t-1} + \Theta_1 z_{t-2} + ... + \Theta_p z_{t-p} + \varepsilon_t = \hat{\Theta}(L)z_{t-1} + \varepsilon_t \tag{11}$$

where $\hat{\Theta}(L) = \Theta_1 - I + \Theta_2 L + ... + \Theta_p L^p$ (Breitung and Candelon, 2006). Geweke (1982) and Hosoya (1991) propose causality measure at a particular frequency based on a decomposition of the spectral density. Breitung and Candelon (2006) who has using a bivariate vector autoregressive model propose a simple test procedure that is based on a set of linear hypothesis on the autoregressive parameters. So that test procedure can be generalized to allow for cointegration relationships and higher-dimensional systems. Breitung and Candelon (2006) assume that ε_t is white noise with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t, \varepsilon_t') = \Sigma$, where Σ is positive definite. Let G be the lower triangular matrix of the Cholesky decomposition $G'G = \Sigma^{-1}$ such that $E(\eta_t \eta_t') = I$ and $\eta_t = G\varepsilon_t$. If the system is stationary, let $\phi(L) = \Theta(L)^{-1}$ and $\psi(L) = \phi(L)G^{-1}$ the MA representation;

$$z_t = \phi(L)\varepsilon_t = \begin{pmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{pmatrix}\begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} = \begin{pmatrix} \psi_{11}(L) & \psi_{12}(L) \\ \psi_{21}(L) & \psi_{22}(L) \end{pmatrix}\begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} \tag{12}$$

Let we can use this representation for the spectral density of x_t;

$$f_x(\omega)=\frac{1}{2\pi}\{|\psi_{11}(e^{-i\omega})|^2+|\psi_{12}(e^{-i\omega})|^2\} \tag{13}$$

Breitung and Candelon (2006) investigate the causal effect of $M_{y\to x}(\omega)=0$ if $|\psi_{12}(e^{-i\omega})|^2=0$. The null hypothesis is equivalent to a linear restriction on the VAR coefficients. $\psi(L)=\Theta(L)^{-1}G^{-1}$ and $\psi_{12}(L)=-\dfrac{g^{22}\Theta_{12}(L)}{|\Theta(L)|}$, with g^{22} as the lower diagonal element of G^{-1} and $|\Theta(L)|$ as the determinant of $\Theta(L)$, it follows y does not cause at frequency ω if

$$|\Theta_{12}(e^{-i\omega})|=\left|\sum_{k=1}^{p}\theta_{12,k}\cos(k\omega)-\sum_{k=1}^{p}\theta_{12,k}\sin(k\omega)i\right|=0 \tag{14}$$

with $\theta_{12,k}$ denoting the (1,2)-element of Θ_k. Thus for $|\Theta_{12}(e^{-i\omega})|=0$,

$$\sum_{k=1}^{p}\theta_{12,k}\cos(k\omega)=0 \quad \text{and} \quad \sum_{k=1}^{p}\theta_{12,k}\sin(k\omega)=0 \tag{15. 16.}$$

Breitung and Condelon's (2006) applied to linear restrictions (14) and (15) for $\alpha_j=\theta_{11,j}$ and $\beta_j=\theta_{12,j}$. Then the VAR equation for x_t can be implied as

$$x_t=\alpha_1 x_{t-1}+...+\alpha_p x_{t-p}+\beta_1 y_{t-1}+...+\beta_p y_{t-p}+\varepsilon_{1t} \tag{17}$$

and the null hypothesis $M_{y\to x}(\omega)=0$ is equivalent to the linear restriction with

$$\beta=[\beta_1,...,\beta_p]'$$

$$H_0:\quad R(\omega)\beta=0 \text{ and } R(\omega)=\begin{bmatrix}\cos(\omega) & \cos(2\omega) & ... & \cos(\mathrm{p}\omega)\\ \sin(\omega) & \sin(2\omega) & ... & \sin(\mathrm{p}\omega)\end{bmatrix} \tag{18.19.}$$

The causality measure for $\omega\in(0,\pi)$ can be tested with the conventional F-test for the linear restrictions imposed by Eq.(15) and Eq. (16). The test procedure follows an F- distribution with (2, T-2p) degrees of freedom.

3.4. Balcılar vd. (2010) Bootstrap Rolling Window Causality Test

Balcılar vd. (2010) in their analysis runned a LR (likelihood ratio) causality test using bootstrap method depending on error term. LR Granger causality test depending on bootsrap has two variables VAR (p) in the model, t=1,2,…,T;

$$y_t=\Phi_0+\Phi_1 y_{t-1}+...+\Phi_p y_{t-p}+\varepsilon_t \tag{20}$$

In the equity above, $\varepsilon_t = (\varepsilon_1, \varepsilon_2) \square\, iid(0, \sigma^2)$ is a covariance matrix ∑ that is not odd. Optimal lag criteria is defined by akaike information criteria (AIC). While $y_t = [y_{1t}, y_{2t}]_{2x1}$ considered as matrix, VAR (p) model will be shown as;

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} \phi_{10} \\ \phi_{20} \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{bmatrix} \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{21}$$

When $\phi_{ij}(L) = \sum_{k=1}^{p} \phi_{ij,k} L^k$, i,j=1,2 k lag operator, $L^k x_t = x_{t-k}$. Null hypothesis of the test is; where $\phi_{12,i} = 0$, y_{2t} is not Granger cause of y_{1t}, or oppositely, where $\phi_{21,i} = 0$, y_{1t} is not Granger cause of y_{2t}. In order to avoid possible structural unit roots and to get over the problems that are related to the size of the sample, Balcılar vd. (2010) uses the bootstrap test that is modified by Koutris vd. (2008) and Shukur ve Mantalos (2000) Rolling Window Granger Causality test. Due to the hypothesis;

$Y := (y_1, y_2, ..., y_T)$ matrix Type: 2xT

$B := (\Phi_0, \Phi_1, ..., \Phi_T)$ matrix Type: (2x(2p+1))

$Z_T := (1, y_t, y_{t-1}, ..., y_{t-p+1})$ matrix Type: ((2p+1)x1)

$Z := (Z_0, Z_1, ..., Z_{T-1})$ matrix Type: ((2p+1)xT)

$\eta := (\varepsilon_1, \varepsilon_2, ..., \varepsilon_T)$ matrix Type: (2xT)

Considered to be matrixes and Φ_0 constant term, when t=1,2,…,T; VAR(p) model $Y = BZ + \eta$ and the least square is shown as: $\hat{B} = YZ'(Z'Z)^{-1}$. From that equation, unrestricted model error term η_U and restricted model error term η_R used, then $S_U = \eta_U' \eta_U$ and $S_R = \eta_R' \eta_R$ derived. Test statistics is defined as below in the equation:

$$LR = (T-k)\ln\left(\frac{\det S_R}{\det S_U}\right) \tag{22}$$

T sample size, k=2x(2p+1)+p error correction term, p VAR model lag length, distributes as χ^2. After the calculation of the test statistics, under the assumption i=1,2,…,T Ordinary Least Squares (OLS) and error terms $(\eta_R - \bar{\eta}_R)$ used and $Y^* = BZ^* + \eta^*$ regression obtained. Null Hypothesis suggests N_b times LR* (Likelihood Ratio) is calculated (LR*≥LR). Finally, the size of the rolling window is considered as; $t = \tau - l + 1, \tau - l, \ldots, l$, $\tau = l, l+1, \ldots, T$ and it is implemented to also rolling sub samples addition to the all sample.

4. Data and Empirical Findings

In this study, we use the data belonging the period 2002:01-2015:09 where the CBRT implements inflation targeting regime. We employ monetary market interest rate (i_{IR}), cash rate (i_{CA}), vehicle credit rate (i_V), housing rate (i_H) and commercial credit rate (i_{CO}) variables[5]. The data belonging monetary market indicative interest rate is obtained from International Financial Statistics data base and the data for other variables are obtained from the Central Bank of Republic of Turkey's electronic data delivery system. All the data are de-seasonalized by employing moving average method. Prior to the identification of possible causality and vector auto regression (VAR) model between the interest rates, it is necessary to determine integration degree of variables. In that respect, we employ a battery of the unit root tests developed by Dickey and Fuller (1979,1981) (henceforth ADF), Phillips and Perron (1988) (henceforth PP).

Table 1: Results for Unit Root Test

		Variables	ADF	PP		*Variables*	ADF	PP
Level	*Intercept*	i_{IR}	-2.022 (1) [0.277]	-1.987 (5) [0.292]	*First Differences*	i_{IR}	-10.333 (0) [0.00]***	-10.409 (4) [0.00] ***
		i_{CA}	-2.748 (1) [0.68]	-2.809 (6) [0.059]*		i_{CA}	--9.092 (0) [0.00] ***	-9.037 (2) [0.00] ***
		i_V	-3.001 (2) [0.036]**	-2.952 (4) [0.041]**		i_V	-9.180 (1) [0.00] ***	-9.503 (1) [0.00] ***
		i_H	-2.725 (2) [0.072]*	-2.300 (5) [0.173]		i_H	-8.356 (1) [0.00] ***	-8.005 (2) [0.00] ***
		i_{CO}	-2.552 (1) [0.105]	-2.513 (6) [0.114]		i_{CO}	-8.405 (0) [0.00] ***	-8.430 (3) [0.00] ***
	Intercept+ Trend	i_{IR}	-2.104 (1) [0.538]	-2.113 (5) [0.533]		i_{IR}	-10.382 (0) [0.00] ***	-10.417 (3) [0.00] ***
		i_{CA}	-2.333 (1) [0.413]	-2.260 (5) [0.452]		i_{CA}	-9.335 (0) [0.00] ***	-9.378 (1) [0.00] ***
		i_V	-2.228 (2)	-2.309 (4)		i_V	-9.526 (1)	-9.705 (1)

[5] Cash, vehicle, housing and commercial credit interest rates are average interest rates which offer by banks. Data is delivered weekly basis by the CBRT. Arithmetical averages are used in the analysis.

	[0.470]	[0.426]		[0.00] ***	[0.00] ***
i_H	-2.555 (1)	-1.857 (5)	i_H	-8.655 (1)	-8.409 (1)
	[0.301]	[0.671]		[0.00] ***	[0.00] ***
i_{CO}	-1.610 (1)	-1.517 (6)	i_{CO}	-8.704 (0)	-8.657 (2)
	[0785]	[0.819]		[0.00] ***	[0.00] ***

Notes: The figures which is ***, **, * shows the level where series are stationary at 1 %, 5 % and 10 % levels, respectively For the ADF test: The results of Dickey Fuller test in the case of zero lag length and lag length chosen due to SIC criteria. For the ADF test, the Mac Kinnon(1996) critical values for with constant -.3.485, -2.885 at the 1 %, and 5 % levels. The critical values for with constant and trend -4.035, -3.447 at the 1 % and 5 % levels, respectively. For the PP test: Values in the parenthesis show bandwidths obtained according to Newey-West using Bartlett Kernel criteria. For the PP test Mac Kinnon (1996) critical values for with constant -3.483, -2.884 at the 1 % and 5 % levels. The critical values for with constant and trend -4.033, -3.446 at the 1 % and 5 % levels, respectively.

Unit root tests results are presented in the table 1. According to PP and ADF test results, in the model where constant term included do not have unit root in level. Moreover the variables can indicate long memory and so the first difference of series has to be used in order to obtain more robust results.

Table 2: Linear Granger Causality MWALD Test Result

H_0	MWALD (Asymptotic p-value)	Bootstrap Critical Value		
		1%	5%	10%
$i_{IR} \not\Rightarrow i_{CA}$	8.573 (0.072)*	15.528	10.335	8.331*
$i_{IR} \not\Rightarrow i_V$	9.148 (0.057)*	17.111	10.716	8.351*
$i_{IR} \not\Rightarrow i_H$	10.172 (0.037)**	14.919	10.049**	8.089*
$i_{IR} \not\Rightarrow i_{CO}$	4.773 (0.311)	13.410	9.691	8.003
$i_{CA} \not\Rightarrow i_{IR}$	13.679 [0.008]***	15.578	10.542**	8.306*
$i_V \not\Rightarrow i_{IR}$	7.356 (0.118)	16.311	10.559	8.247
$i_H \not\Rightarrow i_{IR}$	10.356 [0.038]**	14.599	10.055**	8.198*
$i_{CO} \not\Rightarrow i_{IR}$	5.504 [0.239]	14.138	9.834	8.060

Notes: The notation $i_{IR} \neq> i_C$ implies that indicative interest rate does not Granger cause cash rate. ***, **, and * denote statistical significance at the 1, 5, and 10% level of significance, respectively. The SIC was used to determine the optimal lag lengths for VAR(p+d) models. Bootstrap critical values are obtained from 10,000 replications.

The results obtained from both conventional and bootstrap process based Toda Yamamoto causality analyses reveal that the policy rate has a significant effect on other rates except commercial credit rate. Also there is a bi-directional causal relationship between policy rate, cash and housing interest rates. On the other hand, results imply that there is no causality running from vehicle and commercial credit rates to policy rate. The time domain causality analyses imply that a change in policy interest rate affects credit interest rates and so it would induce aggregate demand shocks and supply would change. According to these results, by the beginning of inflation targeting regime which provides accountability and transparency of monetary policies, interest rate channel of monetary transmission mechanism works well and this result indicates that monetary policy application of the CBRT influences the real side of the economy. Moreover, existence of causality running from vehicle and commercial credit interest rates to policy interest rate shows that the CBRT has been affected by these types of credit interest rates while the bank determines policy interest rate.

Table 3: Results for frequency domain causality test

	Long Term		Medium Term		Short Term	
ω_i	0.01	0.05	1.00	1.50	2.0	2.50
$i_{IR} \neq> i_{CA}$	1.351	1.333	2.179	0.951	0.684	3.412*
$i_{IR} \neq> i_V$	1.986	1.955	0.346	0.997	2.717	4.171*
$i_{IR} \neq> i_H$	1.339	1.310	3.663*	3.850*	0.855	3.010
$i_{IR} \neq> i_{CO}$	0.551	0.525	4.987*	4.663*	0.453	0.317
$i_{CA} \neq> i_{IR}$	7.116*	7.105*	0.131	6.186*	0.312	1.594
$i_V \neq> i_{IR}$	5.380*	5.396*	0.013	2.739	0.218	2.952
$i_H \neq> i_{IR}$	5.623*	5.639*	0.273	3.847*	0.073	3.744*
$i_{CO} \neq> i_{IR}$	5.180*	5.125*	2.186	3.998*	0.877	3.597*

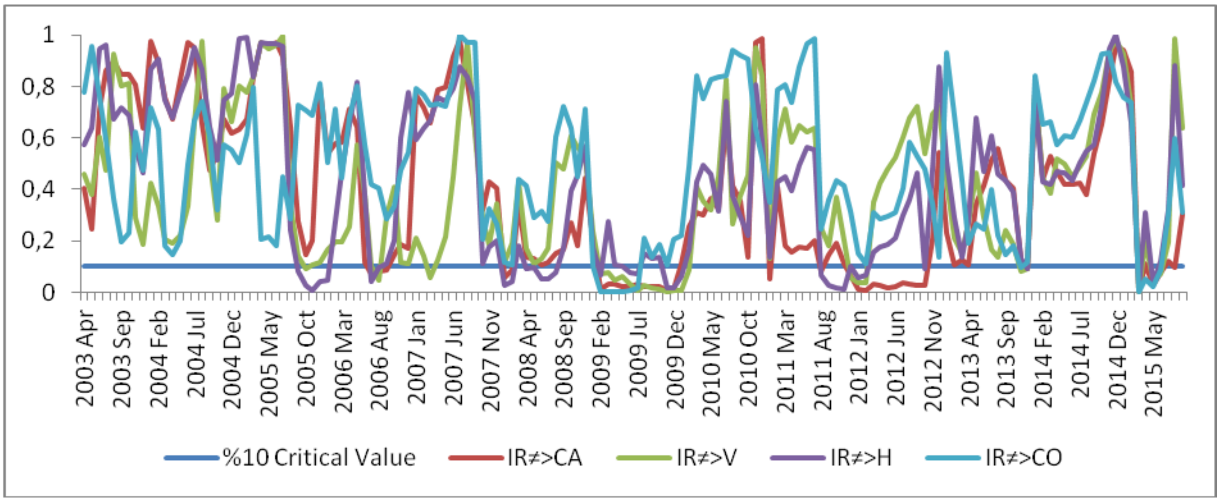
Notes: The lag lengths for the VAR models are determined by SIC. F- distribution with (2, T-2p) degrees of freedom equals 3.054.

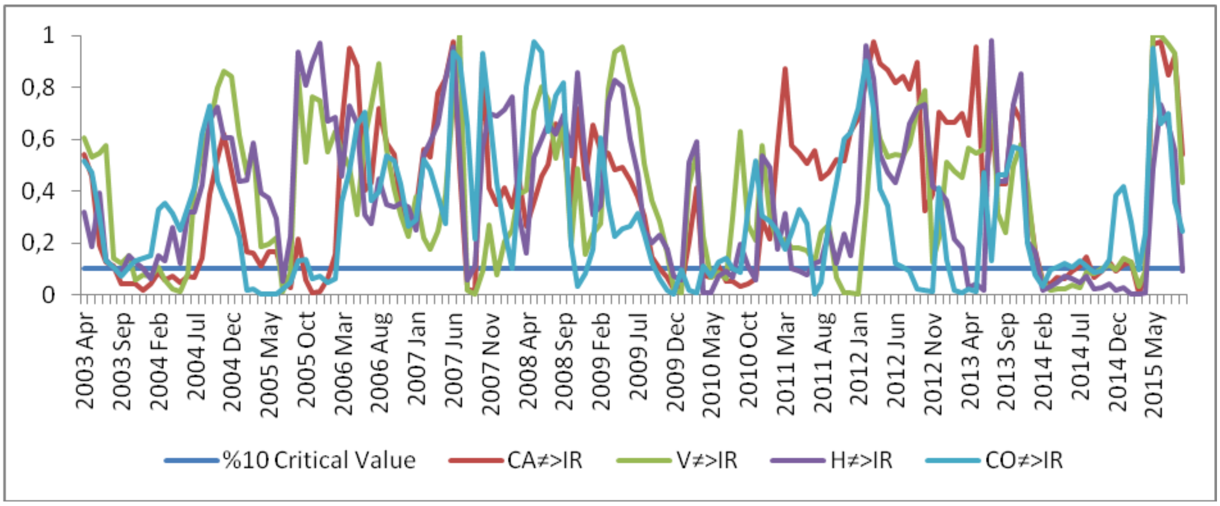
In the second step, we employ Breitung and Candelon's (2006) analysis which permits to decompose the causality test statistic into different frequencies. To calculate the test statistics at a high frequency of ω_i =2.5 and ω_i =2.0 to examine short term causality, ω_i =1.00 and ω_i =1.50 to examine medium term causality and finally ω_i = 0.1 and ω_i = 0.5 to investigate long term causality. By doing so, this paper is able to learn both temporary and permanent relations between variables. According to results, there is no causality running from policy rate to other types of interest rates in the short run while long run analysis results indicate there is a pass through effect in the economy in the long run.

There is only weak causality from policy rate to cash and vehicle interest rate in the short run. It means that the CBRT has a weak effect on the real side of the economy in the short run. These results can be interpreted that the commercial banks use foreign funds to supply housing, commercial, cash and vehicle credits and the firms are dependent to commercial credit supplied by the commercial banks in their business life. According to Aydin (2007:8-10), there is an imperfect pass-through effect between monetary policy interest rate and commercial credit interest rate. This situation is valid in the case of all interest rate types except housing credit interest rate. Petrevski and Bogoev (2012:2) and Aydin (2007:8-10) attribute the imperfection to absence of fund source, shallow financial markets, pass-through costs and dependence of firms to commercial banks. The policy interest rate moves down by the beginning of the inflation targeting regime in Turkey and this induces slow responses of the commercial bank in the context of profit maximization. Because of this reason there is no causality in the shorter periods.

The existence of strong causality in the long run means that there is an asymmetric relationship between variables in the short run. The structure of housing sector is more competitive compare to other sectors. Because of it, there is a bi-directional causality between monetary policy interest rate and housing and commercial credit interest rate in the medium run. There is an interaction between commercial interest rate and monetary policy interest rate in the short and medium run. According to Cavusoglu (2010:100), commercial credits have relatively weak collateral and the price elasticity of commercial credit demand is low. These two points explains the existence of causality in the short run.

Graphic 1: Results for Balcılar et. al. (2010) rolling window regression causality test





Rolling windows causality analysis developed by Balcılar et. al. (2010) allows to find periods which causality appears. The null hypotheses ask for absence of causality. If the significance level is higher than 10 %, null hypothesis is accepted. The detailed information about the exact dates which causality appears is given in the Appendix A. It is possible to say that causality running from policy interest rate to alternative interest rates concentrate on 2009 and 2012.

After decrease in consumption expenditures of household and investment expenditures of private sector, the central bank has begun to reduce policy rate by the last quarter of 2008. Decrease in liquidity concerns was a result of the bank's reduction in its policy rate. Another result is about the speed of decrease of expected real inflation rate and nominal interest rate is faster than speed of decrease of inflation expectations. In developed countries, expectations about short term interest rate would be low for a long time period have steered investors to developing country markets. The national currencies were appreciated due to abundancy of liquidity in developing countries and it induces policy rate reductions. While the conjuncture powers the efficiency of policy rates, the central banks have employed other policy instruments to canalize the economy. Because of these reasons, interest rate pass through effect has accelerated.

5. Concluding Remarks

A working interest rate channel in the monetary transmission mechanism gives opportunity to monetary policymakers to influence real side of the economy. In that respect, this paper investigates the validity of interest rate pass-through effect in order to find if the monetary policy interest rate has effect on the real side of the Turkish economy. According to Dickey and Fuller (1978 and 1981), Phillips and Perron (1988), Elliot et al. (1996), and Kwaitkowski et al. (1992) unit root tests, variables have unit roots in their level. Because of the unit root, first differences of the series are took into account in the analysis. In order to determine the causal linkages the variables, both time and frequency domain causality techniques are used. First, we employ Toda-Yamamoto (1995) and Hacker and Hatemi-J (2005) bootstrap process Toda-Yamamoto (1995) linear Granger causality test. Then, Breitung and Candelon's (2006) analysis which permits to decompose the causality test statistic into different frequencies is employed. According to Toda-Yamamoto (1995) and Hacker and Hatemi-J (2005) linear Toda Yamamoto causality tests, there is a causality running from policy rate to the other credit rates. The results of frequency domain causality test show that the banks adapt their credit interest rates late because of profit maximization aim, there is no causality in the short and medium run. Empirical analyses imply three key findings: (i) The interest rate pass-through effect is complete in the long run, but not in the short run. This results support the conclusion of Özdemir (2009) and Çavuşoğlu (2010) suggesting that there might be different causalities on different time periods. The policy interest rate moves down by the beginning of the inflation targeting regime in Turkey and this induces slow responses of the commercial bank in the context of profit maximization. So there is no causality in the shorter periods. (ii) In the case of Turkey, not only bootstrap causality analysis but also frequency domain causality implies bi-directional relationship between policy rate and commercial, vehicle and housing credit rates. (iii) The results indicating the presence of weak interest rate pass-through effect in the short and medium term also implies that interest rate behaves asymmetrically (changes regime continuously).

Results obtained from this study imply that efficiency of monetary policies is weak in the short run on the real side of the economy and that is why it is inefficient to implement interest rate policy to stimulate economy in a short time period. On the other hand, the announcement about the implication of interest rate policy in order to reduce inflation rate show that the bank is on the right way and the policymakers do not put real side of the economy into account in their policy action decisions at least in the short run. Another important policy implication obtained from the study is about the change in efficiency of policy actions after global crisis in 2008. The rolling windows causality analysis results show that policy rate is more effective on each type of credit rates after the crisis. It is possible to say that the crisis occurred in 2008 has increased the efficiency of monetary policy on the real side of the Turkish economy.

References

- Aydın, H.İ. (2007). Interest Rate Pass-Through in Turkey. Türkiye Cumhuriyeti Merkez Bankası Çalışma Tebliği, No:07/05
- Balcılar, M., Z. A. Özdemir, & Y. Arslantürk (2010). Economic growth and energy consumption causal nexusa viewed through a bootstrap rolling window. Energy Economics, 32, 1398-1410.
- Becker, R. Denise, O.& Yıldırım, D. (2012). A Threshold Coinetgration Analysis of Interest Rate Pass-Through to UK Mortgage Rates. Economic Modelling, 29, 2504-2513
- Breitung, J. & Candelon, B. (2006). Testing For Short And Long-Run Causality: A Frequency Domain Approach. Journal of Econometrics, 12, 363−378.
- Chionis, D. & Leon C. (2006). Interest Rate Transmission in Greece: Did EMU Cause Structural Break?. Journal of Policy Modelling, 28, 453-466
- Ciner, Ç. (2011). Eurocurrency interest Rate Linkages: A Frequency Domain Analysis. International Review of Economics and Finance, 20, 498-505.
- Çavuşoğlu, F. (2010). Para Politikası Faiz Oranlarından Mevduat ve Kredi Faiz Oranlarına Geçişkenlik: Türkiye Örneği. Türkiye Cumhuriyeti Merkez bankası Uzmanlık Yeterlilik Tezi
- Dickey, D. & Fuller, W. (1979). Distribution Of The Estimators For Autoregressive Time Series With A Unit Root. Journal of The American Statistical Association, 74, 427- 431.
- Dickey, D. & Fuller, W. (1981). Likelihood Ratio Statistics For Autoregressive Time Series With A Unit Root. Econometrica, 49, 1057-72.
- Duasa, J. (2007). Malaysian Foreign Direct Investment and Growth: Does Stability Matter. Journal of Economic Corperation, 28(2), 83-98
- Efron, B. (1979). Bootstrap Methods: Another Look At The Jackknife. Annuals of Statistics, 7, 1-26.

- Egert, B. Crespo-Cuaresma, J. & Thomas. R. (2007). Interest Rate Pass-Through in Centraland Eastren Europe: Reborn from Ashes Merely to Pass Away?. Journal of Policy Modeling, 29, 209-225
- Gambacorta, L. (2008). How do banks set interest rate?. European Economic Review, 52, 792-819
- Geweke, J. (1982). Measurement of linear dependence and feedback between multiple time series. Journal of The American Statistical Association, 77, 304-313.
- Hacker, S. & Hatemi-J, A. 2005. A test for multivariate ARCH effects. Applied Economics Letters, 12 (7), 411-417.
- Hacker, S. & Hatemi-J, A. 2006. Tests for Causality Between Integrated Variables Based on Asymptotic and Bootstrap Distributions: Theory and Application. Applied Economics, 38(13), 1489-1500
- Hatemi-J, A. (2003). A new method to choose the optimal lag order in stable and unstable VAR models. Applied Economics Letters, 10 (3), 135-137.
- Hatemi-J, A. (2005). Bootstrap-corrected tests for causality: theory and applications in finance. Invited Key-speaker Presentation at II Simposio Nacional De Docentes En Finanzas, July 1315, Bogota.
- Hatemi-J, A. & Morgan, B. (2009). An Emprical Analysis of the Informational Efficiency of Australian Equity Markets. Journal of Economic Studies, 26(5), 437-445
- Hatemi-J, A. & Roca, E. 2007. Equity Market price Interdependence Based on Bootstrap Causality Tests: Evidence from Australia and its major trading Partners. Applied Financial Economics, 17(10), 827-835
- Hosoya, Y. (1991). The Decomposition And Measurement Of The Interdependence Between Second-Order Stationary Process. Probability Theory and Related Fields, 88, 429-444.
- Hovart, C., Kreko J. & Naszodi A. (2004). Interest Rate Pass-Through: The Case of Hungarian. MNB Working Paper No: 8
- İnal, D. (2006). Türkiye'de para Politikası Faiz Kararlarının Uzun Dönemli Faizler Üzerindeki Etkisi. Türkiye Cumhuriyeti Merkez bankası Uzmanlık Yeterlilik Tezi
- Jovanovski, Z., Krstevska, A. Mitreska A. & Bojceva-Terzijan S. (2005). Monetary Transmission Through Interest Rates in the Republic of Macedonia. National Bank of the Republic Macedonia Working paper No: 13.
- Koutris, A., Heracleous, M.S., & Spanos, A., (2008). Testing for nonstationarity using maximumentropy resampling: amisspecification testing perspective. Econometric Reviews 27, 363–384.
- MacKinnon, J. (1996). Numerical Distribution Functions For Unit Root and Cointegration Tests. Journal of Applied Econometrics, 11, 601–618.
- Özdemir, B.K. (2009). Retail Bank Interest Rate Pass-Through: The Turkish Experience. International Research Journal of Finance and Economics, 28, 7-15
- Petrevski, G. & Bogoev. J. (2012). Interest rate Pass-Through in a Small Open Economy with a Fixed Exchange Rate-The Case of Macedonia. Procedia-Social and Behavioral Sciences, 44, 125-133
- Phillips, P. & Perron, P. (1988). Testing For A Unit Root in Time Series Regressions. Biometrica, 75(2), 335-346.
- Sander, H. & Kleimeier, S. (2004). Convergence in Euro-Zone Retail Banking? What Interest rate Pass-Through Tells us About Monetary Policy Transmission, Competition and Integration. Journal of International Money and Finance, 23, 461-492
- Shukur, G. & P. Mantalos, P. (2000). A simple investigation of the Granger-causality test in integrated-cointegrated VAR systems. Journal of Applied Statistics 27, 1021–1031.

- Toda, H. & Yamamoto, T. (1995). Statistical Inference in Vector Autoregressions with Possibly Integrated Processes. Journal of Econometrics, 66, 225-250.
- Yıldırım, D. (2012). Interest Rate Pass-Through to Turkish Lending Rates: A Threshold Cointegration Analysis. Economic Research Center Working Paper, No:12(07), 1-21
- Zapata, H. & Rambaldi, A. (1997). Monte Carlo Evidence on Cointegration and Causation. Oxford Bulletin of Economics and Statistics, 59, 285-298

Appendix A

The uni-directional causality running from policy rate to cash credit interest rate is valid in July-August- September 2006, January –February 2008, February-March-April-May-June-July-August-September-October-November-December 2009, January –August-December 2011, January- February-March-April-May-June-July-August-September-October-Novermber 2012, March-May-June-August 2015.

The uni-directional causality running from policy rate to vehicle credit interest rate is valid in October 2005, August 2006, February-March-April-May-June-July-August-September-October-November-December 2009, January-February 2010, December 2011, January –February 2012, November-December 2013, March-May-June 2015.

The uni-directional causality running from policy rate to housing credit interest rate is valid in September-October-November-December 2005, January-July-August 2006, January –February-April-May-June-July-August 2008, February- May-June-July- November-December 2009, January 2010, August-September-October 2011, January –February-October 2012, December 2013, March-May 2015.

The uni-directional causality running from policy rate to commercial credit interest rate is valid in February-March-April-May-June-July 2009, November 2013, March-April-May-June 2015.

The uni-directional causality running from cash credit interest rate to policy rate is valid in September-October-November-December 2003, January- February-March-April-May-June-July 2004, July-August- October-November 2005, January 2006, August-September 2007, October-November-December 2009, April-May-July-August- September-October-November 2010, February-March-April-May-June-July- September-October-December 2014, March-April 2015.

The uni-directional causality running from vehicle credit interest rate to policy rate is valid in November-December2003, January- March-April-May-June 2004, July-August 2005, August- September-October- December 2007, December 2009, January- May-June-July-October-November-December 2011- January 2012, February-March-April-May-June-July-August-September-December 2014, March-April 2015.

The uni-directional causality running from housing credit interest rate to policy rate is valid in July 2005, August 2007, December 2009, January-April-May-June-July- August 2010, May-June 2011, April-May-June 2013, February-March-April-May-June-July- August-September-October-November-December 2014, January- February-March-April-September 2015.

The uni-directional causality running from commercial credit interest rate to policy rate is valid in February-March-April-May-June-July-August- November-December 2005, January-February 2006, November-December 2008, October-November-December 2009, January-February-March-May-September 2010, July-August 2011, August- September-October-November 2012, February-March-April-May 2013, January- February-March- September-October 2014, March 2015.