How Exchange Rate Regimes Effect The Causal Relation Between Macroeconomic Indicators?

Dilek Teker, Suat Teker and Elçin Aykac Alp

***Abstract*— The paper examines interaction between selected macroeconomic determinants such as exchange rates, stock exchange market indexes, gold prices, money supply and inflation rates. Considering a nonlinear relationships in various macroeconomic indicators, a Threshold Vector Autoregression (TVAR) model is implemented. The data covers a period from 2003:01 to 2017:07. The level of TL3.35/$ acts as threshold. The outputs of the model point different occasions a number of different ways for each exchange rate level in with different various threshold values. The estimations indicate that monetary authority may use exchange rates as a policy variable for the stability of stock exchange market returns and a number of monetary variables.**

***Keywords*— threshold vector autoregression model, exchange rate transmission JEL codes: C32, E31, E44,**

I. Introduction

As known that there is a strong correlation among financial markets, macroeconomic indicators and VAR models are widely used in recent literature. The standard VAR model is designed to capture the linear dependence of yt on its own lags. This model is linear in the slope parameters as well as linear in the lagged model variables. More generally, however, the conditional mean may be nonlinear in the lagged variables and/or the model parameters. Threshold models allow the model coefficients to evolve from one regime to another when some model variable exceeds a prespecified threshold value. For example, the central bank may tighten monetary policy only if the inflation rate exceeds a certain level. Our data covers a period from 2003:01 to 2017:07. We determine exchange rate as the threshold variable and estimate the threshold value for this system. Thus, the system we analyzed shows the interrelations between these variables for the values exceeding the threshold value and staying below of the threshold value. Our test results indicate a level of TL3.35/$ that acts as the threshold. The outputs point various occasions according to each exchange rate level for various threshold values.

II. Literature Review

In this research we employ TVAR to figure out the interelation among exchange rates, stock market index, gold prices, money policy (M2) and inflation for the Turkish markets. USD/TL rates are modelled as threshold and each of the underlying parameter is estimated for being above or below of this treshold. Therefore, this section examines related literature that depicts the determinants of each macroeconomic parameter modelled in this research. Financial markets are a key factor in producing strong economic growth because they contribute to economic efficiency by diverting financial funds from unproductive to productive uses [1]. Reference [2] combines relevant determinants of stock markets and also discusses these factors. This study employs a multistage statistical data analysis using correlation and cluster analyses to investigate the presence of integration trend between existing stock markets and a multivariable logit regression examines the determinants of stock market integration. Reference [3] employs Vector Autoregressive (VAR) model to examine the relations between BIS100 index and exchange rates, gold, import and export values for the periods of January 1996 to October 2011. After stationary tests, one standard deviation shock is given for each series. It is determined as of the second default of exchange and it explains 31% by share indices.

Reference [4], examines the effect of economic growth on real exchange rate. His findings perform no evidence that relates economic growth and real exchange rate. Reference [5] estimates the relation between exchange rates and current account. Reference [5] proposes that exchange rate and current account are the key factors that deteoriate the small economies. Reference [6] indicate that financially developed economies seem to have advantages of having flexible exchange rates. On the other hand, less developed and poorer countries that have a little access to international funds is expected to face low inflation and higher durability associated with the fixed exchange rate regime. They find no significant relationship between economic performance and exchange rate regime for developing economies. They also indicate that developed economies may succed to grow slightly higher without experiencing higher inflation rates in flexible exchange rate regime. Gold is one of the primary investment alternatives in the volatile market conditions. Therefore, identifying the indicators is a great interest of speculators and investors committing a long-term capital investment. Gold prices, however, are influenced by large variety of factors compared to other instruments. These factors determine the level of supply and demand in the gold market and, consequently, its price. Hence, short- and long-term determinants of gold price may be

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determined. Many researchers point out that there exist relationships between long run determinants and gold price as studied in this paper. A strong positive correlation between gold and crude oil is found by Reference [7]. Mining costs and expenditures on gold exploration which does not lead to successful discoveries are stated as a cause of probable production level decrease and rising gold prices [8]. Leading gold producers don't have significant impact on world gold prices [9].

Many studies point that demand for money has a crucial impact on macroeconomic conditions. Therefore, there are many researches stating the indicators which influence monetary policies. Reference [10] examine that how credit markets are effected by fiscal policies in USA. They employ a threshold vector autoregression (TVAR) model on US quarterly data for the period 1984–2010. The credit conditions are set as the yield spread between BAA-rated corporate bond and 10-year treasury constant maturity rate which capture the premium for external financing. They find that the response of output to fiscal policy shocks is stronger and more reactive when the economy is in the 'tight' credit regime. Reference [11] propose that many studies find a relation between nominal interest rates and expected inflation. On the other hand, [12] discusses that physical goods can be substitutes for money which may reshape a portfolio of pyhsical assets instead of money. Hence, the yields on real assets may also be included in financial models. Reference [13] also indicate that many researches also point that inflation level can exert significant influence on demand for money.

The variables that are commonly modelled for inflation are money supply, exchange rate, interest rate and GDP. Some studies indicate that the money supply is a significant determinant of inflation [14], [15],[16]. On the other hand, [17] and [18] found no evidence that relates money supply and inflation. References [15], [16], [19], [20] explain exchange rate as a factor that triggers a rise in inflation. References [16], [21] finds evidence that inflation is influenced by nominal interest rates whereas [20] found significant relation. Reference [22] states that the short term interest rates have crucial impact on inflation. Reference [23] conduct several tests to to investigate the determinants of inflation in USA over the period 1978-2014. They model the variables as unemployment rate, long-term interest rate, trade openness, budget deficit, money supply, economic growth rate and exchange rate. Their results indicate short-run unidirectional causalities from interest rate, trade openness, economic growth rate and exchange rate to inflation rate, from interest rate to unemployment rate, from economic growth rate to trade openness, and from unemployment rate, trade openness, budget deficit, economic growth rate and exchange rate to money supply.

III. Data And Econometric Methodology

Istanbul Stock Exchange (ISE) indices, exchange rate (EXR), gold price (GOLD), money supply (M2) and inflation (CPI) are used as model variables in this study. The data are obtained from Central Bank of Turkey and analyzed for the period of 2003:01 to 2017:07. In this paper the Threshold Vector Autoregression (TVAR) approach is used as referenced by [24]. This approach is such an easy analysis to get nonlinear structure and asymmetric reactions to shocks in a system. The TVAR model has the following specification.

$$Yt = A^1 Y_t + B^1(L)Y_{t-1} + (A^2 Yt + B^2(L)Y_{t-1})I\left[v_{t-d} > \gamma\right] + U_t$$

where Yt is a nx1 vector of endogenous variables, I is the indicator function which is equals 1 when and 0 if . are lag polynomial matrices, Ut are structural disturbances, is the threshold variable, nx1 vector of endogenous variables denoted as Yt is; $Y_t = \{BIST_t, EXR_t, GOLD_t, M2_t, CPI_t\}$ and constant term is also (5x1) vector of constant terms. The indicator function equals 1 when exchange rate is higher than the threshold value. The lag value noted as "d" is equals to 1 for this study.

In first step we estimated TVAR model and tested for the the differences of the regimes. This test procedure is known as Wald test. Three main test types are revealed in [24] study which are named as sup-Wald, avg-Wald and exp-Wald tests. Nonlinear impulse – response functions estimation is also obtained and interpreted. Formally nonlinear impulse response functions are defined as;

$$NIRF = E\left(Y_{t+k} \left| U_t, \Omega_{t-1}\right.\right) - E\left(Y_{t+k} \left| \Omega_{t-1}\right.\right) \quad (3.2)$$

where Y_{t+k} is a vector of variables and Ω_{t-1} is the information set available before the time of shock t.

We assumed that value of domestic currency effected by macroeconomic variables and exchange rates. The exchange rate, as the value of domestic currency, affects this system but also has exogenous impacts in it. From this point of view we select the exchange rate variable as threshold variable. This variable is also the most important linkage between macroeconomic variables and the financial indicator BIST

IV. Empirical Outputs

The first step of our analysis is to determine the time series determinants for the period of 2003:M2-2017:M7. Percentage change transformation is used for all variables. We used [25] test for testing the nonlinear especially TAR structure. In second stage the unit root process is tested. Whole variables are stationary in levels. In second stage we used TVAR (threshold vector autoregressive) model as in the study of [24].

TABLE I: UNIT ROOT TESTS

	KPSS	ADF	PP	Caner-Hansen BTT (prob.) (lag)
EXR	0.37 (2)	-11.66 (0)	-11.65(2)	27.32 (0.00) (5)
BIST	0.19 (2)	-13.56 (0)	-13.55(2)	27.17 (0.0)(5)
GOLD	0.458 (3)	-14.91 (0)	-14.91(0)	29.23 (0.05)(5)
M2	0.54 (4)	-13.69 (0)	-13.68 (4)	275.7 (0.02) (10)
CPI	0.15 (37)	-5.08 (13)	-16.02(90)	32.34 (0.0) (5)

WTT: Wald test for threshold effect

* %10, ** %5, ***%1 Shows the significance level of stationarity. The numbers in ( ) denotes the selected lag length. The critical values for KPSS test for significance level %10, %5 and %1 are, 0.347, 0.463, 0.739. The critical values for ADF and PP test for significance level %10, %5 and %1 are, -2.576, -2.879, -3.471. Newey West and Bartlett Kernel are used for selecting the lag length in KPSS and PP test. BTT used for [25] Bootstrap Threshold Test. We used TVAR model for estimation of macroeconomic system that brings together the market returns of Istanbul Stock Exchange, gold prices, exchange rates, money supply and CPI variables. This type of estimation method gives us the chance to choose exchange rate as threshold variable. This selection helps to analyze the interactions of other macroeconomic variables subject to the level of threshold variable. The estimated threshold value for the model studied is determined to be 3.35 TL per USD. When the exchange rate is above this threshold value, the first regime realized and this regime is dominated at 22.1% of the period analyzed. Additionally, the second regime dominates and it is persisted at 77.9% of the period if the exchange rate is below the threshold level.

In the first TVAR equation the market return of Istanbul Stock Exchange (BIST) is negatively affected by the gold prices in each period but the impact of this affect is (negatively) stronger in first regime. The different effects of exchange rate on BIST in various regimes also reveal in the first equation. During the first regime exchange rate negatively affects BIST but in second regime this effect turns to be positive and there exists a very weak relation. A similar relation is also faced in M2 variable. The money supply negatively affects BIST in the first regime but the relationship between M2 and BIST is positive in the second regime. The TVAR equation for Gold shows that BIST and CPI variables affect the exchange rates negatively in both regimes. However, the relative strength of this effect differs for different regimes. The exchange rate variable has positive effect on gold prices either in the first and the second regime. Only the money supply has different effects on gold prices in different regimes. In the first regime, where the exchange rate is greater than the threshold value, money supply affects gold prices negatively and in the second regime this effect turns to be positive. The third equation shows that exchange rate is negatively affected by BIST but the Gold price positively affects the exchange rates. For all variables the first regime has stronger effect on the exchange rates. The money supply and inflation have different effects in the regimes. In the first regime money supply has a strong positive effect on the exchange rates but a weak negative effect in the second regime. Also, inflation has different effects in signs in the different regimes. The fourth equation shows a stronger effect of variables in the second regime on money supply. The way of effects on money supply differs for BIST and CPI. Both have negative effect on money supply in the first regimes but positive effect in the second regime. Gold prices and exchange rate variables have positive effect on M2 in both regimes.

The last equation shows a positive effect of BIST and M2 on CPI. Gold prices and exchange rates have negative effect on CPI although they show a positive effect on CPI in the second regime.

$$BIST = \begin{cases} \underset{(3.11)}{3.18} \underset{(0.19)}{-0.43} BIST_{t-1} \underset{(0.25)}{-0.074} \mathrm{GOLD}_{t-1} \underset{(0.58)}{-0.76} EXR_{t-1} \\ \underset{(1.018)}{-0.48} M2_{t-1} \underset{(2.009)}{+1.14} CPI_{t-1} \qquad v_{t-1} \geq \gamma \\ \underset{(1.04)}{1.96} \underset{(0.103)}{-0.008} BIST_{t-1} \underset{(0.15)}{-0.02} \mathrm{GOLD}_{t-1} \underset{(0.32)}{+0.0014} EXR_{t-1} \\ \underset{(0.12)}{+0.20} M2_{t-1} \underset{(0.96)}{-0.27} CPI_{t-1} \qquad v_{t-1} < \gamma \end{cases} \quad \textbf{(4.1)}$$

$$GOLD = \begin{cases} \underset{(2.18)}{-0.69} - \underset{(0.13)}{0.013} BIST_{t-1} \underset{(0.17)}{-0.29} \mathrm{GOLD}_{t-1} \\ \underset{(0.41)}{+0.69} EXR_{t-1} \underset{(0.71)}{-1.52} M2_{t-1} \underset{(1.41)}{-0.64} CPI_{t-1} \quad v_{t-1} \geq \gamma \\ \underset{(0.61)}{1.61} - \underset{(0.06)}{0.02} BIST_{t-1} \underset{(0.09)}{-0.03} \mathrm{GOLD}_{t-1} \\ \underset{(0.19)}{+0.19} EXR_{t-1} \underset{(0.07)}{+0.11} M2_{t-1} \underset{(0.57)}{-0.32} CPI_{t-1} \quad v_{t-1} < \gamma \end{cases} \quad \textbf{(4.2)}$$

$$EXR = \begin{cases} \underset{(1.95)}{-0.52} \underset{(0.12)}{-0.069} BIST_{t-1} \underset{(0.16)}{+0.22} \mathrm{GOLD}_{t-1} \\ \underset{(0.37)}{+0.17} EXR_{t-1} \underset{(0.64)}{+0.56} M2_{t-1} \underset{(1.26)}{-1.17} CPI_{t-1} \quad v_{t-1} \geq \gamma \\ \underset{(0.46)}{0.54} \underset{(0.04)}{-0.06} BIST_{t-1} \underset{(0.06)}{+0.08} \mathrm{GOLD}_{t-1} \\ \underset{(0.14)}{+0.12} EXR_{t-1} \underset{(0.06)}{-0.02} M2_{t-1} \underset{(0.42)}{+0.012} CPI_{t-1} \quad v_{t-1} < \gamma \end{cases} \quad \textbf{(4.3)}$$

$$M2 = \begin{cases} \underset{(0.64)}{0.86} \underset{(0.04)}{-0.007} BIST_{t-1} \underset{(0.05)}{+0.11} \mathrm{GOLD}_{t-1} \underset{(0.12)}{+0.16} EXR_{t-1} \\ \underset{(0.21)}{-0.056} M2_{t-1} \underset{(0.41)}{-0.55} CPI_{t-1} \qquad v_{t-1} \geq \gamma \\ \underset{(0.71)}{1.35} \underset{(0.06)}{+0.18} BIST_{t-1} \underset{(0.10)}{+0.205} \mathrm{GOLD}_{t-1} \underset{(0.22)}{+0.439} EXR_{t-1} \\ \underset{(0.08)}{-0.058} M2_{t-1} \underset{(0.65)}{+0.676} CPI_{t-1} \qquad v_{t-1} < \gamma \end{cases} \quad \textbf{(4.4)}$$

$$CPI = \begin{cases} \underset{(0.32)}{0.65} + \underset{(0.02)}{0.035}BIST_{t-1} - \underset{(0.026)}{0.04}\text{GOLD}_{t-1} - \underset{(0.06)}{0.019}EXR_{t-1} \\ + \underset{(0.011)}{0.164}M2_{t-1} - \underset{(0.21)}{0.0587}CPI_{t-1} \qquad v_{t-1} \geq \gamma \\ \underset{(0.09)}{0.44} + \underset{(0.008)}{0.01}BIST_{t-1} + \underset{(0.012)}{0.02}\text{GOLD}_{t-1} + \underset{(0.026)}{0.044}EXR_{t-1} \\ + \underset{(0.01)}{0.004}M2_{t-1} + \underset{(0.08)}{0.28}CPI_{t-1} \qquad v_{t-1} < \gamma \end{cases} \quad \textbf{(4.5)}$$

V. Conclusion

This study aims to analyze the relationship between selected monetary variables as such stock market index, exchange rates, gold price, money supply and CPI. The interrelation among these variables is analyzed using TVAR model. This model is chosen by employing a test for nonlinear structure of these variables for the period of 2003-2017. The estimation technique TVAR also gives us the opportunity of selecting a threshold variable which dominates the relations between these variables. We select the exchange rate variable as the threshold variable and estimate the threshold value for this system. Thus, the system analyzed in this study shows the interrelations between these variables for the values exceeding the threshold value and staying below of the threshold value as of 3.35 TL per USD. For instance, the effects of M2 and CPI on BIST have opposite sign effects for different regimes. Similarly, M2 have different effects on gold prices for different regimes. For money supply CPI has different effects and exchange rate and gold prices have also different effects on CPI. All these impacts are valid when we take the levels of exchange rate into account. The estimated model describes the transmission mechanism of exchange rate level on monetary variables and BIST for the period of 2003 to 2017 for Turkey.

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