



# A NONLINEAR ANALYSIS OF MONETARY POLICY WITH DOMINANCE INDICES IN TURKEY: MS-VAR APPROACH

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## Abstract

*The study focuses on analyzing the policies followed in Turkey based on inflation targeting with an application of interest rate corridor policy in which the spread between the two policy rates, namely, the borrowing and lending rates. To overcome the difficulty of two different policy rates, two indices, the PDI and the MDI are utilized to capture the response of the monetary authority within a nonlinear Taylor rule context. The empirical findings for the Turkish economy with MS-VAR and MS-Granger causality analyses suggest that while the policy interest rates are determined in the spirit of the Taylor rule, the monetary policy involuntarily affirms inflation after the application of the policy, a finding that is consistent with the FTPL theory. As a result, as the central bank tries to establish price stability and financial stability with two policy interest rates, accepting higher inflation rates could be unavoidable. The results also are in favor of bi-directional nonlinear causality which led to important policy implications.*

**Keywords:** inflation targeting, Taylor rule, nonlinear econometrics, Markov-switching, Granger causality

**JEL Classification:** E5, C01, C23

## 1. Introduction

The unconventional methods in terms of the monetary policies followed by the central banks in addition to the mainstream approaches including the inflation targeting and Taylor rules deserve special interest in the literature regarding the monetary policy and its applications vis-à-vis inflation. Especially in the post-1990 period, in addition to the inflation targeting and Taylor-type interest rate rules, the Fiscal Theory of Price Level (FTPL) that focus on the impacts of fiscal dominance in the Ricardian and non-Ricardian periods underline the possible causes of deviations of the inflation rates from their targets that underpin the price

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stability. As put forth by Leeper (1991) and Woodford (2000), the FTPL approach not only focuses on the causes of inflation but also on producing policy suggestions to achieve price stability. In the literature, the econometric evaluations of the FTPL theory are investigated for various economies. Further, a large fraction of the econometric studies focuses on investigating the Ricardian and non-Ricardian characteristics of the economies by evaluating the fiscal and monetary policies either separately or simultaneously. Nevertheless, in the literature regarding the price stability, undoubtedly, a prominent feature is the recognizable amount of studies focusing on the role of monetary policy in price stability and the effectiveness of the tools under the influence of the central banks in achieving their targets. Among these tools, though the Taylor type rules gained relevance in accordance with inflation targeting policies, the effectiveness of monetary policies are also under the influence of fiscal policies and the role of fiscal policies and their interactions with the monetary policy tools are examined in a vast amount of literature. Accordingly, these approaches not only focus on the causes of inflation or on producing policy suggestions towards achieving stability in price levels, they could be also taken as evaluating the both, the fiscal and the monetary rules separately and simultaneously in a large body of research.

Central Bank of the Republic of Turkey (CBRT) follows a monetary policy strategy in which, instead of utilizing a single instrument, two instruments are applied simultaneously. Within this approach, in contrast to the conventional corridor applications, the announced official policy interest rates and the short-run interest rates faced by the banks could acquire differentiated values. It is of great importance to understand in terms of the transmission mechanism and to evaluate the strand of the central bank which short-run interest rate (or rates) is taken as reference by the banks to determine the credit and the deposit rates. Within this respect, Karagiannis *et al.* (2010) study notes that the differentiation between the market interest rates and the policy interest rates occur unwillingly depending on the perception of risk that takes place especially during the periods of economic crisis. However, in Turkey, this differentiation is a deliberate policy choice. The officially announced interest rates and the effective funding rates of the CBRT within the corridor are differentiated as a manifestation of the funding strategy (Binici *et al.*, 2016). Nevertheless, this differentiation is not unique and other examples of typical differentiation also exist in the literature; as to be discussed in the literature review, examples include Cordemans and Sola Perea (2011), Abbassi and Linzert (2012) and Darracq-Paries and De Santis (2015).

In terms of Turkey, CBRT policies provide an important example of an unconventional monetary policy. CBRT aims at achieving stability in inflation rates and prices under the followed inflation targeting policy in which two official policy interest rates exist that defines the interest rate corridor: the borrowing and the lending interest rates. Both interest rates are announced and determined within a Taylor-type rule which conventionally includes feedbacks from the deviations of the inflation rates from its target level and the deviations of the economic growth rates from its natural level. However, similar to Taylor (1993)'s policy suggestion, with a larger share, the rule includes feedbacks from inflation rates compared to the small fraction of the feedbacks from the economic growth rate variables. Within this respect, the direct control of money supply becomes eliminated as a result of the determination of the policy interest rates. As expected, this policy approach results in a horizontal LM curve, *i.e.* a condition considered as "monetary policy without money" (Woodford, 2000; Bildirici *et al.*, 2014, 2015; Parasız, 2011). As the CBRT alters the LM curve by making it horizontal, it also achieves the determination of the price level. As a result of this type of policy, the "quantity" should be left to the market as suggested by the Economics Theory. Conversely, the CBRT targets the determination of the quantity at the

same time and the simultaneous targeting of both the price (the interest rates, in the context of monetary policy) and the quantity (the money supply) leads unexpectedly to inflationary effects in return. In the spirit of the FTPL where the fiscal dominance that occurs through the fiscal variables including the domestic debt, active monetary policy in an economy in which the policy is also accompanied by active fiscal policies or fiscal dominance, the achievement of price stability is unexpectedly undermined. In Turkey, though the government could finance budget deficits by issuing T-bills and government bonds to the financial markets, the CBRT could not directly finance the budget deficits by buying the government bonds. Consequently, it could affect this process indirectly by procuring the banks operating in the financial markets to buy government bonds (Parasız, 2011; Bildirici *et al.*, 2015). Nonetheless, if the interest rates rise above the lending rate of the CBRT, banks borrow from the CBRT. In periods of having the borrowing interest rate below the market interest rate, the CBRT could be considered as indirectly financing the budget deficits. The most critical point that should be underlined in terms of this policy structure is that by making money abundant in the market, the central bank falls into a situation in which it cannot avoid supporting inflation in the spirit of FTPL theory, where fiscal dominance has important inflationary effects (Bildirici *et al.*, 2014). Therefore, the resulted inflation rates deviate from the target inflation rates and inflation becomes above the target levels. Hence, even though the interest rate corridor has been introduced to achieve the inflation targets, the posterior inflation could not be controlled so that the target inflation rates before the application of the inflation targeting with the borrowing and lending rates could not be reached effectively (Bildirici *et al.*, 2015; Parasız, 2011). For that reason, the study aims at investigating the factors that lead to success or failure in terms of unexpected inflation rates in the sense that the resulting rate of inflation fails to catch the inflation target in an economy that follows inflation targeting. Accordingly, the monetary authority may unwillingly affirm inflation rates that deviate drastically from those targeted. As to be discussed below, the main problem that results in this type of phenomenon is the inflationary effects of the monetary policy that is under the influence of both the difference between the lending and borrowing rates and targeting the quantities simultaneously. This type of policy interaction in this economy is further analyzed in Bildirici *et al.* (2015) which relates this finding to trying to control both the quantity and price as in general economic theory. In the monetary policy setting, if the price is determined, quantity should be left to the market mechanism. Consequently, as discussed by Bildirici *et al.* (2015), as long as the central bank attempts to determine both the price and quantity, the accomplishment of price stability becomes unachievable and large deviations from the inflation targets become inevitable while fiscal dominance has a prominent role in obtaining the type of inflation equilibria in the spirit of Leeper's (1993) monetary-fiscal policy mixes.

Following the above-mentioned discussion, the study aims at evaluating the effects of two indices, the psychological dominance index and the market dominance index (PDI and MDI indices), which reflect the magnitude of fiscal dominance in the economy. Both indices are alternative measures based on the lending and borrowing rates in Turkey within a Taylor rule context. Following Bildirici *et al.* (2015) and as to be outlined in Part 4, the PDI index is based on the ratio of lending to borrowing rates, whereas the MDI is calculated as the ratio of the difference of lending to borrowing rates to their averages. Both indices represent the spread between the two policy rates and they are in relation to each other. It should be noted that as long as the spread between the two rates remains below at an acceptable level, inflation rate follows a decelerating process, otherwise, if the spread increases, inflation accelerates. Since the process hints possible nonlinear effects, the study aims at benefiting from nonlinear MS-VAR models that allow regime-dependent asymmetry and regime change

dynamics based on Markov chains. Further, the MS-VAR approach could also be extended to MS-Granger causality analysis to evaluate the regime dependent behavior in the inflation rates in addition to providing possibly different causality relations, which, compared to linear Granger causality, could provide deviating results that would change the policy implications. The study has two objectives. The first is a further development and investigation of two indices, the psychological dominance index and the market dominance index (henceforth, PDI and MDI). The second is the analysis of inflationary effects of policy interest rates within a nonlinear context. With this respect, Markov-switching vector autoregressive (MS-VAR) models are estimated. The interrelations of these indices to inflation rates and economic growth rates are evaluated with Markov-switching nonlinear causality analysis. Accordingly, the monetary policy is defined nonlinear versions of the Taylor-type rules that are generalized to include the PDI and MDI indices.

The literature review is given in Part 2. The recent developments in the Turkish economy in terms of the monetary policy and the psychological and market dominance measures are discussed in Part 3. The econometric methodology is given in Part 4. The empirical results and the policy implications are evaluated in Part 5.

## **2. Literature Review**

In the literature, the unconventional methods regarding the monetary policies have been examined in various studies. Cordemans and Sola Perea (2011) evaluate the unconventional monetary tools including the full liquidity allowance, longer term refinancing operations, covered bond purchases, and securities market programs and their impacts on the Euro area and the effects of these policies on determinacy of the retail bank interest rates in Belgium. Abbassi and Linzert (2012) question money market rates on the basis of monetary policy expectations and the impacts of extraordinary central bank measures on the financial market rates. Gambacorta and Marques-Ibanez (2011) emphasize on the bank lending channel by focusing especially on the crisis periods and provide policy implications based on the short-term impact of monetary policy changes on bank lending channels. Additionally, regarding the mitigation of liquidity and funding risks in the financial markets, Darracq-Paries and Santis (2015) investigate the macroeconomic impact of long-term refinancing operations through the bank lending. Among the studies that questioned the impacts of unconventional monetary policies, two papers deserve special attention that investigate the simultaneous effects of the interest rate and credit channels of monetary transmission. Lenza, Pill and Reichlin (2010) evaluate and compare the responses of the ECB, the Fed and the Bank of England to the financial crisis by using non-standard monetary policy measures and show significant impacts of these policies on money market spreads and the real economy variables. Bonaccorsi di Pati and Sette (2016) examine the transmission of monetary shocks in the balance sheets of the banks in Italy and underline the various effects on the volume and cost of credits granted to nonfinancial corporations.

In addition to the above-mentioned studies and following the need to augment the effectiveness of the monetary policy rules especially after the 2008 global crisis, the successes and failures of the monetary policies are evaluated in the literature. Among many, the nonlinear channels of monetary policies are investigated by Belke, Beckmann and Verheyen (2013) who conducted a cross-country analysis of the pass-through in 12 European Monetary Union member countries after the crisis. Their findings suggest that nonlinear patterns cannot be rejected in the short-run dynamics of the loan rates. Aristei and Gallo (2014) investigate the interest rate channel in five distinct markets; the money market,

the internal debt market, the lending market various non-financial markets. By estimating Markov-switching vector autoregressive models, they suggest that nonlinearity cannot be disregarded and the pass-through mechanism deteriorated during the crisis, in addition to emphasizing the largest effects being prominent in the credit markets, which have had significant impacts on the non-financial corporations. Gigineishvili (2011) investigates the financial structure as a possible cause of heterogeneity of worldwide monetary transmission mechanisms. The findings of Gigineishvili (2011) point at the fact that, even within the Eurozone, the heterogeneity in the transmission of the policies of ECB regarding the macroeconomic determinants such as the per capita GDP, the inflation rates cannot be disregarded and additionally, many important variables regarding the financial market structure including the exchange rate volatility, the credit quality, and the overhead costs have significant effects on the interest rate pass-through. Furthermore, Panagopoulos, Reziti and Spiliotis (2010) provide an analysis of the interest rate channels of monetary policies with cointegration techniques within a comparative context in which the revelation of the banking sector pass-through interest rate behavior is measured for the Eurozone, the USA, the UK and Canada during the financial turmoil. Their findings suggest that the financial markets seem to favor the money market interest rates in the USA and the Eurozone while in the UK and in Canada, the central bank policy interest rates are favored and they conclude that the US and UK banking systems contrast to that of the Canada and the Eurozone. Similarly, Karagiannis, Panagopoulos and Vlamis (2010) provide a comparative analysis focusing on the Eurozone and USA compare the interest rate transmission mechanism in the Eurozone and the US. Their findings suggest nonlinear responses to the policy interest rates exist in different markets in terms of passing a 1% change in the policy rate to the relevant rates and in addition to the asymmetric response, they underline the importance of close cooperation between the monetary and fiscal authorities to design optimal policy-mix to achieve price and output stability. In terms of the pass-through from the ECB rate to the market interest rates, Creel, Hubert and Viennot (2013) show that the pass-through has been effective in line with the literature, while the transmission mechanism of the ECB rate to volumes and of quantitative easing (QE) operations to interest rates and volumes has been null or uneven over the analyzed sample with country-specific VAR models.

In addition to the above-mentioned studies, a strand of more recent literature further investigates the pass-through mechanism following the financial crisis. The findings of Hristov, Hulsewig, and Wollmershauser (2012) are in line with Karagiannis, Panagopoulos and Vlamis (2010) and Panagopoulos, Reziti and Spiliotis (2010) with regard to the monetary policies in the Euro area. According to their empirical results, the pass-through in the Euro area became significantly less complete, especially during the crisis. The findings of Darracq-Paries, Moccero, Krylova, and Marchini (2014) also point at the heterogeneity in interest rates in the Euro area and suggest significant relations between the financial and sovereign debt crisis and credit risk and risk perceptions which also have important effects on the bank under-capitalizations, poor quality of banking assets and fragmentation in the funding conditions among different banks. Albertazzi, Ropele, Sene and Signoretti (2012) investigate the sovereign bond yields and suggest that an increase in the sovereign bond yield has a positive impact on the cost of funding which results in a rise in the costs of credits given to the private sector. Illes and Lombardi (2013) investigate a number of developed economies to evaluate the relationship between policy and lending rates. Their findings suggest misalignments between the two rates during the financial crisis in 2008 between which an alignment has not been reached; an alignment to the pre-crisis levels in the United States and Germany until 2013, further, the two rates continue to remain impaired in peripheral euro area countries. Additionally, the findings of Arnold and van Ewijk (2014)

suggest a strong degree of dispersion in the interest rates across the Euro area, which results from the influence of the heterogeneity in sovereign and credit risks in the financial markets. More recently, Illes, Lombardi, and Mizen (2015) show that the differences in the weighted average cost of funding in different banks have been the main reason in explaining the comparatively large values of the lending rates compared to the policy rates. Holton and d'Acr (2015) discuss the incomplete pass-through to money market rates, particularly in stressed countries. Accordingly, individual bank characteristics have an effect on pass-through during the crisis and this effect accelerates depending on the characteristics of the banks with funding difficulties. As a policy implication, they suggest that restoration of banks' funding capacities would have an important effect on the success of the transmission mechanism.

Various studies investigate the effectiveness of the monetary policies in Turkey. Binici *et al.* (2016) analyze the differentiation between the official rates and the market rates including the deposit rates and the credit rates. By using panel regression methods and banking level data, their findings suggest the major role of market rates in contrast to the policy rates while showing the importance of the interbank rates in the determination of the credit and deposit rates in the financial markets. In terms of the rules-based approaches, Alper and Hatipoğlu (2009) focus on the investigation of the pre-2001-crisis and post-2001-crisis monetary policy in Turkey. By evaluating the Taylor-rule models with time varying coefficients, they point at a steady increase in the coefficient of the inflation rate suggesting that the CBRT has been more concerned with fiscal dominance in the initial stages of the post-crisis period. Bildirici *et al.* (2015) is one of the early studies that suggest Taylor-rule based models that take the PDI and MDI indices into focus to incorporate the fiscal dominance to the monetary policy rules. Recently, by proposing a composite index of systematic stress, Çamlıca (2016) investigates the responsiveness of the CBRT in Turkey to financial stress for the 2005-2010 period. The index is comprised of the overnight rate, the BIST interbank rate, and the weighted average funding rate. His econometric findings indicate that the CBRT's monetary policy was leaning more against financial stress after mid-2010 period. In the selection of the policy rate variable, Çamlıca (2016) follows the approach adopted by Binici *et al.* (2016) by taking a policy rate proxy as a generic policy rate calculated that consists of 40% of the average funding rate and 60% of the BIST interbank rate. Our study has several important differences. Firstly, the proposed PDI and MDI indices are derived from the spread of two policy rates, the lending and the borrowing rates announced by the CBRT. Hence, the indices take the spread between the actual policy rates into account following Bildirici *et al.* (2015). Secondly, though the financial stress is taken into consideration as an explanatory variable as in the context of Çamlıca (2016), the fiscal dominance reflects itself into the two proposed indices of policy rate which are taken as dependent variables in our study following Bildirici *et al.* (2015). The two policy rate indices are also in a nonlinear relation with the output gap and the inflation gap, a nonlinear extension of Taylor (1993) allowing the investigation of the asymmetric response of the policy rates in the recessionary and expansionary regimes. Further, as noted by Taylor (2017), though many central banks focus on unconventional methods to accelerate growth to achieve pre-crisis levels after the global crisis, a return to less-interventionist rules-based policy that focuses on price stability instead of focusing on factors such as productivity and long-term growth could further encourage reforms in other policy areas such as the fiscal policy including reforms on tax, budget and public debt. Accordingly, instead of focusing fundamentally on financial stress, the main focus of the monetary policy should take price stability into consideration. Within this respect, a general outlook will be provided regarding the Turkish economy in the next section.

### 3. Developments in the Monetary Policy of Turkey

After the crisis of 2000-2001, implicit inflation targeting has been implemented as of 2002-2005. Since its adoption, the Central Bank has begun to use the policy tools that allowed Woodford's Neo-Wicksellian monetary policy or monetary policy without money. The first two are applications of an inflation-targeting regime. The second phase is the application of Taylor rule. The third method is the use of short-term interest rates as basic policy tools. These decisions, in a sense, showed that Neo-Wicksellian monetary policy was being performed. As of 2006, when inflation targeting was adopted, evidence of a full Neo-Wicksellian monetary policy became highly obvious (Bildirici *et al.*, 2015). The most significant evidence of Neo-Wicksellian monetary policy in inflation targeting was having all interest rate determination responsibility left to a monetary policy board. Another significant evidence was the declaration of the usage of short-term interest rates as basic monetary policy tools. On the other hand, the declaration that long-term inflation predictions would be made and the commitment of accountability in major deviations from the goal is a strong evidence of a Neo-Wicksellian monetary policy, due to accepting the management of expectations as a priority (Bildirici *et al.*, 2014, 2015).

Following the end of 2010, the CBRT followed an unconventional interest rate corridor policy and a funding policy to respond timely to the financial volatility. With this purpose, the composition of short-run funds provided by the CBRT has been altered with high frequencies and for the required periods, the deviation of the announced official rates and CBRT funding rates from the market rates is a suggested way of conducting the monetary policy. In this unconventional approach, the interaction of the monetary policy with the financial system had become more complex compared to the classical interest rate corridor applications. Within the interest corridor policy, the CBRT could affect the financial markets by implying a change in the policy interest rate by affecting the borrowing interest rates, *i.e.* an increase in the borrowing rate to increase the policy rate. To alter the spread between the official borrowing and the lending rates, the gap between two interest rates could be changed without changing the borrowing rate; hence by increasing the lending rate, the gap could be widened. The other effect emerging with the rise of interest rate is the increase in inflation. Behind the inflation, the increase is the terms brought by inflation targeting (Bildirici *et al.*, 2014).

Two separate indices are developed in Bildirici *et al.* (2014, 2015) first to propose a single variable to overcome the difficulty in the interest rate corridor followed by the CBRT to achieve a single variable derived from the two policy rates. The second and probably the most important reason of proposing the two indices is, as shown by Bildirici *et al.* (2015), to obtain measures to evaluate the magnitude of the fiscal dominance that produces inflationist effects. The psychological dominance index ( $pdi_t$ ) is simply based on the ratio of LR/BR rate and is calculated as the logarithmic difference of the form  $pdi_t = \ln(lr_t/br_t)$ . The market dominance index ( $mdi_t$ ) is the second index that is based on the logarithmic difference between the lending and borrowing rates and is normalized by the average of the two policy rates given as  $mdi_t = \ln(lr_t - br_t) / \ln(avg_t)$ , where the  $avg_t$  is the average of the  $lr_t/br_t$  in logarithms and the lending and borrowing rates are denoted as  $lr_t$  and  $br_t$ .

## 4. Econometric Methodology

In the econometric methodology section, two groups of models are analyzed. First, the response of the *pdi* and *mdi* indices to inflation rates are analyzed. Therefore, for the first group of models, a two-variate environment exists and by including each index one by one separately, Markov-switching vector autoregressive models (MS-VAR) are estimated. In the second group of models, the output gap is also included to derive a nonlinear Taylor rule type analysis by three-variate MS-VAR models. Again, by including only one index to represent the policy rate, nonlinear variants of Taylor-rules are evaluated. Lastly, MS-VAR Granger causality analysis is conducted and compared to the baseline linear VAR based models to investigate possible deviations from the mainstream linear approach. The introduction of nonlinearity in this setting is expected to hint important insights regarding the response of CBRT and the CBRT's use of the Taylor rule based policy to achieve price stability with various policy interest rates. Since all models are in a VAR setting that allows all variables to be defined as endogenous variables, the MS-VAR analysis also allows the researcher to evaluate the effect of inflation on the two psychological and market dominance indices in addition to analyzing the success of raising the policy rates effectively to cope with inflation.

### 4.1. Markov-Switching VAR

The study follows a nonlinear and multivariate framework that benefits from Markov switching and Markov switching Granger causality by incorporating the *pdi* and *mdi* indices following the MS-VAR approach of Krolzig (2006) and Markov-switching Granger causality approach generalized by Fallahi (2011) and Bildirici (2012, 2013). Krolzig (2006) denoted obtaining the impulse response functions generalized to MS-VAR models possessing autoregressive dynamics which are regime independent. This approach will be utilized as indicated below for an MS-VAR(l) model. According to Krolzig (2006) methodology, if  $y_t = (y'_t, \dots, y'_{t-p+1})'$ , the process could be stated as  $y_t = H \xi_t + A y_{t-1} + u_t$ . The matrices in this equivalence are,

$$A = \begin{bmatrix} A_1 & \dots & A_{p-1} & A_p \\ I_K & & 0 & 0 \\ & \ddots & & \\ 0 & & I_K & 0 \end{bmatrix}, \quad H = \begin{bmatrix} M \\ 0 \\ \vdots \\ 0 \end{bmatrix} = I_1 \otimes M$$

$(K_p \times K_p)$  and  $(K_p \times M)$  dimensional matrices, respectively. Further, the expectation of  $y_{t+h}$  conditional on  $\{u_t, \xi_t, Y_{t-1}\}$  is defined as  $y_{t+h|t} = H \xi_{t+h|t} + A y_{t+h-1|t}$ . The conditional expectation of  $\xi_{t+h}$  is  $\xi_{t+h|t} = F^h \xi_t$ ,  $F = P'$ . Within this framework, the impact of regime switching is calculated by the response of  $y_{t+h}$  by applying an impulse at time  $t$  to evaluate the change in the path followed by the process (Krolzig, 2006).

### 4.2. Markov-Switching Granger Causality

By generalizing the MS-VAR approach, Fallahi (2011) and Bildirici (2012, 2013) evaluate the short-run or weak Granger causality for an MSIA-VAR( $q$ ) model to achieve inference about the Markov regimes being closely linked to Granger causality. Suppose that  $y_t$  is equal to  $\mu_{1,st}$  plus an *i.i.d.* Gaussian residual.  $m$  will be non-causal in mean for  $y$  if and only if the

history of  $m$  does not contain any unique information about the regime in the next period. As a typical, assume that the psychological dominance index and inflation will be evaluated where the index is denoted as  $pdit$  and the deviation of the inflation rate from the inflation target is given as  $inf_t$ . Based on the coefficients of the lagged values of  $inf_t$  and  $pdit_t$ , in both of the equations which have either  $pdit_t$  or  $inf_t$  as the dependent variable, the existence of causalities between the two variables could be investigated following the estimation of the MSIA-VAR(q) models of the form,

$$\begin{bmatrix} inf_t \\ pdit_t \end{bmatrix} = \begin{bmatrix} \mu_{10} + \mu_{1,st} \\ \mu_{20} + \mu_{2,st} \end{bmatrix} + \sum_{k=1}^q \begin{bmatrix} \phi_{10}^{(k)} + \phi_{11,st}^{(k)} & \phi_{1,st}^{(k)} \\ \phi_{20}^{(k)} & \phi_{20}^{(k)} + \phi_{21,st}^{(k)} \end{bmatrix} \begin{bmatrix} inf_{t-k} \\ pdit_{t-k} \end{bmatrix} + \sum_{k=1}^q \begin{bmatrix} \theta_{10}^{(k)} + \theta_{11,st}^{(k)} \\ \theta_{20}^{(k)} + \theta_{21,st}^{(k)} \end{bmatrix} Z_{t-k} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix} \quad (1)$$

Similarly, for the MDI index, the relation is stated as,

$$\begin{bmatrix} inf_t \\ mdi_t \end{bmatrix} = \begin{bmatrix} \mu_{10} + \mu_{1,st} \\ \mu_{20} + \mu_{21,st} \end{bmatrix} + \sum_{k=1}^q \begin{bmatrix} \phi_{10}^{(k)} + \phi_{11,st}^{(k)} & \phi_{1,st}^{(k)} \\ \phi_{20}^{(k)} & \phi_{20}^{(k)} + \phi_{21,st}^{(k)} \end{bmatrix} \begin{bmatrix} inf_{t-k} \\ mdi_{t-k} \end{bmatrix} + \sum_{k=1}^q \begin{bmatrix} \theta_{10}^{(k)} + \theta_{11,st}^{(k)} \\ \theta_{20}^{(k)} + \theta_{21,st}^{(k)} \end{bmatrix} Z_{t-k} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \quad (2)$$

where:  $s_{1,t}$  and  $s_{2,t}$  are variables which reflect the regime of the system at time  $t$  which take values in the zero to one interval  $\{0,1\}$ ;  $\{e_t' = [e_{1,t} : e_{2,t}]\}$  and  $\{\varepsilon_t' = [\varepsilon_{1,t} : \varepsilon_{2,t}]\}$  are white noise processes. Accordingly, four alternative states are possible,

$$S_t = \begin{cases} 1 & \text{if } S_{1,t} = 1 \text{ and } S_{2,t} = 1 \\ 2 & \text{if } S_{1,t} = 0 \text{ and } S_{2,t} = 1 \\ 3 & \text{if } S_{1,t} = 1 \text{ and } S_{2,t} = 0 \\ 4 & \text{if } S_{1,t} = 0 \text{ and } S_{2,t} = 0. \end{cases} \quad (3)$$

The covariance matrix of the disturbances is specified as for  $E(\varepsilon_t \varepsilon_t' | S_t = t) = [\sigma_{ij,t}]$  where:  $i, j = 1, 2; t = 1, \dots, 4$ . The regime indicators  $s_{1,t}$  and  $s_{2,t}$  determine causal links in the model. Following Fallahi (2011), the Granger causalities are detected by testing the following hypotheses,  $H_0 : \phi_{12}^{(k)} = 0$  and  $H_0 : \phi_{21}^{(k)} = 0$ . As a typical, if any of the coefficients of the lagged  $inf_t$  is significantly different than zero in the  $pdit_t$  vector, the null of  $inf_t$  does not Granger-cause  $pdit_t$  is rejected in favor of the alternative hypothesis of Granger-causality (Fallahi, 2011; Bildirici, 2013).

## 5. Econometric Results

### 5.1. Data

The data used in the study is taken from the electronic database system (EVDS) of CBRT. The dataset is monthly and covers 2002:01-2015:12 period. The dataset includes the CBRT borrowing rate ( $br_t$ ) and the lending rate ( $lr_t$ ). As noted in Section 3, the psychological dominance and market dominance indices are calculated as  $pdit_t = \ln(lr_t/br_t)$  and  $mdi_t = \ln(lr_t - br_t) / \ln(avg_t)$ . The consumer price index is denoted with  $cpit_t$  and is in natural logarithms. The GDP data in the EVDS system is calculated in quarterly frequency. As a result, the industrial production index (IPI), which is collected as monthly basis, is taken as a proxy of the GDP to increase the sample size in the study. As a result, the output gap is measured as  $og_t = IPI_t - hptrend_t$ , the deviations of the IPI from its trend where the  $hptrend_t$  is taken from the Hodrick-

Prescott filter<sup>3</sup>. Further, in the case of unit root processes, the variables that are in first differences are denoted with  $\Delta$ . It should be noted that the inflation rate is calculated as  $\Delta cpi_t = \ln(cpi_t) - \ln(cpi_{t-1})$  where  $\ln(\cdot)$  is the natural logarithms. Accordingly, in the case of unit roots in variables in levels,  $\Delta mdi_t$ ,  $\Delta pdi_t$  and  $\Delta ogt_t$  denote the growth rates of the MDI and the PDI indices and the growth rate of the output gap, respectively.

## 5.2. Unit Root and Stationarity Test Results

At the first stage, the time series to be evaluated are analyzed with linear and nonlinear unit root tests. The results are given in Table 1 where the traditional ADF and PP unit root tests are reported in the first two columns followed by the KPSS test of stationarity and (Kapetanios *et al.*, 2003; KSS) STAR type unit root test at the 3<sup>rd</sup> and 4<sup>th</sup> columns. The KPSS test has the well-known robustness to nonlinearity characteristics as discussed in many studies. Further, the KSS nonlinear STAR type unit root test allows simultaneous analysis of unit roots and nonlinearity. According to the traditional ADF and PP tests, all variables are accepted as following I(1) integrated of order 1 processes at conventional significance levels. The KPSS tests also confirm this result for the analyzed variables. Further, for all analyzed variables in levels, the nonlinear unit root hypothesis cannot be accepted with the KSS tests and the results for first differenced series confirm that first differenced variables are stationary at conventional significance levels.

**Table 1**

**Unit Root, Stationarity and Cointegration Tests**

Unit root and stationarity tests				
Variables:	ADF	PP	KPSS	KSS
cpit	-2.55	-1.88	1.18	-2.39
$\Delta$ cpit	-5.03***	-6.56 ***	0.05***	-3.09***
pdit	-1.49 t	-1.72 t	0.82 t	-0.91 t
$\Delta$ pdit	-8.94*** t	-9.01*** t	0.08*** t	-4.05*** t
mdit	-0.56 t	-1.86 t	0.33 t	-1.58t
$\Delta$ mdit	-4.65*** t	-10.14*** t	0.15** t	-5.49***t
ogt	-2.47	-2.12	0.73	-1.93
$\Delta$ ogt	-5.38***	-12.42***	0.06***	-3.16***
Johansen cointegration tests				
inft and pdit: $r=0:11.14, r\leq 1: 1.119$		inft and mdit: $r=0: 12.5573, r\leq 1 2.012$		

Notes. \* %10, \*\* %5, \*\*\*%1 denote significance levels of stationarity. For ADF tests, lag length is selected by modified Schwarz information criteria. For the PP and KPSS tests, the spectral estimation method is the Bartlett kernel and bandwidth is selected with Andrews method. For ADF and PP tests, the MacKinnon (1996) critical values for tests with intercept and trend (denoted with t) are -3.15, -3.45 and -4.04 at significance levels of %10, %5 and %1. Without trend, the respective critical values are -2.58, -2.89 and -3.49. For the KPSS test, critical values (with intercept and trend, denoted with t) are 0.119, 0.146 and 0.216 at the significance levels of 10%, 5%, and 1%. Without trend, (no t), the critical values are 0.347, 0.463, 0.739. The critical values for KSS nonlinear STAR type unit root tests (demeaned, no detrended data, Case 2) the critical values are -3.48, -2.93 and -2.66 (Kapetanios *et al.*, 2003; Table 1). For Case 3 (intercept+ trend, denoted with t), the KSS critical values are -3.13, -3.40 and -3.93.

<sup>3</sup> The HP filter is calculated with the default value of  $\lambda=14400$  in Eviews 8. The MS-VAR and MS-VAR Granger causality analyses are conducted in Oxmetrics package ver. 3 and the Oxmetrics MS-VAR library.

At the second step, the maximum likelihood procedure of Johansen is utilized to determine the possible existence of cointegration between  $inf_t$ - $pd_i$  and  $inf_t$ - $mdi$  in Table 1. According to Johansen Cointegration results, the null hypothesis of no cointegration was not rejected. Since they are not cointegrated, the first differenced or innovations of the variables,  $\Delta inf_t$ ,  $\Delta pd_i$  and  $\Delta mdi$  will be used to test for MS- Granger causality. If the overall unit root analyses are evaluated, variables are stationary at their first differences and among the nonlinear econometric approaches, the MS-VAR method is suitable.

### 5.3. The PDI and Inflation: MS-VAR Analysis

Below, the relation between the inflation rate and psychological dominance index is examined. Similar to the previous section, the MS-VAR approach gives important insights about the regime properties and the regime dependent behavior of the series analyzed.

**Table 2**  
**Estimation Results of MSIA(3)-VAR(2) Model: PDI and Inflation**

	Regime 1		Regime 2		Regime 3	
Variables	$\Delta cpi_t$	$\Delta pdi_t$	$\Delta cpi_t$	$\Delta pdi_t$	$\Delta cpi_t$	$\Delta pdi_t$
Constant	0.143**	-0.239**	-0.013**	-0.005*	0.074**	-0.448**
$\Delta cpi_{t-1}$	1.051* (1.88)	0.970* (1.87)	0.916 (1.37)	0.872* (1.86)	0.678*** (4.08)	0.454** (2.46)
$\Delta cpi_{t-2}$	-0.179 (1.25)	0.002* (1.93)	0.517** (2.42)	0.285* (1.91)	-0.011 (-0.72)	0.655** (1.98)
$\Delta pdi_{t-1}$	0.835*** (2.85)	1.149** (2.01)	0.412 (0.91)	1.872** (2.63)	0.813*** (2.85)	0.359** (2.57)
$\Delta pdi_{t-2}$	0.095*** (3.01)	-0.154 (1.01)	1.177 (0.08)	-0.111 (1.01)	0.433* (1.72)	0.542 (1.02)
Se	0.209	0.463	0.151	0.463	0.084	0.003
<b>Matrix of transition probabilities</b>						
$Pp_0$	0.811		0.187		0.001	
$Pp_1$	0.113		0.852		0.099	
$Pp_2$	0.061		0.0003		0.911	
<b>Contemporaneous Correlations</b>						
	Regime 1		Regime		Regime 3	
	$\Delta cpi_t$	$\Delta pdi_t$	$\Delta cpi_t$	$\Delta pdi_t$	$\Delta cpi_t$	$\Delta pdi_t$
$\Delta cpi_t$	1.000	0.679	1.000	0.202	1.000	0.117
$\Delta pdi_t$	0.679	1.000	0.202	1.000	0.117	1.000
Test Results: LogL: 440.7; Linearity test: 146.6 [0.0000]; AIC: -7.418; LR linearity test: 588.2 [0.000]; Chi(10) =[0.0000]; Chi(16)=[0.0000]; DAVIES=[0.0000]. * %10, ** %5, ***%1 denote significance levels of stationarity.						

The relation between  $pdi$  and inflation are modeled with various models that have different numbers of regimes, different orders of autoregression and different MS-VAR types including the MSIA, MSI and the MSIAH structures. Accordingly, based on statistical tests and information criteria, the optimum model is selected as a three regime MSIA(3)-VAR(2) model. As a typical, the Davies test (p val=0.0000) suggests rejection of the null hypothesis and the LR test statistic suggest rejection of 2 regimes MSIA(2)-VAR(2) model under the null and the acceptance of the alternative hypothesis of the three regimes MSIA(3)-VAR(2) model. The estimation results are given in Table 2. The transition probabilities are calculated

as  $\text{Prob}(s_t=1|s_{t-1}=1)=0.81$ ,  $\text{Prob}(s_t=2|s_{t-1}=2)=0.85$  and  $\text{Prob}(s_t=3|s_{t-1}=3)=0.91$  showing strong level of persistence in each of the three regimes.

The MSIA(3)-VAR(2) model points at a very significant finding. The first regime tends to last 1.23 month on average, while the second regime is found to be the regime with the highest persistence with the duration of 15.08 months comparatively. The computed probability ( $\text{Prob}(s_t=2|s_{t-1}=1)=0.1873$ ) reflects that the probability of switching to the second regime in the next period while the economy is in the first regime is very low. On the other hand, the computed probability  $\text{Prob}(s_t=3|s_{t-1}=1)=0.0009821$  reflects that the lowest probability among the regime switches: once the economy is in high inflation regime, the probability of switching to a low inflation rate regime is almost equal to zero. The possibility of entering to the high inflation rate regime following a moderate inflation rate regime (regime 2) is higher than the possibility of entering the high inflation rate regime (regime 3) phase from a low inflation rate regime (regime 1). Ergodic probabilities show that the dominant regime is the second regime and the transition probabilities,  $p_{11}=0.8118$ ,  $p_{22}=0.8517$  and  $p_{33}=0.9113$  signify to important asymmetries in the business cycle. The characteristics and the dominance of regime 3 signals that the economy is in the most persistent phases. Thus, this situation describes the presence of significant asymmetries between the regimes corresponding to different levels of inflation rates.

Furthermore, the maximum eigenvalues of the matrix of transition probabilities related to the stated three regime MS-VAR model is one and the other two eigenvalues are less than one and the transition probability matrix is ergodic. Ergodic transition probability matrix confirms stationarity of the regime. Ergodic transition probabilities matrix is always covariance-stationary. The matrix of transition probabilities and some regime properties can be calculated by using the smoothed regime inferences. In addition, the contemporaneous correlations point at an important result. In regime 1, the correlation between the inflation rate ( $\Delta cpi_t$ ) and psychological dominance index ( $\Delta pdi_t$ ) is 0.6787, comparatively high than those obtained in the other 2 regimes. In regime 1, the parameter estimates of the  $\Delta pdi_{t-1}$  and  $\Delta pdi_{t-2}$  in the  $\Delta cpi_t$  vector are 0.835 and 0.095; both are statistically significant and positive, suggesting that the accumulated result of a 1% increase in the  $pdi$  is almost equal to 1% increase in the inflation rates while in regime 3, at 5% significance level, 1% increase in  $pdi$  results in a 0.81% increase in the inflation rate at the 5% significance level. Though fiscal dominance, shown with the  $pdi$  index, has positive effects in both regime 1 and 3, the parameter estimates of 1<sup>st</sup> and 2<sup>nd</sup> lags of  $pdi$  are statistically insignificant in regime 2.

The overall evaluation of the results suggests that, in the low inflation and high inflation regimes, the increases in PDI, which represent contractionary monetary policies that aim at lowering inflation, result in increases in the inflation rate, the opposite of what is expected a priori. The empirical results confirm inflationary effects of the anti-inflationary policy in the low and high inflation regimes, while the effects on inflation are statistically insignificant in the moderate inflation regime (regime 2). If the PDI vectors are evaluated, the overall effect of inflation rates on the PDI index is positive in all three regimes suggesting that increases in inflation result in increases in PDI. However, given the results obtained for the inflation vectors, the anti-inflationary policies fail to cope with inflation though they have adverse and unexpected results, a finding in line with the FTPL theory and fiscal dominance in the economy.

#### **5.4. MDI and Inflation: MS-VAR Analysis**

The relation between inflation and MDI is analyzed with the MS-VAR method. The MS-VAR approach not only provides regime dependent nonlinear behavior between the two series, it also gives important insight regarding the regime dependent properties of this relation. To

determine the number of regimes in the MS-VAR model, 2 and 3 regime MS-VAR models with varying and non-varying autoregressive parameters, regime specific variances or common variance in all regimes are taken into consideration to determine the model architecture. The optimum model is selected as a MSIA(3)-VAR(1) model for which the LR test statistic is calculated as 767.7. For this model, the test statistics have a  $\chi^2(16)$  distribution since there are 10 constraints and 6 unidentified parameters. Accordingly, the test statistic is larger than the critical value both at 1% and 5% significance levels showing that the  $H_0$  hypothesis under which the model has a 2 regime is strongly rejected against the alternative  $H_1$  that there are 3 regimes.

Table 3

Estimation Results of MSIA(3)-VAR(1) Model: MDI and Inflation

Variables	Regime1 (low inflation)		Regime2 (moderate inflation)		Regim3 (high inflation)	
	$\Delta cpi_t$	$\Delta mdi_t$	$\Delta cpi_t$	$\Delta mdi_t$	$\Delta cpi_t$	$\Delta mdi_t$
Constant	0.560 (1.115)	-0.356 (1.36)	-0.191** (1.97)	-0.040* (1.68)	0.041** (2.01)	0.821** (1.99)
$\Delta cpi_{t-1}$	1.169** (2.11)	0.998** (1.99)	0.684 (1.163)	1.016* (1.93)	0.81*** (4.11)	0.662*** (2.68)
$\Delta mdi_{t-1}$	0.696*** (2.96)	0.536 (1.023)	0.558*** (3.91)	0.765*** (2.55)	0.33** (2.15)	0.589*** (2.71)
se	0.305	0.463	0.114	0.287	0.084	0.051
<b>Matrix of transition probabilities</b>						
$Pp_0$	0.927		0.099		0.0009	
$Pp_1$	0.0003		0.912		0.066	
$Pp_2$	0.091		0.0001		0.901	
<b>Contemporaneous Correlations</b>						
	Regime 1		Regime 2		Regime 3	
	$\Delta cpi_t$	$\Delta mdi_t$	$\Delta cpi_t$	$\Delta mdi_t$	$\Delta cpi_t$	$\Delta mdi_t$
$\Delta cpi_t$	1.000	0.602	1.000	0.483	1.000	0.501
$\Delta mdi_t$	0.602	1.000	0.483	1.000	0.501	1.000
Log-likelihood = 768.7; Linear system=715.6; AIC=-30.669; Linear system=-29.7; LR linearity test=106.4; Chi(10) =[0.0000]; Chi(16)=[0.0000]; DAVIES=[0.0000]. * %10, ** %5, ***%1 denote significance levels of stationarity.						

Similarly, for the Davies test, the p value is calculated as [0.0000] and shows that the null hypothesis is rejected. As a result, the MSIA(3)-VAR(1) model is preferred over its one and two regime counterparts.

The estimated MSIA(3)-VAR(1) model is reported in Table 3. The majority of the coefficients are found to be statistically significant at 5% significance level. The transition probabilities are  $\text{Prob}(s_t = 1|s_{t-1}=1)=0.9268$ ,  $\text{Prob}(s_t = 2|s_{t-1}=2)= 0.9120$  and  $\text{Prob}(s_t = 3|s_{t-1} = 3)= 0.901$  which suggest high level of persistence. Further, the transition probabilities of regime 2 and 3 are very close. The average duration calculated for each regime are consistent with various results.

The MSIA(3)-VAR(1) model point to a very significant finding. The three regimes can be attributed to different economic phases, namely the low, moderate and high inflation regimes, the regimes 1, 2 and 3, respectively. The computed probability reflects that the

lowest probability of regime switches could be stated as follows: once the economy is in high inflation rate regime, the probability of switching to a low inflation rate regime is almost equal to zero. The possibility of entering to the high inflation rate regime following a moderate inflation rate regime is higher than the possibility of entering the high inflation rate regime phase from a low inflation rate regime.

The t values of parameter estimates are reported in parentheses. If an overall look is to be presented, in all regimes for both  $\Delta mdi$  and  $\Delta cpi$  vectors, the estimates of the statistically significant parameters have positive signs. The contemporaneous correlations are also in line with this finding. In the low inflation regime (regime 1), a 1% point increase in  $mdi$  leads to a 0.696% points increase in inflation rates. The dominant characteristics of regime 2 show that the economy is in the most persistent phases in which the economy is subject to significant asymmetries once compared to the other regimes. In both vectors, a positive association between the  $\Delta mdi$  and  $\Delta cpi$  cannot be rejected. At 1% significance level, a 1% point increase in  $mdi$  results in a 0.558 % points increase in the inflation rate; at 10% significance level. On the other hand, a 1% point increase in  $cpi$  results in a 1.016 % point increase in  $mdi$ . While being estimated as 0.558 in the moderate inflation (regime 2), the parameter estimate of  $\Delta mdi_{t-1}$  is 0.33 in the high inflation regime. As a result, the difference in the parameter estimates represents a high degree of asymmetry.

If the response of  $mdi$  is analyzed, important information could be gathered regarding the reaction of the monetary authority against changes in inflation rates. According to the results, a 1% point increase in the inflation rate results in a 0.998% increase in the  $mdi$  in regime 1, an almost 1 to 1 response to a 1% point increase in the inflation rates. Similarly, in regime 2, the relevant parameter estimate is 1.016, representing again an almost 1 to 1 response with one difference: compared to regime 1, this response could only be accepted at 10% significance level and with a higher degree of accepting a type 1 error, at 5 % significance level, this response is statistically insignificant. In regime 3 which represents the high inflation regime, the relevant parameter is estimated as 0.66, comparatively lower than those in regimes 1 and 2. In the high inflation regime, the response of the monetary authority is 0.66% point increase in MDI as a result of a 1% point increase in the inflation rate; comparatively lower than what is expected in the high inflation regime.

If the evaluated MDI vectors are investigated in the spirit of a Taylor-rule type policy, the significant deviations should be kept in mind since instead of a policy rate, an interest rate corridor policy rule is followed in Turkey for the analyzed period. As noted in section 2, the study aimed at overcoming this difficulty by utilizing two interest rate policy indices derived from the spread in these two policy rates. As given in the literature section, recent studies also followed a similar approach to overcome this difficulty. In light of the models evaluated above, the response of the policy interest rate differential is far from being close or larger than 1.5 in each regime in contrast to the suggestion of Taylor (1993). The response parameter diminishes to 0.66, far lower than 1.5 even in the high inflation regime. According to the results, though the monetary authority tries to cope effectively with inflation, the obtained responses of the CBRT fail to achieve the inflation targets for the sample analyzed mainly due to the fiscal dominance in the economy captured with the PDI and MDI indices. For a discussion of fiscal dominance and interest rate corridor policy, readers are referred to Bildirici *et al.* (2015).

## **5.5. Traditional and MS-Granger Causality Results**

MS-Granger causality test is used to examine the causal relationship between  $\Delta mdi - \Delta cpi$  and  $\Delta pdi - \Delta cpi$ . As noted in Table 1, the hypotheses of a unit root cannot be rejected at 5% level of significance for the analyzed variables in levels and are integrated of order 1.

Therefore, 1<sup>st</sup> differences or put in other words, the innovations of the variables are utilized in the analysis. To obtain a comparison with the baseline approach, the linear Granger causality results are reported in Table 4. According to the results, the null hypotheses of  $\Delta mdi$  and  $\Delta pdi$  are not the Granger-causes of  $\Delta cpi$ , the inflation rate, cannot be rejected at 5% significance level. However, the opposite holds and at 1% significance level, the alternative hypotheses that  $\Delta cpi$  Granger-cause  $\Delta pdi$  (at 10% significance level) and  $\Delta pdi$  Granger-cause  $\Delta mdi$  (at 1% significance level) are accepted<sup>4</sup>. Therefore, if the data generating process is assumed to be linear, while the policy rate indices do not Granger-cause inflation rates, while the direction of causality runs in the opposite way, from inflation rates to the policy rate indices.

Table 4

Results of Linear Granger Causality

Direction:	$\Delta pdi \rightarrow \Delta cpi$ $\Delta cpi \rightarrow \Delta pdi$	$\Delta mdi \rightarrow \Delta cpi$ $\Delta cpi \rightarrow \Delta mdi$
F stat.:	0.88(0.45)	1.33(0.26)
F stat:	2.41(0.07)	4.56(0.004)

Following the methodology given by Fallahi (2011) and Bildirici (2012, 2013), the nonlinear MS-Granger causality analysis is conducted using the estimated MSIA-VAR model given in Table 3. The dependent variable in the first equation is the innovation of  $cpi$ , i.e., the inflation rate ( $\Delta cpi$ ). The estimated coefficients of  $mdi$  innovations,  $\Delta mdi$ , are significant at 5% significance level, suggesting that the rejection of the null of  $mdi$  does not Granger-cause inflation. Further, if the second vectors of the model given in Table 3 are evaluated, in all of the three vectors, the parameters of  $\Delta cpi$  are statistically significant. The nonlinear MS-Granger causality results suggest evidence of bidirectional Granger causality from  $\Delta cpi$  to  $\Delta mdi$  and from  $\Delta mdi$  to  $\Delta cpi$  at 5% significance level.

The MS-Granger causality test is further evaluated by the use of the model reported in Table 2 for  $\Delta pdi$  and  $\Delta cpi$  variables. The dependent variables in the first and second vectors are the innovations of inflation rates and  $pdi$ . In regime 1, the estimated coefficients of  $pdi$  innovations ( $\Delta pdi$ ) are significant at 5% significance level which suggests that  $pdi$  is the Granger cause of inflation rates in the low inflation regime. Further, in the  $\Delta pdi$  vector of regime 1, the parameters of inflation are statistically significant at 10%. The results suggest bi-directional causality at 10% and unidirectional causality at 5% from  $pdi$  to inflation. In regime 2, unidirectional causality from inflation to  $pdi$  exists at 5% significant level. In regime 3, bi-directional causality cannot be rejected both from  $pdi$  to  $cpi$  and from  $cpi$  to  $pdi$ . The results are in line with the interpretations conducted for the parameter estimates in the previous section and the empirical findings show that  $pdi$  is a strong indicator of inflation in all of the three regimes and bi-directional causality exists in low and high inflation regimes. One interesting finding is that, compared to the baseline approach, the linear Granger causality that favors unidirectional causality from inflation to  $pdi$  and unidirectional causality from inflation to  $mdi$  only, our nonlinear Granger causality results suggest that bidirectional causality exists between inflation and  $mdi$  and between  $pdi$  and inflation once the nonlinearity is taken into consideration. Accordingly,  $cpi$  appears to be Granger cause of  $pdi$  and  $mdi$  in the majority of regimes and both indices, the  $pdi$  and  $mdi$  appear to be the Granger cause of

<sup>4</sup> In the analysis, lag length  $p$  are selected with SIC information criteria, similar to the models given in Tables.

*cpi*. In sum, in contrast to the linear causality results, the nonlinear causality approach suggests evidence of bi-directional Granger causality between *cpi* - *pdi* in regimes 1 and 3, uni-directional causality (from *inf* to *pdi* in regime 2 and bi-directional causality between *cpi*-*mdi* in all of the 3 regimes, respectively.

## **5.6. Results for the MDI and PDI Based Nonlinear Taylor Rules**

Because CBRT set the policy interest rate in light of the Taylor rule, the analysis conducted above is extended to nonlinear interest rate rules that take feedback from the output in addition to a feedback from the inflation rate. In the Taylor rule, the definition of the variables deserves special attention. In terms of the selection of the price level variable, Taylor (1993) uses the annual change of Gross National Product (GNP) deflator to calculate the inflation rates. Kozicki (1999) investigates the Taylor rule and possible differentiations in terms of the results with four different inflation variables. Similar to the previous analysis, this section utilizes the CPI index with one difference: following Taylor (1993), this section utilizes the deviations of the inflation from the inflation target instead of the inflation rate itself as done in the previous sections. The inflation targets ( $it_t$ ) are taken from the Central Bank and the deviation of the inflation rate from the target is defined as  $inf_t = \Delta cpi_t - it_t$ . For the definition of the potential production variable, the original article of Taylor utilizes a time series approach to calculate the trend as a proxy for the actual production (Taylor, 1993). The other approaches in the literature include linear and parabolic trend equations, structural equation approaches and the usage of the Hodrick-Prescott (HP) filter. In the study, as shown in section 5.1, due to the lack of monthly GDP statistics, the industrial production index (IPI) is taken as a proxy of production and by using the HP filter, the output gap ( $og_t$ ) is calculated as  $og_t = IPI_t - hptrend_t$ , where the IPI is in natural logarithms. Further, due to following an I(1) process, the utilized variable, the first difference of  $og_t$  ( $\Delta og_t$ ) also represents the growth rate of the output gap. The equilibrium real interest rate calculations in the literature focus on the approaches of Kozicki (1999) and Judd and Rudebusch (1998) that use the average of federal fund rates and the average of inflation rates to obtain a real equilibrium interest rate measure.

By following a similar approach, Rudebusch (2001) shows that the equilibrium interest rate is calculated as 2.2%. Due to the difference in terms of following two different policy rates, the borrowing and the lending rates, as shown by the previous analysis, the study focuses on the *pdi* and *mdi* indices<sup>5</sup>. Since both *pdi* and *mdi* indices are derived from both borrowing and lending rates, these indices are utilized in two different MS-VAR models one by one. Other variables to provide a measure of equilibrium interest rates exist in the literature. Additionally, Judd and Rudebusch (1998) generalize the original Taylor rule to MS-VAR models to analyze the federal fund rates. Following Judd and Rudebusch (1998), the study also benefits from the MS-VAR approach by adding the MS-Granger causality analysis while the equilibrium interest rate is taken as the *pdi* and *mdi* indexes due to the characteristics of the monetary policy in Turkey. With this respect, our study is also an additional contribution to the literature in the sense of adding additional variables to investigate the Taylor-type rules within econometric approaches.

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<sup>5</sup> As discussed in the literature section, to our knowledge, two other studies exist that aim to overcome this difficulty by proposing indices, Binici et al. (2016) and Çamlıca (2016) in addition to the early studies of Bildirici et al. (2014, 2015) where the PDI and MDI indices are suggested. The difference of the two PDI and MDI indices is their theoretic relation to FTPL and fiscal dominance.

The first nonlinear MS-VAR type Taylor rule and the estimation results are given in Table 5. In this model, the *mdi* index is used as the policy interest rate to measure the response of the central bank to the deviations in the inflation from its target and to the output gap. The model is selected as a MSIA(3)-VAR(2) model following the sequential tests discussed in the previous section and are not reported to save space.

Table 5

Taylor Rule Results for the MDI index: MSIA(3)-VAR(2) Model

	Regime 1			Regime 2			Regime 3		
	<i>inf<sub>t</sub></i>	$\Delta mdi_t$	$\Delta og_t$	<i>inf<sub>t</sub></i>	$\Delta mdi_t$	$\Delta og_t$	<i>inf<sub>t</sub></i>	$\Delta mdi_t$	$\Delta og_t$
<i>Cons.</i>	0.01 (1.12)	1.25* (1.82)	0.01* (1.78)	0.77 (1.23)	1.25* (1.82)	0.14* (1.78)	0.17* (1.82)	0.08* (1.87)	0.31* (1.78)
<i>inf<sub>t-1</sub></i>	0.06 (1.23)	0.01* (1.72)	0.96* (1.87)	1.54* (1.77)	0.59* (1.77)	1.66* (1.87)	0.13 (1.23)	0.58* (1.88)	0.61* (1.79)
<i>inf<sub>t-2</sub></i>	0.90 (1.53)	1.57** (1.97)	1.11*** (2.85)	0.97* (1.93)	1.50* (1.93)	1.33** (2.51)	0.88* (1.76)	0.10* (1.77)	1.11*** (2.85)
$\Delta og_{t-1}$	1.11** (2.02)	0.31 (1.05)	0.98** (1.99)	1.34** (2.42)	0.56* (1.75)	0.78** (2.01)	0.23** (2.13)	0.66* (1.85)	0.98** (1.99)
$\Delta og_{t-2}$	0.53* (1.81)	0.83* (1.89)	0.73* (1.65)	0.76* (1.93)	0.39* (1.92)	1.07 (0.05)	0.38 (1.44)	0.44* (1.77)	0.23* (1.88)
$\Delta mdi_{t-1}$	1.10* (1.89)	1.23 (0.86)	1.11* (1.78)	0.83* (1.76)	1.36 (0.64)	1.09 (1.23)	0.48* (1.91)	1.33 (1.16)	1.31* (1.88)
$\Delta mdi_{t-2}$	0.89* (1.65)	0.87* (1.89)	0.93** (2.00)	0.36* (1.85)	0.82* (1.78)	0.47** (2.1)	0.53* (1.78)	0.87* (1.89)	0.38** (2.11)
<i>se</i>	0.785	0.227	0.553	0.011	0.027	0.001	0.005	0.032	0.056
<b>Matrix of transition probabilities</b>									
<i>Pp<sub>0</sub></i>	0.8112			0.1873			0.0009		
<i>Pp<sub>1</sub></i>	0.0003			0.9112			0.0663		
<i>Pp<sub>2</sub></i>	0.1017			0.0001			0.8703		
<b>Contemporaneous Correlations</b>									
	Regime 1			Regime 2			Regime 3		
	<i>inf<sub>t</sub></i>	$\Delta og_t$	$\Delta mdi_t$	<i>inf<sub>t</sub></i>	$\Delta og_t$	$\Delta mdi_t$	<i>inf<sub>t</sub></i>	$\Delta og_t$	$\Delta mdi_t$
<i>inf<sub>t</sub></i>	1.00	0.402	0.55	1.00	0.18	0.46	1.00	0.36	0.40
$\Delta og_t$	0.40	1.00	0.33	0.18	1.00	0.58	0.36	1.00	0.27
$\Delta mdi_t$	0.55	0.33	1.00	0.46	0.58	1.00	0.40	0.27	1.00
Log-likelihood = 750.57, Linear system = 707.40; AIC criterion = -33.46, Linear system = -32.83; LR linearity test = 86.35, Chi(10)=[0.0000], Chi(14)=[0.0000], DAVIES=[0.0000]									

Note that the model consists of *Inf<sub>t</sub>*,  $\Delta mdi_t$  and  $\Delta og_t$  vectors. Among these, by taking the policy response endogenous, the  $\Delta mdi_t$  vector represents a nonlinear variant of the Taylor rule. As discussed in Sections 1 and 2, as the spread between the borrowing and lending rates widens, the fiscal dominance increases. Therefore, the three regimes could also be interpreted as high, moderate and low fiscal dominance regimes. In regime 1, the parameter of the second lag of the inflation rate *inf<sub>t-2</sub>* is estimated as 1.57 and is statistically significant at 5% significance level suggesting that a 1% point increase in the inflation rates results in a 1.57 % point increase in the *mdi*. In the moderate fiscal dominance regime, the parameter estimate of *inf<sub>t-2</sub>* is very close to that estimated for the low fiscal dominance regime. This

parameter estimate is equal to 1.5, suggesting a strong response to inflation similar to that suggested by Taylor (1993). Further, the parameter of  $\Delta cpi_{t-1}$  is 0.59. As a result, the accumulated response advocates a 2.09% point increase in the policy rate response resulting from a 1% increase in inflation rates in the two preceding periods. However, both of these parameters are statistically significant at 10% significance level though a large response exists in regime 2. Contrarily, in regime 3 which represents low fiscal dominance, the relevant parameter estimates of inflation are 0.58 and 0.10 characterizing a very truncated response to increases in the inflation rates. Yet again this response is statistically significant only at 10% significance level. Overall results lead to the conclusion that strong asymmetry among the three regimes exists and Taylor type responses of *mdi* to inflation rates cannot be rejected, however, this type of response is statistically significant only at 10% significance level in regimes 2 and 3.

If the responses that result from increases in the output gap on *mdi* are analyzed, the parameter of  $og_{t-1}$  is statistically insignificant while the parameter of  $og_{t-2}$  is statistically significant at 10% with an estimate equal to 0.83 in regime 1; a lower than 1% positive response in the policy rates resulting from a 1% point increase in the output gap. In regime 2, the relevant parameter estimates are 0.56 and 0.39, accumulating to a 0.95% point increase in the policy rate resulting from 1% increases in the output gap in the two previous periods, a conclusion that is statistically significant at 10% significance level. In regime 3, these parameters are estimated as 0.66 and 0.44, and overall, the accumulated response sums to a 1% point increase in the policy rate if the output gap increases 1% in each of the previous periods. The overall evaluation shows that, in addition to responding positively to the output gap, this policy response is a less than 1 to 1 effect though this finding cannot be accepted at 5% significance level. The results are in line with the Taylor rule and embody asymmetry and regime-dependency in *mdi* resulting from the deviations of economic growth from its trend.

Last but not least, the first vectors in three distinct regimes require intensive evaluation in terms of the main focus of the study that aims at evaluating the effects of *mdi* on inflation rates. In all three regimes, increases in the *mdi* index have positive effects on the inflation rates, the opposite of what is expected from active monetary policies. However, this interpretation is only valid at 10% significance level. One important finding is in regards to the 3<sup>rd</sup> vectors of each regime. In contrast to the general consensus, increases in the policy rates, represented by the *mdi* index, results in increases in the output gap and this finding is statistically significant at 5% significance level in the majority of the parameters of  $\Delta mdi_{t-1}$  and  $\Delta mdi_{t-2}$ . This type of real effects that result from policy interest rate increases are in line with economies with non-Ricardian characteristics and are in favor of the propositions of the FTPL theory (Leeper, 1991; Woodford, 2000).

Further evaluation will be conducted with the *pdi* index. The results are given in Table 6. The transition probabilities are calculated as  $\text{Prob}(s_t = 1 | s_{t-1} = 1) = 0.88$ ,  $\text{Prob}(s_t = 2 | s_{t-1} = 2) = 0.90$  and  $\text{Prob}(s_t = 3 | s_{t-1} = 3) = 0.88$  showing strong level of persistence in each of the three regimes while the highest is achieved for regime 2. In all of the three regimes, the effect of *pdi* is positive on the inflation rates while the highest coefficient is achieved for regime 1 with 1.27. In all regimes, the coefficients of the output gap are positive; 1.38, 1.04 and 0.23 in regimes 1, 2 and 3. The results suggest a more than 1 to 1 impact of economic growth on inflation in regimes 1 and 2. In terms of the Taylor rule, the second vectors in each regime deserve special attention. The results obtained with the *pdi* index in the context of nonlinear Taylor rule shows that, in regime 1, the parameter estimate of  $Inf_{t-1}$  is 0.22, suggesting that a 1% point increase in the inflation rate results in a 0.22% point increase in the  $\Delta pdi$ ; a very

low response compared to the suggestion of Taylor (1993) that requires a more than one to one response in the policy rates. Additionally, this parameter is statistically significant at 10% significance level only. In regime 2 that represents the moderate fiscal dominance, the policy response to inflation is comparatively larger than that occurs in regime 1: a 1% point increase in  $inf_{t-1}$  leads to a 0.92% increase in  $\Delta pdi_t$ . Additionally, though the response is greater in regime 2, it is statistically significant only at 10%. In the high fiscal dominance regime, a 1% increase in  $Inf_{t-1}$  results in a 0.92% increase in  $\Delta pdi_t$  at 10% significance level. The overall evaluation shows that though the monetary policy responds positively by increasing the policy interest rate, the response fails to be in line with the expected magnitude. One additional note is that the significance of the parameters, mostly in the output gap followed by the inflation rate vectors, increase drastically compared to the  $pdi$  vectors in the analysis. Further, in addition to the positive effects of the  $mdi$  on the output gap, the relevant results obtained for the  $pdi$  index are in line with those given in Table 5.

Table 6

Taylor Rule Results for the PDI Index: MSIA(3)-VAR(1) Model

Variable	Regime 1			Regime 2			Regime 3		
	$Inf_t$	$\Delta pdi_t$	$\Delta og_t$	$Inf_t$	$\Delta pdi_t$	$\Delta og_t$	$Inf_t$	$\Delta pdi_t$	$\Delta og_t$
Constant	0.83* (1.68)	1.25* (1.82)	0.002* (1.78)	0.77 (1.23)	1.34* (1.77)	0.13* (1.78)	0.65* (1.82)	0.35* (1.87)	0.45* (1.89)
$Inf_{t-1}$	0.75* (1.88)	0.22* (1.72)	0.67* (1.87)	1.11* (1.88)	0.92* (1.77)	0.98* (1.93)	0.26 (1.23)	0.95* (1.88)	0.81** (1.97)
$\Delta og_{t-1}$	1.38** (2.44)	0.61 (1.05)	0.91** (1.99)	1.04** (2.27)	0.71* (1.85)	0.66** (2.31)	0.23** (2.13)	0.66* (1.85)	0.86** (1.98)
$\Delta pdi_{t-1}$	1.27* (1.77)	1.1 (0.86)	1.87* (1.81)	0.37* (1.76)	1.23*** (2.65)	1.92* (1.88)	0.48* (1.91)	0.38** (1.96)	1.21** (1.97)
se	0.39	0.24	0.22	0.03	0.05	0.044	0.083	0.012	0.056
<b>Matrix of transition probabilities</b>									
$Pp_0$	0.8772		0.119		0.0034				
$Pp_1$	0.006		0.901		0.0885				
$Pp_2$	0.107		0.001		0.8803				
<b>Contemporaneous correlations</b>									
	Regime 1			Regime 2			Regime 3		
	$Inf_t$	$\Delta og_t$	$\Delta pdi_t$	$Inf_t$	$\Delta og_t$	$\Delta pdi_t$	$Inf_t$	$\Delta og_t$	$\Delta pdi_t$
$Inf_t$	1.00	0.52	0.49	1.000	0.62	0.51	1.000	0.13	0.501
$\Delta og_t$	0.52	1.00	0.35	0.62	1.00	0.39	0.13	1.00	0.20
$\Delta pdi_t$	0.49	0.35	1.00	0.51	0.39	1.00	0.501	0.20	1.000
Log-likelihood = 742.44, Linear system = 680.6; AIC criterion = -29.02, Linear system = -28.42; LR linearity test = 123.75, Chi(12)=[0.0000]**, Chi(14)=[0.0000]**, DAVIES=[0.0000]**									

The results show that fiscal dominance has strong positive impacts on inflation in all three regimes in addition to its positive effects on the production. Accordingly, active monetary policies that aim at lowering inflation rates have failed to provide the characteristics that are in line with the Taylor (1993) and though the monetary authority aims at lowering the inflation rates to their target levels, the inflation targets cannot be reached adequately due to fiscal dominance in the economy.

### 5.7. Linear and Nonlinear Causality Results Based on Taylor Rules

The aim of this section is to investigate possible similarities and/or differences since the identification of the direction of causality provides important insights regarding the policy suggestions. The baseline linear Granger causality results are given in Table 7. The optimum lag length in each VAR( $p$ ) model is selected with the SIC information criterion as those suggested in Tables 5 and 6.

**Table 7**

**Linear Granger Causality Results for the PDI Based Taylor Rule**

Direction:	$\Delta PDI \rightarrow \Delta CPI$	$\Delta PDI \rightarrow \Delta OG$	$\Delta OG \rightarrow \Delta CPI$
	$\Delta CPI \rightarrow \Delta PDI$	$\Delta OG \rightarrow \Delta PDI$	$\Delta CPI \rightarrow \Delta OG$
F stat.:	0.73(0.53)	5.01(0.00)	0.43(0.76)
F stat:	3.11(0.01)	0.91(0.43)	4.69(0.00)
Direction of causality	$\Delta CPI \rightarrow \Delta PDI$	$\Delta PDI \rightarrow \Delta OG$	$\Delta CPI \rightarrow \Delta OG$

The results suggest that, at 5% significance level, the null hypothesis that *pdi* innovations are not the Granger-cause of inflation rates cannot be rejected. Further, the opposite holds: the null of inflation rates are not the Granger-cause of *pdi* innovations is rejected in favor of the alternative. The results suggest that, at 5% significance level, uni-directional Granger-causality exists between  $\Delta pdi$  and  $\Delta cpi$ . Further, the findings show that uni-directional causality cannot be rejected between  $\Delta pdi$  and  $\Delta og$ , the direction of causality running from *pdi* to the output gap innovations. Lastly, the results obtained for the  $\Delta og$  and  $\Delta cpi$  suggest that, at 5% significance level, uni-directional causality cannot be rejected where the direction of causality is from the inflation rates to the output gap innovations.

The results of MS-Granger causality for the analyses conducted for the *pdi* index are given in Table 8 and 10. The overlook show that the results obtained with MS-Granger causality are again differentiated compared to the results obtained in the linear causality setting (in Table 7 and 9).

**Table 8**

**MS-Granger Causality Results for the PDI Based Taylor Rule**

	<b>Regime 1</b>	<b>Regime 2</b>	<b>Regime 3</b>
Direction of causality	$\Delta PDI \leftrightarrow INF$	$\Delta PDI \leftrightarrow INF$	$\Delta PDI \leftrightarrow INF$
Direction of causality	$\Delta PDI \rightarrow \Delta OG$	$\Delta PDI \leftrightarrow \Delta OG$	$\Delta PDI \leftrightarrow \Delta OG$
Direction of causality	$INF \leftrightarrow \Delta OG$	$INF \leftrightarrow \Delta OG$	$INF \leftrightarrow \Delta OG$

Further, the general conclusion is that the utilization of the traditional linear Granger causality could result in wrong policy suggestions especially if the analyzed series and relations are subject to nonlinearity. According to the MS-Granger causality results, bi-directional causality cannot be rejected for all of the regimes analyzed. A comparison of two methods, namely, linear and nonlinear Granger causality results could be achieved by investigating Table 9 and 10.

If the linear causality results are investigated, the null hypothesis of  $\Delta mdi$  does not Granger cause  $\Delta cpi$  cannot be rejected, therefore the alternative hypothesis of  $\Delta mdi \rightarrow \Delta cpi$  is rejected at conventional significance levels. Contrarily, the null that states that a reverse

causation that runs from cause  $\Delta cpi$  to  $\Delta mdi$  is accepted given that the F stat = 5.561. The overall results suggest that, with the linear approach, though  $\Delta mdi \rightarrow \Delta cpi$  is rejected, the hypothesis of  $\Delta cpi \rightarrow \Delta mdi$  is accepted. Accordingly, if the linear Granger causality is followed, a uni-directional causality that runs from inflation rates to policy rates exists while the opposite does not hold. The causal relations between  $\Delta mdi$  and  $\Delta og$  are investigated at column 2. Accordingly, uni-directional causality is accepted between  $\Delta mdi$  and  $\Delta og$ , the policy rates and the output gap, where the causal link that runs from the policy rates to the output gap,  $\Delta mdi \rightarrow \Delta og$ , cannot be rejected. Similarly, at the third column, a uni-directional causality cannot be rejected between the inflation rates and the output gap, while bidirectional causality is rejected. Accordingly, the causality is accepted to be from the inflation rates to the output gap,  $\Delta cpi \rightarrow \Delta og$ .

Table 9

Linear Granger Causality Results for the MDI Based Taylor Rule

Direction:	$\Delta mdi \rightarrow \Delta cpi$ $\Delta cpi \rightarrow \Delta mdi$	$\Delta mdi \rightarrow \Delta og$ $\Delta og \rightarrow \Delta mdi$	$\Delta og \rightarrow \Delta cpi$ $\Delta cpi \rightarrow \Delta og$
F stat.:	0.87(0.48)	4.98(0.00)	0.89(0.23)
F stat:	5.561(0.00)	0.071(0.93)	3.91(0.01)
Direction of causality	$\Delta cpi \rightarrow \Delta mdi$	$\Delta mdi \rightarrow \Delta og$	$\Delta cpi \rightarrow \Delta og$

Following the estimation results of the MS-VAR models for the Taylor rules presented in Tables 5 and 6, the nonlinear Granger causality results are evaluated in the spirit of Fallahi (2011) and Bildirici (2013). The results are summarized in Table 10. Accordingly, bi-directional causality cannot be rejected for the variables analyzed within the nonlinear MS-VAR context for the analyzed sample in Turkey. Though the linear Granger causality results suggest uni-directional causality between the analyzed variables, the results of the nonlinear causality approach are in favor of the finding that bi-directional causality cannot be rejected for the analyzed variables once the nonlinearity between the analyzed variables is taken into consideration. If the linear and nonlinear causality results are compared, even though the linear approach suggests that the policy rates proxied with the *mdi* respond to the changes in the inflation rates, the opposite direction of causality also exists as shown with the nonlinear approach.

Table 10

MS-Granger Causality Results for the MDI Based Taylor Rule

	Regime 1	Regime 2	Regime 3
Direction of Causality	$\Delta mdi \leftrightarrow inf$	$\Delta mdi \leftrightarrow inf$	$\Delta mdi \leftrightarrow inf$
Direction of Causality	$\Delta mdi \leftrightarrow \Delta og$	$\Delta mdi \leftrightarrow \Delta og$	$\Delta mdi \leftrightarrow \Delta og$
Direction of Causality	$inf \leftrightarrow \Delta og$	$inf \leftrightarrow \Delta og$	$inf \leftrightarrow \Delta og$

In contrast to the findings of the uni-directional causality in the form of  $\Delta MDI \rightarrow \Delta OG$  and  $\Delta CPI \rightarrow \Delta OG$  which was accepted with the linear approach, the nonlinear approach suggests that the opposite direction of causality also cannot be rejected for the analyzed variables. By comparing the linear and nonlinear Granger causality approaches, strong implications could be derived in terms of policy suggestions. According to the results, since the bi-directional causality between the inflation rates and the policy rate indices cannot be rejected, policy makers should be kept in mind the fact that the analyzed macroeconomic

variables of output growth and inflation also have strong effects on the policy rates. As a result, instead of following a direct policy approach in cases of small deviations, i.e. small deviations of inflation from the target rate, policy makers should not focus on altering the policy rates and especially the spread between the two rates that define the interest corridor, since the bi-directional causalities have strong implications on the GDP growth rate and inflation rates; especially a positive effect on inflation after widening the spread between the two policy rates. In such cases, the policy makers should focus on utilizing indirect policies without altering the policy rates unless strong deviations from the macroeconomic variables occur. In other cases, the results suggest that instead of widening the spread, by increasing the policy rates simultaneously by narrowing the spread between the two rates could help on achieving lowering the inflation rates towards their target levels, whereas, this type of policy could have adverse effects on the economic growth rates; a finding that suggests throughout investigation of the tradeoff between the policies targeting both the economic growth and inflation rates.

## **6. Conclusion**

The study focused on analyzing an economy that applies inflation targeting rule by determining the policy interest rate was determined actively by the Taylor rule. In contrast to the intentions behind such policy, the monetary authority involuntarily faced unanticipated inflation. Further, depending on the level of the fiscal dominance in certain regimes, the policy maker could fail to lower the inflation rates effectively towards their targeted levels. In the study, two separate indices, the market dominance and psychological dominance were utilized not only to produce dependent variables that consisted of the two policy rates of the monetary policy in an interest rate corridor policy environment, but also the two indices were evaluated in terms of investigating the possibility of the inflationary effects of the spread between CBRT's borrowing and lending interest rates. Both PDI and MDI indices are in line with the spread between the borrowing and lending interest rates applied by the monetary authority and the historical investigation of the monetary policies was known to fail in catching up the inflation targets adequately.

In the empirical section, two sets of analyses were conducted. The first set focused on the effects of the psychological dominance and market dominance indices on the inflation rates with Markov switching models, while the second set of models focused on estimating nonlinear Taylor type rules with the MS-VAR models. Additionally, all sets of models were investigated with linear and nonlinear causality approaches. The testing procedure allowed estimating MSIA-VAR type nonlinear models that could be extended to nonlinear Granger causality. The empirical results provided important findings. In all of the estimated models, the level of persistence of the regimes could not be rejected. The 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> regimes corresponded to high, moderate and low inflation periods. 3<sup>rd</sup> regime was calculated as lasting 11.03 months on the average; whereas the average duration of 1<sup>st</sup> regime was 1.23 months. The second regime that corresponded to moderate inflation periods was observed to possess the highest persistence with the duration of 15.08 months in Turkey for the analyzed period. The analyses conducted with the MDI index showed that, if the economy was in a high inflation regime, the probability to switch to a low inflation regime was almost equal zero. On the other hand, the possibility of entering to a high inflation rate following a moderate inflation rate regime was higher than the possibility of entering into this regime from low inflation rate regime.

Following the MS-VAR analysis, important implications were obtained with causality analyses. While the conventional Granger causality test showed a uni-directional relation, we had obtained a more detailed analysis with MS-Granger causality once nonlinearity was taken into consideration. The analysis provided strong evidence of persistence of inflation and confirmed the discussions given in the literature regarding the impact of fiscal dominance in Turkish economy given the fact that the monetary policy tools were shown to affect inversely in terms of coping with inflation. In terms of the results determined for the Taylor rules, the coefficient of inflation was positive in all PDI vectors of all three regimes. This finding suggested a positive response of the monetary authority to cope with inflation; however, the findings had been statistically significant only at 10% significance level. Further, increases in the MDI index had positive effects on the inflation rates, the opposite of what was expected to achieve strong stabilizing effects on inflationary pressures. The results showed that fiscal dominance has strong positive impacts on inflation in all regimes in the models estimated with PDI and MDI indices. Further, the active monetary policies that aimed at lowering inflation rates had been insufficient in lowering the inflation rates to their targeted levels and the spread between two policy rates had adverse effects on inflation.

By comparing the linear and nonlinear causality results, the findings of bi-directional causality had strong implications in terms of policy suggestions. Since especially the positive effect of widening the spread determined with the two indices could not be rejected in addition to bi-directional nonlinear causality between economic growth, inflation rates and the policy rates, policies should consider focusing on indirect policies without altering the policy rates in cases of small deviations of inflation from its target and it is suggested to utilize the spread between the two policy rates in cases limited to strong deviations of inflation. Accordingly, by narrowing the spread between the two rates could help achieving lowered inflation rates towards their target levels in Turkey.

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