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Reaction of Monetary Policy to Cost-Push Inflation in Turkey: A Leaning against Wind?

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Türkiye'de Para Politikasının Maliyet İtişli Şoklara Tepkisi: Rüzgâra Karşı Bir Duruş mu?

Öz

Türkiye'de para politikası reel efektif döviz kurundaki değişmelere odaklanmakta, enflasyon açığı ve çıktı açığından ziyade maliyet şoklarına tepki vermektedir. Bu politikayı netleştirmek için, 2006:01-2020:07 için Eşik GMM kullanarak doğrusal ve doğrusal olmayan Taylor kuralı tahmin edilmektedir. Doğrusal model, politika faizinin enflasyon açığına ve reel efektif döviz kuruna önemli ölçüde tepki verdiğini tahmin etmektedir. Doğrusal olmayan model ise ithal mal ve girdi fiyatlarının yüksek ve düşük olarak ayarlandığı rejimlerde para politikasının farklılık gösterdiğini ortaya koymaktadır. Yüksek fiyat rejiminde, para politikası maliyet şoklarına da tepki vermektedir. Para politikasının döviz kuruna tepkisi örtük bir şekilde "rüzgâra karşı bir duruş" sergiliyor.

Anahtar Kelimeler: Enflasyon, Maliyet İtişli Şoklar, Taylor Kuralı, Eşik Genelleştirilmiş Momentler Metodu

JEL Kodları: E31, E52, C33

Reaction of Monetary policy to Cost-Push Inflation in Turkey: A Leaning against Wind?

Abstract

In Turkey, monetary policy responds to cost shocks rather than the inflation gap and output gap. To clarify this policy, we estimate the linear and non-linear Taylor rule using the Threshold GMM for 2006:01-2020:07. The linear model estimates that the policy rate responds significantly to the inflation gap and the real effective exchange rate. The non-linear model captures that monetary policy differs in regimes where imported goods and input prices are set as high and low. In a high price regime, monetary policy also reacts to cost-push shocks. The response of monetary policy to the exchange rate implicitly leads to "a leaning against the wind".

Keywords: Inflation, Cost-push Shocks, Taylor Rule, Threshold Generalized Methods of Moment

JEL Codes E31, E52, C33

Araştırma ve Yayın Etiği Beyanı	Bu çalışma bilimsel araştırma ve yayın etiği kurallarına uygun olarak hazırlanmıştır.
Yazarların Makaleye Olan Katkıları	Çalışmanın tamamı iki yazar ile birlikte oluşturulmuştur. Bununla birlikte çalışmanın teorik altyapısı ve ilgili literatür Bilgin Bari; analiz içeren kısımlar ise Metin Tetik tarafından yapılmıştır. Sonuç kısmı yazarların birlikte katkısı ile hazırlanmıştır. Metin Tetik'in makaleye katkısı %50, Bilgin Bari'nin makaleye katkısı %50'dir.
Çıkar Beyanı	Yazarlar açısından ya da üçüncü taraflar açısından çalışmadan kaynaklı çıkar çatışması bulunmamaktadır.

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1. Introduction

In the inflation targeting regime, the central bank should effectively use the short-term interest rate. Changes in the policy rate affect the aggregate demand/expenditure through the monetary transmission mechanism. The aim here is to prevent inflationary pressures originating from aggregate demand. When aggregate demand is suppressed, inflationary effects disappear. This situation is called divine coincidence by Blanchard and Gali (2005). Accordingly, the inflationary effects of the output gap are expected to return to their previous level due to a policy that reduces the output gap. This policy makes it easier for a central bank to keep inflation close to its target level. It is necessary to draw attention to the close relationship between inflation and economic activities. An economic environment in which developed countries provide price stability results from these countries' not being dependent on intense imported goods in terms of production structure. However, this is not the case for most developing countries. The price changes resulting from the dependence of these countries on energy and imported intermediate goods lead to an increase in consumer prices through production costs. However, another critical problem is that the domestic currencies of these countries are not stable. As a result of the changes in exchange rates, imported goods and input prices change and cause an increase in consumer prices directly or indirectly. The reasons for the movements in the exchange rate are the same structural problems: The existence of a savings deficit or a foreign trade deficit makes the economy sensitive to capital movements.

Exchange rate-induced price shocks cause inflation, and the policy rate should be increased as per the monetary policy rule. Inflation resulting from cost shocks eliminates the chances of a divine coincidence for the central bank and causes bad luck caused by structural problems. In this case, a trade-off occurs. Accordingly, the central bank has to choose one of the two policy objectives in cost-push inflation and a negative output gap. Increasing the policy rate can suppress aggregate demand, but this causes the economy to shrink. Alternatively, as a result of lowering the policy rate to recover the economy, output increases, but inflation rises even more. This situation may even cause stagflation depending on the state of the economy.

With the new monetary policy framework established in 2001 after the severe crises experienced, the Central Bank of the Republic of Turkey (CBRT) adopted an inflation-targeting regime. The regime started implicitly in 2002. After the necessary prerequisites were met, inflation targeting was started in 2006. The use of short-term interest rates as a monetary policy tool started in 2002. With the global financial crisis, the purpose function of the CBRT has been rearranged as of November 2010 to include financial stability to prevent the effects of fluctuations in financial markets and unhealthy price formations. In this period the policy instruments were diversified to ensure that both loans and exchange rates move in the desired direction. The aim was to create a funding rate that could react more quickly to changes in the global risk appetite. The interest rate corridor was also used to increase the credit and exchange rate channel's efficiency in the monetary transmission mechanism.

This study analyzes how the policy rate responds to inflation stemming from cost shocks during the inflation targeting regime. Indirect inflationary effects arise due to the dependency on imported intermediate goods and energy in the production process in Turkey. Direct effects comes from imported final goods. These price changes are related to the global changes in imported input prices and the depreciation of the domestic currency. In addition, price/exchange rate shocks become an important determinant of inflation due to the high exchange rate pass-through effect. Therefore, we focus on explaining the behavior of the monetary policy response function against cost shocks by employing TL denominated oil and import unit prices. To this end, we develop an open economy Taylor rule model in which oil prices and import prices are set as threshold variables. We estimate the linear and nonlinear Taylor rule using the Threshold Generalized Moments Method (Threshold GMM) for 2006:01-2020:07. Unlike other studies, this study focuses on the monetary policy stance in the presence of cost-push shocks and develops a theoretical model for this purpose. The study also compares the CBRT's policy response by examining the effects of domestic oil prices and import prices using two different models.

The rest of the work was planned as follows: The second part explains the theoretical framework. The third part summarizes previous studies. The fourth chapter presents the data, the empirical method, and results. The last section includes policy analysis and recommendations.

2. Theoritical Framework

According to non-monetary inflation theories, inflation occurs for two main reasons: Demand-pull inflation and cost-push inflation. Demand-pull inflation occurs due to current output exceeding its potential level during expansion periods and results in a higher equilibrium price (inflation). Inflation is the result of marginal increases in production costs. A rise in production costs increases the prices of final goods and causes cost-push inflation. Bernanke (2006) states the first and second-round effects of increases in energy prices. Increases in prices paid by households for energy (fuel, heating, natural gas) also cause an upsurge in consumer inflation and living costs. In the literature, the direct effects of high energy prices are called first-round effects. However, high energy prices also have indirect effects on inflation. As a result of these effects that cause increased production costs, companies have to reflect these increases on their prices. Then, it causes an increase in consumer prices. General prices comprise both first-round effects and second-round effects. Economists and policymakers consider the effects of core inflation, which excludes the direct effects of the rise in energy prices. The effects are also extended by Gregorio (2012) for changes in commodity prices.

In addition, changes in the exchange rate have different inflationary effects for a country with high import, intermediate goods, and energy dependency. The direct effects of the increase in the exchange rate are realized through imported consumer goods. The cost channel states that the exchange rate affects inflation through imported inputs used in production. What is important here is the ratio of imported goods in consumption and imported inputs in total production costs. Ozmen and Topaloglu (2017) state that the degree of pass-through to prices and rates of pass-through of import prices and exchange rates are different from each other in Turkey. Moreover, the effect of the exchange rate on inflation occurs through the indexation channel. The price expectations of economic agents, who expect that a rise in exchange rates causes inflation, also increase. Kara et al. (2017) emphasize that the exchange rate is quite a determinant of expectations in the Turkish economy.

Cost-push inflation results directly from the increase in production costs. Changes in factor prices used in production cause an increase in producer prices first and then consumer prices. It is called the cost channel or indirect effects. However, the increase in production costs may be due to price shocks. In this case, the central bank's preference for an anti-inflationary policy causes the economy to shrink. On the other hand, an expansionary policy causes inflation to accelerate further, and in this case, the inflationary process emerges. The inflation that emerged in economies as a result of the increases in global oil prices in the 1970s can be given as an example of this situation. After this experience, Phelps (1967) and Friedman (1968) developed the Modern Phillips curve by adding price shocks in economies to the basic model. Undoubtedly, in a small open economy, these price shocks may be caused by the exchange rate. Even if there is no change in global prices, changes occur in domestic prices due to changes in the country's currency. The modern Phillips curve underlines that the three main determinants of inflation are inflation expectations, output gap, and price shocks:

$$\pi_t = E_t\pi_{t-1} + E_t\pi_{t+1} + \kappa(Y - Y_P) + u_t \quad (1)$$

According to Eq. (1), inflation expectations can be backward-looking (π_{t-1}) and / or forward-looking (π_{t+1}). In economies where the inflation problem cannot be solved, backward pricing behavior is effective. However, the current high inflation may also have an impact on forward-looking expectations. This pricing behavior mostly arises as a result of losing the guidance of inflation targets. The effect of the output gap on inflation occurs by increasing marginal costs resulting from current output exceeding its potential. Price shocks, on the other hand, cause domestic prices to increase directly and indirectly. While direct effects increase the prices of final goods, indirect effects occur through production costs. In Eq. (1), u_t can be interpreted as a cost-push shock as in Clarida et al. (1999). According to Gali and Gertler (2007), u_t captures the change in real marginal costs and depends on traditional real shocks such as productivity shock-oil shocks:

$$\pi_t = \psi\, E_t\pi_{t+1} + \kappa\, \tilde{y} + u_t \quad (2)$$

The New Keynesian Phillips Curve (NKPC) in Eq. (2) is derived from the optimal price-setting behavior of firms. The impact of expected inflation on current inflation is represented by the household's subjective discount factor (ψ). The effect of excessive demand is denoted by κ. κ is a function of the marginal cost response to production increases due to excessive demand and the response of prices to marginal costs. Firms take into account the expected changes in marginal costs while determining their prices. These are real marginal cost increases due to the change in aggregate demand. u_t captures other factors that cause an increase in real marginal costs. In Eq. (2), u_t is considered external and represents cost-push shocks. Prices in the economy are affected by cost-push shocks with a stochastic characteristic and they have a normal distribution: $u \sim N(0, \sigma_u^2)$.

The inflation equation for NKPC is derived from the price-setting behavior of each firm. In the monopolistic competition model of Dixit and Stiglitz (1977), firms produce differentiated goods and determine the price by taking into account the expectations regarding the general price level, the real output gap, and the cost-push shocks. Accordingly, the optimal price of a firm *i* is determined as follows:

$$p_i = E_i(p + \varepsilon\tilde{y} + u) \quad (3)$$

where the variables are expressed as percentage deviations from the deterministic state. Each firm determines its price according to its expectation for output gap ($\tilde{y}$) and cost-push shocks (u). However, the general price level (p) represents the pricing decisions of other firms. The parameter ε shows the response of optimal prices to the output gap. It is assumed that firms set prices gradually in order to capture the inertia/rigidity in nominal prices. Accordingly, it is accepted that firms set their prices with a fixed probability with the help of the Calvo formulation. When firms determine their prices for a certain period, they consider the current and expected marginal costs in the future. NKPC, therefore, evolves into a forward-looking form. Inflation is not only dependent on the present values of the output gap and cost shocks, but also includes the expected future values of the relevant variables. Thus, the forward-looking feature of the Philips curve draws attention to the fact that the central bank's success does not only depend on the current policy stance. The private sector's perception of the stance of monetary policy in the future also gains importance.

A central bank with a flexible inflation targeting regime has two main priorities when determining its policy choices: price stability and output stability. Which of these the central bank gives priority is expressed by the loss function. According to the loss function, the central bank tries to minimize the output gap and inflation gap using the policy tool:

$$L = \min E\, \lambda\left(y - y_p\right)^2 + \left(\pi - \pi^T\right)^2 \tag{4}$$

According to the loss function, there are two primary policy priorities: inflation should not deviate from the target level and the output from the potential level. In Eq. (4), the λ coefficient indicates which of these is given priority. The weights/priorities given to the targets are also taken into account in determining the policy rate. The central bank's policy reaction to these two instabilities is determined according to the rule. This rule is referred to in the literature as the Taylor (1993) rule:

$$i_t^p = r_t^n + \phi_\pi(\pi_t - \pi_t^T) + \phi_\pi(Y_t - Y_t^P) \tag{5}$$

where i_t^p is the short-term nominal policy rate, r_t^n refers the natural real interest rate, $\phi_\pi > 1$ and $\phi_\pi > 0$ are the responses to the inflation gap and the output gap, respectively. The Taylor rule guides how much the central bank should increase the interest rate when inflation and output gap occur. If inflation and the output gap are zero, the central bank's policy rate equals the natural real interest rate. In times of overheating in the economy (positive output gap and inflation gap), the central bank has to increase the nominal interest rate. The fact that the response to the inflation deficit is greater than 1 emphasizes that the central bank must increase the real interest rate to suppress aggregate demand adequately. Thus, the central bank stabilizes the output by controlling the aggregate demand.

Following Baeriswyl and Cornand (2010), the effect of cost-push shocks on pricing behavior can be included as follows:

$$p_i = p = \varepsilon\hat{y} + (1 - \varepsilon)u \tag{6}$$

where ε is between 0 and 1: 0< ε<1. Accordingly, the smaller the ε, the more weight is given to cost shocks. In this case, the central bank tries to minimize the loss function due to the increase from cost-push shocks using the interest rate instrument:

$$u_{cb} = u + \nu\ ;\ \nu \sim N(0, \sigma_\nu^2) \tag{7}$$

In such a situation, monetary policy reacts linearly:

$$r = \delta u_{cb} \tag{8}$$

where δ indicates the response of monetary policy to cost-push shocks. If the central bank has complete knowledge of the shock, we can write the monetary policy response as below:

$$r = \delta u \tag{9}$$

When we transform the response function in Eq. (5) to Eq. (9), taking into account cost shocks, the loss function in Eq. (4) turns into the following form:

$$L = \lambda(-(1 - \varepsilon)u)^2 + [(1 - \varepsilon) + \delta)u]^2 \tag{10}$$

In order to minimize the loss function in Eq. (10), the response coefficient for the optimal monetary policy is as follows:

$$\delta = -\frac{1}{\varepsilon} \tag{11}$$

In this case, the expected loss is a function of the variance of cost shocks:

$$E(L) = \frac{\lambda}{\varepsilon^2}\, \sigma_u^2 \tag{12}$$

The optimal monetary policy coefficient δ in Eq. (11) highlights that the central bank responds to a one-unit cost-push shock increase by tightening aggregate demand by $-\frac{1}{\varepsilon}$.

Where cost-push shocks are positive, the central bank's tightening aggregate demand is called leaning against the wind. Most economists describe an excellent monetary policy as "a leaning against the wind." Keeping inflation under control by suppressing aggregate demand is the priority of such a policy. Clarida et al. (1999) define this policy as follows: "*In all cases where inflation is above the target level, aggregate demand should be kept below the potential level by increasing the interest rate (creating a negative output gap). Since positive cost-push shocks create inflation, the central bank suppresses future price increases over aggregate demand.*" The weight of ε in Eq. (10) determines the central bank's response.

3. Empirical Literature

Studies estimating the monetary policy response function of the CBRT have used linear and nonlinear methods. However, some studies measure the policy response for different sub-periods during the inflation-targeting period. For example, Soybilgen et al. (2019) argue that four different sub-periods emerged in monetary policy between 2002 and 2018. The Taylor rule reacts to different variables. According to the findings; While the Taylor rule reacts to the deviation of inflation expectations from the target in the second sub-period (2004: 09-2008: 11), the third sub-period (2008: 12-2011: 10) follows a pro-cyclical policy that focuses less on inflation. In the last period (2011: 11-2018: 08), the CBRT reacts more strongly to the inflation gap than the second and third sub-periods and aims to moderate the economic volatility. Similarly, Soybilgen and Eroglu (2019) stated that the monetary policy changed over time in the 2006-2019 period. For this purpose, they predicted a Taylor rule that changes over time. While the findings point to a policy that did not react much to the inflation gap until 2011, the policy response to the inflation gap after 2012 has gradually gained importance.

Gurkaynak et al. (2015) point to a structural break in monetary policy in 2009. The researchers estimate different versions of the Taylor rule for 2003-2014 and state that the response to inflation in the post-2009 period has decreased compared to the previous period. The monetary policy responds poorly to the output gap measured by industrial production in each sub-period. Similarly, Yagcibasi and Yildirim (2019) found that in the high-interest rate regime in the 2003-2009 period, monetary policy reacted more firmly to deviations from inflation and did not consider the output gap. After 2009, this policy stance is reversed, and the response of monetary policy to the output gap and inflation increases. In the extended policy rule with the exchange rate, CBRT responds to the depreciation of the exchange rate by increasing the policy rate in the low-interest regime.

Erdem et al. (2017) state that the CBRT's monetary policy response to inflation, output gap, and exchange rate. Bulut (2016) found that expected inflation is effective in determining the policy rate. Oge-Guney (2016) states that the monetary policy response is affected by expected inflation and uncertainties in output and inflation. In another study, Oge-Guney (2018) estimated the non-linear monetary policy response function and focused on the periods of contraction and expansion, taking the output gap as a threshold value. The findings suggest that while CBRT takes inflation into account in both periods, reaction function also includes output during recession periods. Bulut (2019) predicts a non-linear response function. The function considers the reaction of the deviation of inflation expectations 12 months ahead of the target. According to the findings, CBRT raises the policy rate in cases where inflation expectations exceed inflation targets while decreasing output by lowering the interest rate. The study also highlights cost-push inflation rather than demand-pull inflation in Turkey. CBRT introduces a policy that suppresses aggregate demand and prevents possible inflationary pressures from here. Deniz et al. (2020) examines the specifications of the Taylor rule model employing the structural threshold approach in Turkey. They preferred the real exchange rate as a threshold variable in their standard Taylor rule model. Their results imply different CBRT stances according to whether the real exchange is above or below the threshold. They conculeded the Taylor rule exhibits its expected characteristics in the appreciated currency period.

In this study, unlike other studies in the literature, we also consider the response of the monetary policy response function to cost-push shocks. As far as we know, for the first time, this study predicts the monetary policy response by considering cost-push effects come from domestic import and oil prices. These effects arising due to the changes in the exchange rate make the CBRT face a policy choice. As explained earlier, the policy response in such a situation may tighten the economy. Nevertheless, if the policy priority is inflation, CBRT should ignore it and lean against the wind.

4. Empirical Analysis

Our analysis focuses on how the change in imported input prices affects the CBRT's policy behavior. For this purpose, we develop an open economy Taylor rule model in which imported input prices (oil price and import price denominated in TL) are determined as threshold variables. We estimate this model linearly and nonlinearly using the Threshold GMM.

4.1. Data

The study uses the monthly data set covering the period 2006: 01-2020: 07. We exclude the Pandemic period in the data range. Table 1 presents detailed information on the data set. All data are obtained from the CBRT-Electronic Data Delivery System.

Table 1: Data Set

Variables		Definition
CBRT overnight borrowing rate	i_t	Level
Inflation gap	$\pi_t - \pi^T$	The difference between the annual percentage change of the consumer price index and the year-end inflation target
Output gap	y_t	Calculated from seasonally adjusted industrial production index by Hodrick-Prescott (HP) filtering method.
Real effective exchange rate gap	rer_t	Calculated from seasonally adjusted real effective exchange rate by Hodrick-Prescott (HP) filtering method.
Oil price	OP_t	Europe Brent Petrol Spot FOB Price per Barrel (calculated in TL)
Import price index	IPI_t	Foreign Trade Import Price Index (calculated in TL)

In the study, we follow the CBRT's policy stance with a Taylor rule type reaction function. In this reaction function, the CBRT overnight borrowing rate is used as the policy rate, which is the dependent variable. The inflation gap, one of the explanatory variables in the model, is calculated by taking the difference of the annual percentage change of the consumer price index from the targeted inflation rate. We use the industrial production index for economic activity. As in Aklan and Nargeleçekenler (2008), the output gap is calculated by the Hodrick-Prescott (HP) filtering method. The logarithm of CPI-based the real effective exchange rate is used as the exchange rate. It is calculated by taking the weighted average of the ratio of the price level in Turkey to the price levels of 36 countries with foreign trade. CBRT calculates the weights given to countries according to the foreign trade weight of the countries with Turkey. The real effective exchange rate gap is obtained by employing the HP filtering method. Oil prices were taken as the European Brent Oil Spot FOB price in US dollar and then calculated in TL. Similarly, the import price index is denominated in TL. CBRT average dollar rate for the relevant month is used for TL conversions. Figure 2 presents the course of the variables.

Figure 1: The Time Series Path of the Variables

Source: Based on data from the CBRT’s database.

Figure 1 shows that the policy rate declined to its lowest level, especially after the 2008 financial crisis, and reached its maximum level in 2018-2019. The recent increased volatility in the inflation gap and deviations from the targeted inflation is remarkable. We observe excessive fluctuation in the output gap. It is regarded as the equilibrium value of 100 at the real effective exchange rate. If the index is over 100, TL gains value, and over 120 is considered overvalued. If the index falls below 100, TL depreciates, while falling below 80 indicates that TL depreciates excessively.

Table 2: Descriptive Statistics

	i_t	π_{t+k}	y_{t+k}	rer_{t+k}	OP_t	IPI_t
Mean	9.847706	4.470688	0.060555	0.025236	181.5934	241.5273
Maximum	22.5	18.79268	15.70478	9.912558	495.956	586.8981
Minimum	1.5	-2.27229	-33.2816	-23.5193	54.64162	107.1677
Std. Dev.	5.626654	3.798487	8.400038	5.284067	89.85477	122.5419
Skewness	0.740383	1.313278	-0.90719	-1.01538	1.244302	1.271994
Kurtosis	2.456422	5.839643	4.125353	5.145302	4.268294	3.585766
J-B	17.83169	107.2303	32.66839	62.53869	55.91234	48.84081
Observations	172	172	172	172	172	172

Note: i_t, π_{t+k}, y_{t+k}, rer_{t+k}, OP_t and IPI_t denote the short-term policy rate, inflation gap, real effective exchange rate gap, output gap, oil price and import price index. JB is the Jarque-Bera test for normality. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Table 2 shows descriptive statistics for all variables. In Table 2, the means of all variables are positive. Among these variables, the import price index (IPI) and the oil price (OP) have the highest volatility. The reason for this is the volatility in the USD / TL exchange rate. Jarque-Bera (J-B) test result states that not all variables are normally distributed.

Before estimating the models, the stationarity properties of the series are examined. For this purpose, the Lee-Strazicich (LS) unit root test with two breaks, is used. LS test results are in Table 3.

Table 3: Lee-Strazicich (LS) Testi

	Model A (break in level)			**Model C (break in level&slope)**				
	LM Stats.	Breakpoints		LM Stats.	λ_1	λ_2	Breakpoints	
		D_{1t}	D_{2t}				DT_{1t}	DT_{2t}
i_t	-2.878	2011:10 (-2.007)	2014:03 (-1.915)	-6.793***	0.973	-2.580	2010:01 (-5.0165)	2018:04 (6.073)
$\pi_{t+k}-\pi^T$	-2.683	2008:12 (-9.058)	2018:09 (0.973)	-7.220***	-4.192	-0.651	2008:12 (-2.131)	2018:01 (5.851)
y_{t+k}	-3.469*	2007:11 (1.365)	2010:04 (-0.004)	-5.704**	-2.401	-15.901	2008:05 (-0.418)	2009:01 (5.150)
rer_{t+k}	- 5.623***	2011:10 (1.340)	2015:10 (1.796)	-6.168**	-4.654	1.633	2009:10 (3.159)	2018:05 (-1.629)
OP_t	-3.442*	2015:11 (-2.062)	2018:10 (-2.517)	-4.511**	27.414	*9.616	2014:07 (3.029)	2017:11 (3.325)
IPI_t	-2.265	2018:04 (3.529)	2018:07 (9.442)	-6.674***	2.977	13.703	2015:09 (-3.324)	2018:06 (5.512)

Note: t-statistics are presented in parentheses. Critical values are obtained from Lee and Strazicich (2003). Model A allows for breaks in the constant term, while Model C allows for breaks in both the constant and trend term. . ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

According to the Lagrange multiplier (LM) statistical values, all series are stationary, except for the policy interest rate in both Model A (break in level) and Model C (break in level and trend). Significant breakpoints are detected for the policy rate, inflation gap, output gap, and the real effective exchange rate gap during the 2008 global crisis and the 2018 Turkey debt crisis.

4.2. Methodology

We use the following equation to estimate the linear Taylor rule by employing the GMM method as in Claria et al. (1998, 2000):

$$i_t = \beta_1 + \beta_2 i_{t-1} + \beta_3 \sum_{k=1}^{3} (E_{t-1}\pi_{t+k} - \pi^T) + \beta_4 \sum_{k=1}^{3} (E_{t-1}y_{t+k}) + \beta_5 \sum_{k=1}^{3} (E_{t-1}rer_{t+k}) + \varepsilon_t \tag{13}$$

where i_t is the rate, π_{t+k} is the inflation rate, π^T is targeted inflation, y_{t+k} is the output gap, and rer_{t+k} is the real effective exchange rate gap. We use the 3-month premise averages of inflation, output, and real effective exchange rate gap. For estimation in nonlinear form, the following threshold model was employed as in Taylor and Davradakis (2006), Martin and Milas (2013):

$$\begin{aligned} i_t = D(TV_{t-1} \leq TV^*) \Bigg[& \alpha_1^L + \alpha_2^L i_{t-1} + \alpha_3^L (E_{t-1}\pi_{t+k} - \pi^T) \\ & + \alpha_4^L \sum_{k=1}^{3} (E_{t-1}y_{t+k}) + \alpha_5^L \sum_{k=1}^{3} (E_{t-1}rer_{t+k}) \Bigg] \\ + D(TV_{t-1} \leq TV^*) \Bigg[& \alpha_1^H + \alpha_2^H i_{t-1} + \alpha_3^H (E_{t-1}\pi_{t+k} - \pi^T) \\ & + \alpha_4^H \sum_{k=1}^{3} (E_{t-1}y_{t+k}) + \alpha_5^H \sum_{k=1}^{3} (E_{t-1}rer_{t+k}) \Bigg] + \varepsilon_t \end{aligned} \tag{14}$$

We estimate Eq. (14) using the Threshold GMM method. Here, *TV* is the threshold variable[3]. TV^* is the optimal value of the threshold variable and is determined endogenously. The optimal value of the threshold variable defines the high and low regimes. The *D* function is a dummy function and takes the value 0 when $TV_{t-1} < TV^*$ is and 1 when $TV_{t-1} \geq TV^*$ is. The optimal value of TV^* is estimated as in Taylor and Davradakis (2006) and obtained by using a one-dimensional grid search that includes the possible breakpoints of the threshold variable together with the parameters.

[3] Two threshold variables are used in this study. While one of them is oil prices (OP_t), the other is the import price index (IPI_t).

4.3. Empirical Findings

Table 4 presents the results of the linear Taylor model estimated using the GMM method.

Table 4: Linear Taylor Rule GMM Results

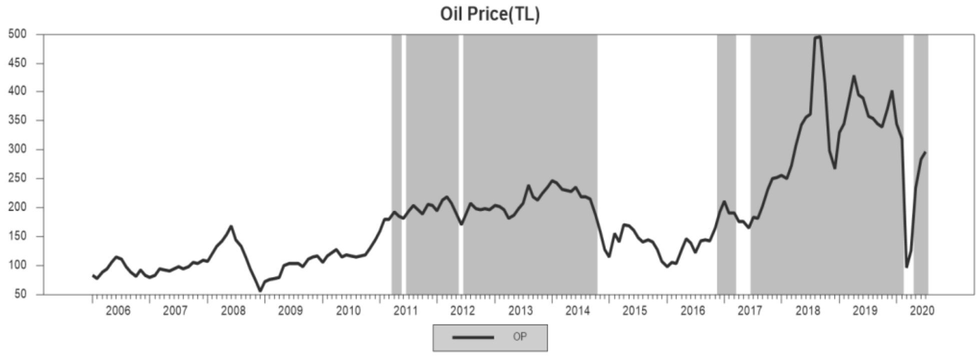
Variables	Parameters	Std. Error	T-stat.	Prob. Value
$Constant$	-0.0474	0.0188	-2.5215	0.0117
i_{t-1}	0.9972**	0.0024	410.4369	0.000
$\pi_{t+k} - \pi^T$	0.0116**	0.0046	2.5255	0.0116
y_{t+k}	0.0045**	0.002	2.2143	0.0268
rer_{t+k}	0.0039*	0.0021	1.8518	0.0641
Sargan-J test	46.540			
Sig. Sargan-J Test	0.368			
Durbin Watsaon Stat.	1.762			

Note: In the study, the 12th lag of policy interest rate, inflation gap, output gap and real effective exchange rate gap was used as the instrument variable. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

According to Table 4, the estimated parameter of the lagged value of the policy rate (β_2) is statistically significant and takes a value close to 1. It means that the CBRT adjusts the policy interest rates using the smoothing parameter. Similarly, the estimated parameters of inflation gap, output gap, and real exchange rate gap (β_3, β_4, β_5), respectively, are statistically significant and positive. Accordingly, the policy rate in the whole period reacts positively to the inflation gap and the positive output gap. Findings support the existence of Taylor rule in Turkey. However, the CBRT responds more to the inflation gap rather than the output gap and real exchange rate gap. These results are similar to Soybilgen and Eroglu (2009).

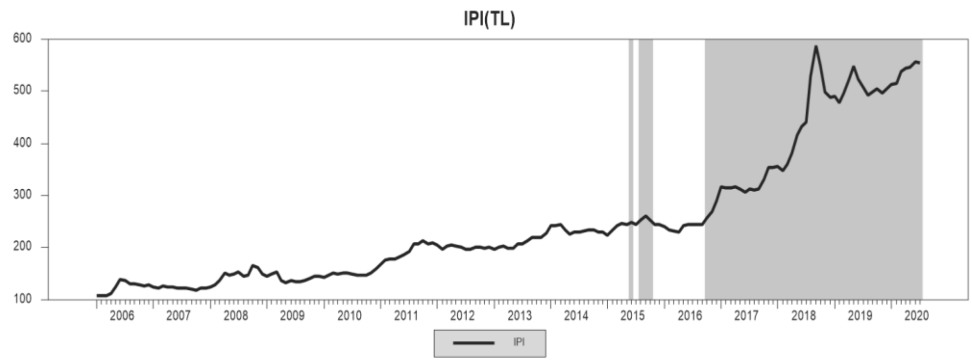
The linear structure of the Taylor rule causes the response of the policy rate to the inflation gap, output gap, and exchange rate gap to remain constant. However, the central bank may react differently over time due to the structural changes, the crises, and the changes in other policies. For these reasons, the nonlinear Taylor rule becomes more explanatory to assess the stance of central banks (Akdeniz & Catik, 2019). After estimating the Taylor rule in Eq. (13) with linear GMM, we estimate the model in Eq. (14) with the threshold GMM. For this purpose, the optimum threshold value of OP and IPI is estimated by using one-dimensional grid search. According to estimation results, the optimum threshold value of OP is 181 TL (OP * = 181). While OP> 181 is a regime with high oil prices, OP <181 is the regime with low oil prices. Similarly, the optimum threshold value of IPI is 246 (IP * = 246). Accordingly, if IPI> 241, a high IPI regime occurs; if IPI <241, a low IPI regime occurs. The dark-colored periods in Figures 2 and 3 show the high regime periods for OP and IPI, respectively.

Figure 2: Oil Price Regimes



Source: The authors.
Note: Shaded areas indicate a high oil price regime; white areas indicate a low oil price regime.

Figure 3: Import Prices Regimes



Source: The authors.
Note: Shaded areas indicate a high import price regime; white areas indicate a low import price regime.

Table 5 presents the estimation results for the nonlinear Taylor rule. The interest rate smoothing coefficient is close to 1 in both regimes. This result confirms the smoothness in interest rate adjustment for the CBRT.

Table 5: Non-linear Taylor Rule Threshold GMM Results

Low Oil Price Regime				*Low IPI Regime*			
Variables	**Parameters**	**Std. Error**	**Prob. Value**	**Variables**	**Parameters**	**Std. Error**	**Prob. Value**
$Constant$	0.0001	0.0338	0.9987	$Constant$	-0.0559	0.0869	0.5202
i_{t-1}	1.006***	0.009	0.0000	i_{t-1}	0.9975***	0.0071	0.0000
$\pi_{t+k}-\pi^T$	-0.0077	0.0142	0.5852	$\pi_{t+k}-\pi^T$	0.0114	0.0142	0.4204
y_{t+k}	-0.0027	0.0058	0.6415	y_{t+k}	0.0081	0.0052	0.1178
rer_{t+k}	-0.0056	0.0066	0.3996	rer_{t+k}	0.0013	0.0083	0.8759
High Oil Price Regime				*High IPI Regime*			
Variables	**Parameters**	**Std Error**	**Prob Value**	**Variables**	**Parameters**	**Std Error**	**Prob Value**
$Constant$	-0.1877***	0.0695	0.0069	$Constant$	-0.0865**	0.0403	0.0317
i_{t-1}	0.9834***	0.008	0.0000	i_{t-1}	0.9736***	0.0043	0.0000
$\pi_{t+k}-\pi^T$	0.0602***	0.012	0.0000	$\pi_{t+k}-\pi^T$	0.0697***	0.0076	0.0000
y_{t+k}	0.013***	0.0048	0.0072	y_{t+k}	0.0061**	0.0031	0.0523
rer_{t+k}	0.0291***	0.0066	0.0000	rer_{t+k}	0.0099***	0.0036	0.0063
Sargan-J Test	30.3233			**Sargan-J Test**	36.5141		
Sig. of J Test	0.8387			**Sig.of J Test**	0.5838		
Durbin-Watson	1.8292			**Durbin-Watson**	1.8214		

Note: In the study, the 12th lag of policy interest rate, inflation gap, output gap and real effective exchange rate gap was used as the instrument variable. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5 provides evidence that the CBRT responds non-linearly to inflation, output, and the real exchange rate gaps and the results are consistent with Deniz et al. (2020)'s finding that the CBRT has changed in its policy behavior under different regimes. The inflation gap coefficient is positive and significant in the high OP and high IPI regime, and its size is similar. In the low OP and low IPI regime, the inflation gap coefficient is not significant. The results prove that there is an interest rate reaction to inflation caused by price shocks. In Figure 1, the fact that high OP and high IPI regimes coincide with an upward trend in exchange rates draws attention to the inflation-exchange rate relationship. Bari (2020) stated that the exchange rate pass-through was high compared to the import price volatility in the relevant period. Similarly, Bari and Adalı (2020) found that the inflationary effect of crude oil and fuel prices also increased during this period.

According to Table 5, the output gap coefficient is positive and significant in the high OP and high IPI regimes. However, it is not significant in the low OP and low IPI regimes. This finding indicates that the CBRT uses a contractionary monetary policy to suppress the output gap-excess demand in a period of high input costs. Finally, CBRT responds to fluctuations in the real effective exchange rate in the high OP and high IPI regimes. Therefore, it is seen that the real effective exchange rate plays an essential role in determining the behavior of the CBRT in the high input costs regime. These findings support the results of Yagcibasi and Yildirim (2019) for the high exchange rate regime. Our results are consistent with the literature suggesting that emerging markets, even if they do not set an exchange rate target, have an implicit comfort zone for smoothing exchange rate fluctuations (Coprale et al., 2018; Ghosh et al., 2016).

5. Conclusion

In Turkish Economy, the increase and volatility in exchange rates have a significant impact on inflation. Exchange rate increases indirectly increase production costs because of high usage of imported intermediate goods and inputs in production. Also, the effects of the exchange rate increase on imported consumption goods are directly determine consumer inflation. The volatility in exchange rates creates uncertainty and causes high pricing behavior. Besides, the expectation for an increase in exchange rates also causes high pricing through the indexation channel.

What should the central bank do in the face of inflation? Should it lean against the wind caused by price shocks? This study aims to describe the CBRT's policy rate response to cost-driven inflationary shocks to answer this question. For this purpose, we develop a theoretical model that explains the relationship between the policy rate and cost-push inflation. In addition, the estimated empirical model employs a data set specific to the Turkish economy. The standard Taylor rule is extended by adding the real effective exchange rate, domestic oil prices, and domestic import prices. The extended Taylor rule is estimated using threshold values for oil prices and import prices. According to this method, Taylor's rule reacts differently above and below thresholds.

The empirical results of our study reveal that CBRT follows a moderate policy due to adverse effects on inflation in sub-threshold periods. However, the policy rate response occurs against price/currency shocks in the above-threshold periods. Especially in the period after 2011, the continuous increase in the exchange rate leads to high price regimes. In this regime, the inflation deficit increases with the indirect effect of cost increases and the direct effect of final goods prices. The main reason for the interest rate response of CBRT in periods of the exchange rate increase is the depreciation of the domestic currency rather than the deviation of inflation from the target. This result can be attributed to the economy's structural problems, which strengthens the exchange rate-inflation relationship specific to Turkey. The exchange rate pass-through effect gains importance due to high import dependency on intermediate goods and inputs, the indexing effect on pricing behavior, and the high import share in final consumption.

The findings show that the central bank has also reacted to exchange rate/price shocks by increasing the policy rate. We note that real interest rates were kept low for the relevant period as a policy preference, and the CBRT had to increase the policy rate after exchange rate shocks. In practice, leaning against the wind is leaning against the exchange rate. However, it is vital to determine a policy rate that reacts to the exchange rate or does not pressure it. In this context, the real policy rate can be used not as a reaction to the exchange rate increase but as a preventive measure against the exchange rate increase. Thus, it becomes an effective policy instrument to prevent both exchange rate shocks and inflation.

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