ASYMMETRIES IN EXCHANGE RATE PASS-THROUGH IN TURKEY: A THRESHOLD VAR ANALYSIS

Meryem Türel [a], Ayhan Orhan [a]

Abstract

This paper analyses the asymmetric behaviour of exchange rate pass-through in Turkey using a threshold VAR model. The main purpose is to examine the asymmetries in the exchange rate pass-through based on size, direction and inflationary environment of an emerging market economy with a highly depreciated domestic currency and two-digit inflation rate. Monthly exchange rate movements and monthly inflation rates were used as threshold variables. Nonlinear impulse response functions were employed to compare upper and lower regimes. According to our findings, the transmission of exchange rate shocks to domestic inflation in the upper regime is stronger than that in the lower regime. The pass-through increases with the magnitude of shocks. Besides, positive shocks have more effect on domestic prices than negative shocks, especially in the upper regime. A positive relationship between inflation and exchange rate pass-through exists. During high inflation periods, pass-through to domestic prices increases.

Keywords: Exchange rate, pass-through, inflation rate, threshold VAR
JEL Classification: E31, F31, F47

1. Introduction

Exchange rate movements can have significant effects on import prices, producer prices and consumer prices along with the distribution chain. This association between exchange rates and domestic prices is known as exchange rate pass-through (EPRT). Understanding the scale and magnitude of exchange rate pass-through on the domestic prices is a key topic for macroeconomic policy design, especially in small and import-dependent economies. EPRT has been researched extensively in the literature both theoretically and empirically, as outlined in Goldberg and Knetter (1997), McCarthy (1999), Taylor (2000), Campa and Goldberg (2005), and Choudhri and Hakura (2006).

a Department of Economics, Kocaeli University, Kocaeli, Turkey
Emails: meryem.turel@kocaeli.edu.tr; aorhan@kocaeli.edu.tr

The pass-through effect is theoretically related to the pricing behaviour of importers. When the domestic currency depreciates (appreciates), imports become more expensive (cheaper). Importer firms determine the pass-through effect by reflecting the changes in the exchange rate into prices. Exchange rate changes can be fully or partially reflected in prices, but a vast body of literature has shown that changes in exchange rates only partially transmit to domestic prices. The magnitude of pass-through depends on the volatility of exchange rate movements, persistence of exchange rate movements, demand elasticities, market structure, size of the economy and the inflationary environment. McCarthy (1999) argued that high import share countries have stronger pass-through, and their prices are more sensitive to exchange rate movements. Since small and open economies usually rely on imported products as intermediate goods, the pass-through effect is stronger in them. Another factor affecting the pass-through is volatility. More volatile exchange rates can make importers reluctant to change their prices and lead to weak pass-through. On the other hand, Taylor (2000) suggested that the persistence of exchange rate movements leads to higher pass-through by causing higher costs to firms. Furthermore, an inflationary environment can strengthen the pass-through effect by causing persistent costs, while a low inflationary environment decreases the pass-through by decreasing firms' pricing power. Choudhri and Hakura (2006) tested this hypothesis and concluded a positive and significant association between pass-through and average inflation rate.

On the other hand, existing literature usually evaluates pass-through as a symmetric process. Nevertheless, it is a very limiting and unrealistic perspective for dealing with the subject. From a symmetric perspective, it is assumed that appreciation and depreciation are transmitted to prices at the same rate, but this does not reflect the reality entirely because of downward price rigidities (Delatte and Villavicencio, 2012). Asymmetries in pass-through may arise from different sources such as the direction of exchange rate fluctuations, size of exchange rate fluctuations, and macroeconomic conditions. Direction asymmetry indicates the different magnitude of pass-through after an appreciation or a depreciation in the exchange rate. Size asymmetry refers that a large change may cause a higher pass-through than a small change or vice versa (Pollard and Coughlin, 2004). Macroeconomic conditions refer to demand conditions or inflationary environments that might cause asymmetries in the pass-through mechanism.

Recently, the Turkish economy has been facing a highly depreciated currency (TL) and increased inflation simultaneously as a small and open economy. Besides, Turkey has been implementing an inflation targeting regime explicitly since 2006. Therefore, the effectiveness of the monetary policy, as well as credible targeting, are directly related to the pass-through mechanism. As for monetary policy tools implemented during the analysed period, the Central Bank of the Republic of Turkey (CBRT) has used open market operations and reserve requirements heavily, and selective credit controls have not been implemented seriously. Furthermore, the studied period can be divided into two sub-periods based on the CBRT's primary objectives. Between 2005–2014, the CBRT followed a current account deficit-based growth approach as well as prioritizing price stability. However, after 2014, the CBRT headed towards a current account surplus-based growth model and prioritized economic growth and employment. However, this policy has led to inflation risks, and the impact of the EPRT mechanism on inflation has become a fundamental element of the Turkish economy.

The association between exchange rate and inflation in the Turkish economy has been reviewed extensively in empirical studies such as Leigh and Rossi (2002), Kara *et al*. (2007), Yüncüler (2011), and Tunc and Kilinc (2018). However, taking asymmetries into account has received less attention. In this paper, we considered domestic price sensitivity to exchange rate movements by taking the asymmetries in pass-through into account. The main purpose of this study is to examine the asymmetries in the exchange rate pass-through to bring new insights into an emerging market economy with a highly depreciated domestic currency and high inflation rates. In order to do that, a threshold vector autoregression model (TVAR) is employed. The TVAR model allows us to capture asymmetries in exchange rate pass-through by permitting regime-switching. We examine asymmetries in two different categories: asymmetries caused by the size of exchange rate fluctuations and the direction of exchange rate fluctuations. Furthermore, we investigate the effect of the inflationary environment on the exchange rate pass-through mechanism.

This paper is organized as follows: Section 2 presents a literature review. Section 3 explains the methodology, data and model. Section 4 provides the empirical results, and Section 5 concludes the article.

2. Literature Review

Exchange rate pass-through is analysed extensively in the literature as summarized by Goldberg and Knetter (1997) examining asymmetries; however, has received less attention. There are several studies investigating asymmetries in pass-through. Pollard and Coughlin (2004) investigated asymmetries in both the direction and size of exchange rate fluctuations. They showed that firms respond asymmetrically to appreciation and depreciation of exchange rate; also, large and small changes have an asymmetric effect on the pricing behaviour of firms. Moreover, they found that the size effect is more significant than the direction effect. Tica and Posedel (2009) showed that the EPRT is asymmetric around a particular threshold value, and the EPRT effect is strong and significant above the threshold, but the EPRT is weak in Croatia below the threshold. Alvarez *et al*. (2012) found a complete and non-declining pass-through to import prices but weak evidence of asymmetric pass-through from appreciation vs. depreciation in both the short run and long run. Aleem (2010) estimated a TVAR model to examine EPRT in Mexico. The author used the inflation rate as the threshold and showed that domestic prices react strongly above the threshold level of inflation. Delatte and Villavicencio (2012) found that pass-through for exchange rate depreciation is stronger than appreciations. Baharumshah *et al*. (2017) demonstrated with a nonlinear autoregressive distributed-lag model that transmission of currency depreciation to consumer prices is higher than currency appreciations in Mexico. Another important aspect of pass-through is its monetary policy implications. With a structural VAR model for 55 countries, Ha *et al*. (2020) documented that monetary policy shocks are associated with higher exchange rate pass-through than other shocks. Furthermore, countries with credible inflation targeting and flexible exchange rate regime tend to have lower pass through.

There are limited studies examining asymmetries in the EPRT regarding the Turkish economy. Arbatli (2003) found the pass-through effect and the presence of asymmetries statistically insignificant and weak for the period 1994–2004 using the threshold vector autoregression model. Kara and Ögünç (2008) investigated pass-through by separating their data set; before the floating exchange rate regime (1995–2001) and during the floating exchange rate regime (2001–2004). They concluded that the pass-through had decreased after adopting the floating exchange rate regime considerably due to the loss of persistency of exchange rate shocks. Çatık and Güçlü (2012) provided empirical evidence for Taylor's (2000) hypothesis by demonstrating that exchange rate pass-through is weaker in low inflationary periods in the Turkish economy with an MS-VAR model. Doğan (2013) examined the existence of asymmetries in exchange rate pass-through in terms of volatility, demand conditions, and inflationary environment using a TAR model with Hansen's (2000) methodology and did not find sufficient evidence for asymmetry. Akkoç and Yücel (2017) reported that the exchange rate pass-through to inflation is 3% in the stable regime and 21% in the unstable regime periods using a Markov regime-switching model.

3. Methodology, Data and Model

3.1 Methodology

We employed a threshold vector autoregression (TVAR) model based on Balke (2000). This model allows us to capture the asymmetries in the exchange rate pass-through by dividing the system into different regimes. In TVAR models, endogenously determined threshold value split the sample into different regimes (in our case, two different regimes). Regime switching occurs after a shock to threshold variables as well as other variables. Each regime is estimated by ordinary least squares. Thus, each regime is linear in the parameters, but the parameters change from one regime to another, providing non-linearity for the model. A structural TVAR model can be written as follows:

$$Y_t = A^1 Y_t + B^1(L) Y_{t-1} + \left(A^2 Y_t + B^2(L) Y_{t-1}\right) I\left[e_{t-d} > \gamma\right] + u_t , \quad (1)$$

where Y_t is a vector of endogenous variables, u_t is structural disturbances, B1(L) and B2(L) are the lag polynomial matrices that vary between regimes, A^1 and A^2 represent the contemporaneous structural terms in the two regimes respectively and are assumed to have a recursive structure. Besides, e_{t-d} is the threshold variable that indicates which regime the system is in, the time delay of the threshold variable was set to $d = 1$, γ is the value of the threshold variable, and $I[e_{t-d} > \gamma]$ is an indicator function that takes the value of 1 if the threshold variable is higher than the threshold value, and zero otherwise (Balke, 2000). To test whether there is a threshold behaviour, the conventional F-test for the null hypothesis $A1 = B1(L)$ cannot give reliable results since the threshold value (γ) is not known a priori and must be estimated. In our case, testing requires nonstandard inference because (γ) is not identified under the null hypothesis of no threshold behaviour (Balke, 2000).

In order to test for thresholds, the TVAR model is estimated by least squares for all possible threshold values. The scope of possible thresholds is trimmed by 15% to prevent over-fitting. For each possible threshold value, three different Wald test statistics which evaluate the hypothesis of no difference between regimes were calculated: avg-Wald, exp-Wald, and sup-Wald. Sup-Wald refers to the maximum Wald statistic for all possible threshold values, avg-Wald refers to the average Wald statistics for all possible threshold values, and exp-Wald refers to the sum of exponential Wald statistics for all possible threshold values. Estimated *p*-values associated with these test statistics are used to evaluate the significance of the threshold behaviour. The *p*-values are calculated following Hansen's (1996) bootstrap method with 500 replications (Balke, 2000).

To assess the effect of the exchange rate pass-through, we used nonlinear impulse response functions (IRF). Nonlinear impulse responses allow us to investigate both size (small vs. large) and direction effects (positive vs. negative) of shocks. However, constructing impulse response functions for a nonlinear model is much more complicated than in a linear model because, in nonlinear models, shocks are allowed to lead the regime changes. Thus, the responses to a particular shock have to be regime-dependent. To deal with this issue, Koop *et al*. (1996) proposed a nonlinear IRF, which is defined as follows:

$$NIRFy\left(k,u_t,\Omega_{t-1}\right)=E\left(Y_{t+k}\mid,\Omega_{t-1},u_t\right)-E\left(Y_{t+k}\mid\Omega_{t-1}\right), \tag{2}$$

where Ω_{t-1} is the information set at the time $t-1$ and u_t is a particular realization of exogenous shock. The response of the variable can be shown as the difference in expectations conditional on a certain history (Ω_{t-1}) with and without the shock u_t. Thus, nonlinear impulse response functions are calculated with conditional expectations of the entire history of the variables and the size and sign of the shock. As a result, for calculating nonlinear IRF, we need to specify the sign and size of the shock as well as the initial condition. This can be done by simulating a model for various sizes and signs of shock and conditional expectations: $E(Y_{t+k}\mid,\Omega_{t-1},u_t)$ and $E(Y_{t+k}\mid\Omega_{t-1})$. By following the simula- tion procedure outlined in Balke (2000), we conducted the simulation procedure 500 times conditional on the specified initial condition and a given realization of shock; the resulting average was the estimated conditional expectations. We estimated the model with WinRATS using the code provided by Balke which we modified for our purpose. To examine the asymmetrical behaviour of prices, we investigated two types of asymmetries depending on the size and direction of shocks. Under size asymmetry, we considered the effects of the magnitudes of shocks between regimes. Under direction asymmetry, we considered the effect of negative and positive shocks between regimes.

3.2 Data

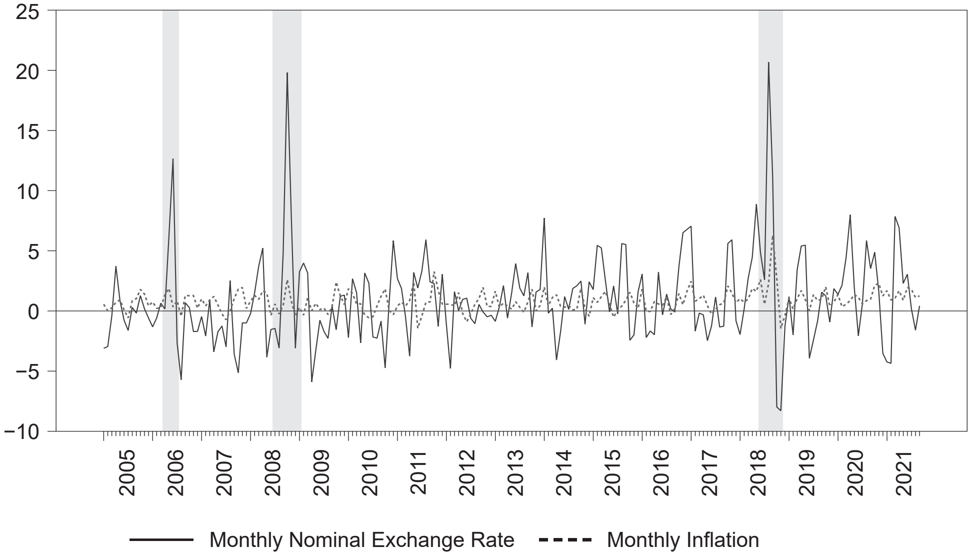
We used monthly seasonally adjusted data for the period 2005:01–2021:09. The Census X-13 method was carried out for the seasonal adjustment process. Besides, we used the output gap to represent demand. The output gap ($y_t-y_t^*$) was specified as the difference between real industrial production and the industrial production trend, calculated with the Hodrick-Prescott filter. Thus, the industrial production index was converted into an output gap. The monthly percentage change in nominal TL/USD was employed to represent the exchange rate since the US dollar is dominant in international monetary transactions. Lastly, monthly percentage changes in producer price index (PPI) and consumer price index (CPI) are used to represent producer prices and consumer prices, respectively. All data were retrieved from the CBRT-EVDS database (see Table 1 for a data description).

Table 1: Data description

Variable	Label	Source	Serial Code
Industrial production (total industry, level)	*ygap*	CBRT-EVDS	TP.SANAYREV4.Y1
Nominal exchange rate (US dollar, monthly percentage change)	*er*	CBRT-EVDS	TP.DK.USD.A.YTL_1
Consumer price index (monthly percentage change)	*cpi*	CBRT-EVDS	TP.FG.J0
Producer price index (monthly percentage change	*ppi*	CBRT-EVDS	TP.TUFE1YI.T1
Interest rate (overnight lending)	*int*	CBRT-EVDS	TP.PY.P06.ON

Source: CBRT, Electronic Data Delivery System

Figure 1: Monthly inflation and monthly nominal exchange rate



Source: CBRT-EVDS

Figure 1 shows the monthly nominal exchange rate and inflation (dashed line) between 2005:01 and 2021:09. Shaded areas show exchange rate attacks which the Turkish economy experienced in this period. As we can see from the graph, the Turkish lira is much more volatile than most developing country currencies. Recently, this volatility increased with the government's 'keeping interest rates low' policy. In the last few years, the government has intended to boost economic growth and increase exports with a competitive currency, but this policy has driven inflation to double digits, and the impact of the exchange rate on inflation has become a fiercely debated topic.

3.3 Model

Constructing the TVAR model, we employed a VAR framework similar to the one proposed by McCarthy (1999). The vector of endogenous variables includes five variables: output gap, exchange rate, manufacturing prices, consumer prices and nominal interest rates (*Yt = ygap, er, ppi, cpi, int*). Structural shocks were identified using the Cholesky decomposition by ordering variables in the given order. We used two thresholds to capture both exchange rate regimes and inflationary regimes' effect on EPRT. The monthly growth rate of the nominal exchange rate and inflation rate are used as thresholds, respectively. We determined the delay of the threshold variable as 1, which is quite common in TVAR studies. To capture the categorical responsiveness of prices, we took prices as two categories: producer prices and consumer prices. Before estimating the TVAR model, the linear VAR model was estimated to select the optimal lag length. The lag length is determined as 2 according to the Akaike information criterion in all models.

The augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller, 1981), the Phillips-Perron (PP) unit root test (Phillips and Perron, 1988), and the Lee-Strazicich (LS) unit root test with two structural breaks (Lee and Strazicich, 2003) were carried out to determine the time series properties of variables. The null hypothesis for the three tests is that the time series contains a unit root. Table 2 presents the results of ADF and PP. According to both test results, the null hypothesis is rejected for all series with a 1% significance, and all variables are stationary in their levels except the interest rate. The interest rate is stationary in its first difference. The LS test is employed as two different models. One is the AA model, which allows two structural breaks in constant, and the other is the CC model, which allows two structural breaks in constant and trend. Table 3 presents the results of the LS unit root test. According to AA and CC model results, all variables are stationary in their levels with a 1% significance level except the interest rate. The interest rate is stationary in its first difference. The unit root results are consistent for all three tests. According to these test results, all variables except the interest rate enter into models in their levels; the interest rate enters into models in its first differences.

In order to estimate the TVAR model, one has to test whether the data indicate the presence of statistically significant threshold behaviour. We run a non-linearity test for a threshold VAR model against a linear VAR model by using the monthly growth rate of the nominal exchange rate and monthly inflation rate as threshold variables alternatively, with an optimal trimming of 15%. Table 4 reports the test results: the null hypothesis of linearity was rejected at every significance level for the exchange rate. The system shows non-linearity. Hence, the threshold splits the sample into two; a higher exchange rate regime and a lower exchange rate regime. In our case, the estimated threshold value is 2.73, which indicates that a monthly change in exchange rate above 2.73% can be considered an upper regime, and changes below that level can be regarded as a lower regime. Similarly, the inflation threshold significantly takes the value of 1.04, which indicates that 1.04% and greater change in monthly CPI inflation can be considered as in upper regime and changes below that level can be considered as in lower regime.

Table 2: Augmented Dickey-Fuller and Philips Perron unit root test results

	Augmented Dickey-Fuller		Philips-Perron	
Variable	Constant	Constant and trend	Constant	Constant and trend
ygap	–6.2158***	–6.1930***	–12.6567***	–12.6318***
Δ *ygap*	–28.5181***	–28.4522***	–76.1647***	–76.8401***
er	–10.8700***	–11.1703***	–9.3277***	–9.3980***
Δ *er*	–10.0389***	–10.0109***	–47.1463***	–47.3984***
ppi	–7.7418***	–8.2012***	–7.6068***	–8.3699***
Δ *ppi*	–10.3805***	–10.3516***	–33.3746***	–32.9188***
cpi	–10.1158***	–10.6808***	–10.1668***	–10.5595***
Δ *cpi*	–10.0937***	–10.0695***	–97.0584***	–96.1135***
int	–2.8523*	–2.8300	–2.2371	–2.1321
Δ *int*	–4.9072***	–4.9170***	–11.2931***	–11.3256***

Note: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.
The lag order is determined by the Schwarz Bayesian criterion.

Source: Authors

Table 3: LS test results

	AA model		CC model	
Variable	**LM statistics**	**Break I-II**	**LM statistics**	**Break I-II**
ygap	–3.5652***	2017:08 / 2019:06	–7.1337***	2018:06 / 2020:03
Δ *ygap*	–2.9624*	2018:08 / 2020:03	–11.9597***	2016:06 / 2020:03
er	–10.7643***	2008:01 / 2016:11	–10.9981***	2008:12 / 2018:06
Δ *er*	–15.4861***	2012:06 / 2017:04	–16.2859***	2008:04 / 2017:02
ppi	–5.2409***	2016:11 / 2019:12	–8.5660***	2016:06 / 2018:10
Δ *ppi*	–3.4558*	2011:07 / 2016:10	–13.2446***	2010:09 / 2012:11
cpi	–6.9150***	2010:04 / 2017:09	–9.9148***	2011:04 / 2016:12
Δ *cpi*	–5.5425***	2017:12 / 2020:02	–15.2326***	2010:12 / 2019:11
int	–3.0627	2013:12 / 2018:05	–5.4225	2008:11 / 2012:01
int	–5.4673***	2007:10 / 2010:11	–9.1108***	2018:05 / 2020:03

Note: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.
The lag order is determined by the Schwarz Bayesian criterion.

Source: Authors

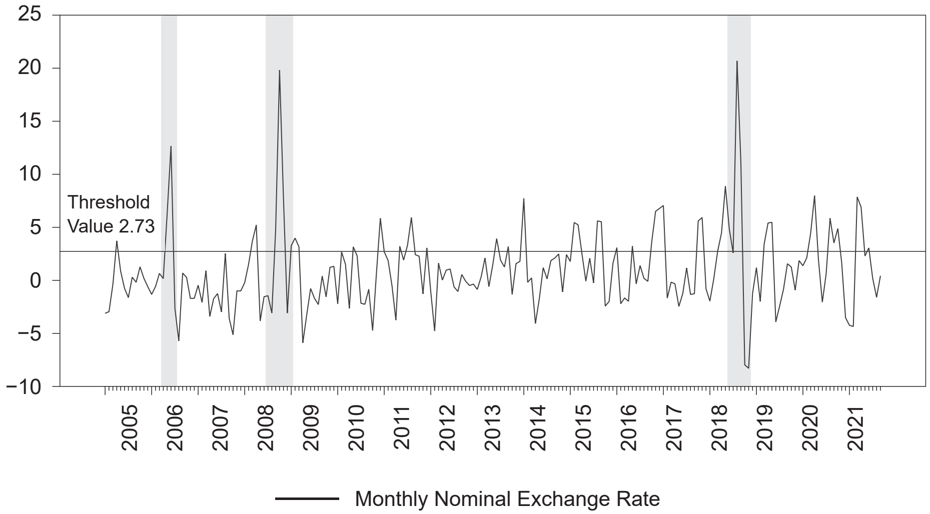
Table 4: Test for threshold VAR

Lag	Threshold variable	Delay of threshold variable	Best threshold value	LR test	Wald statistics		
					Sup-Wald	**Avg-Wald**	**Exp-Wald**
2	*er*	1	2.73	378.4079	199.0562 (0.000***)	106.9251 (0.000***)	95.0047 (0.000**)
2	*cpi*	1	1.04	293.3588	169.5985 (0.000***)	104.5985 (0.000***)	80.2772 (0.000**)

Note: The threshold variable delay is 1, and the lag of the TVAR is 2.

Source: Authors

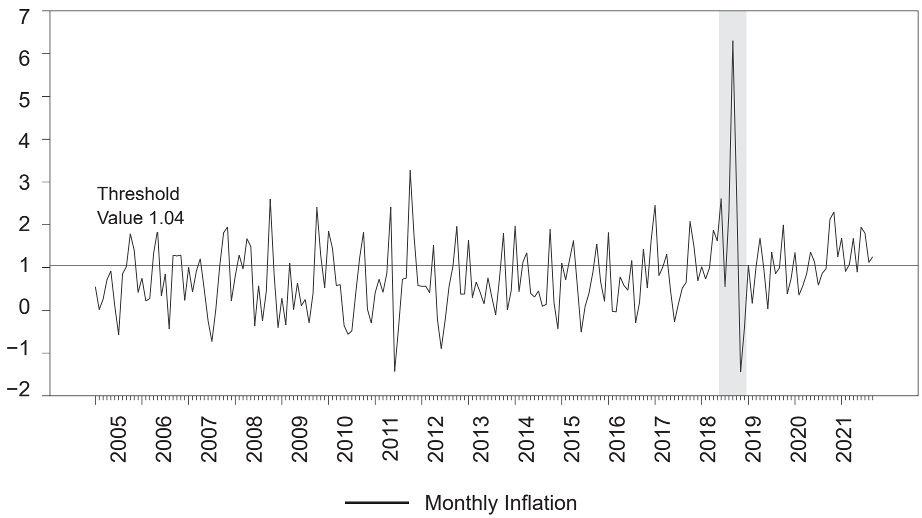
Figure 2: Sample splitting of threshold values for exchange rate (2.73)



Note: The middle line represents the threshold value. The area above the line is the upper regime, and below the line are lower regime values.

Source: Authors

Figure 3: Sample splitting of threshold values for inflation rate (1.04)



Note: The middle line represents the threshold value. The area above the line is the upper regime, and below the line are lower regime values.

Source: Authors

Figures 2 and 3 show the time plot of the upper and lower periods based on the threshold values for exchange rate and inflation rate, respectively. Additionally, Figure 2 shows the exchange rate threshold, in which the total sample size is 201, and the number of observations is 41 in the upper regime and 160 in the lower regime. Figure 3 shows the inflation rate threshold, in which the total sample size is 201, and the number of observations is 76 in the upper regime and 125 in the lower regime. The upper samples reasonably corresponded to some of the exchange rate attacks and inflationary periods in the Turkish economy. As a result, we conclude that the estimated threshold values split the samples accurately.

4. Results

4.1 Nonlinear impulse responses with exchange rate as a threshold variable

In this section, a nonlinear impulse response analysis is employed to investigate the asymmetries in exchange rate pass-through within high and low exchange rate regimes when the exchange rate is a threshold variable. Figure 4 and Figure 5 show impulse response functions after negative and positive one standard deviation (1 s.d.) and two standard deviation (2 s.d.) exchange rate shocks in lower and upper regimes, respectively. A 1 s.d. shock refers to relatively smaller shocks, and a 2 s.d. shock refers to relatively larger ones. Impulse responses are estimated for a 24-month horizon. All variables in the system give consistent responses with existing empirical and theoretical evidence. After a positive one and two standard deviation exchange rate shock, the output gap decreases, while the exchange rate and the interest rate increase. Conversely, after a negative one and two standard deviation shock, the output gap increases, while the exchange rate and the interest rate decrease. Nevertheless, the responses vary in terms of magnitudes of shock and which regimes the system is in. In the upper regime, the variables give a stronger response than in the lower regime. However, larger shocks (2 s.d.) lead to larger responses in both regimes.

Since our main interest is investigating the pass-through, important variables for our scope are PPI inflation (producer prices) and CPI inflation (consumer prices). PPI and CPI inflation respond positively after a positive exchange rate shock (domestic currency depreciation) and a negatively after a negative shock (domestic currency appreciation). In both regimes, producer prices respond more strongly to exchange rate shocks than consumer prices. We can conclude that pass-through to producer prices is higher than pass-through to consumer prices. As for between-regimes analysis, Figures 4 and 5 suggest the existence of asymmetric pass-through across regimes, and the magnitude of impulse responses differs strongly by the regime. The response of producer prices is nearly twice higher in the upper regime than in the lower one. Similarly, the response of consumer prices is nearly three times higher in the upper regime than in the lower regime. This is an indication that exchange rate shocks have substantially larger effects on consumer and producer prices when the system is in upper exchange rate regime, and this is particularly true for large (2 s.d.) and positive shocks.

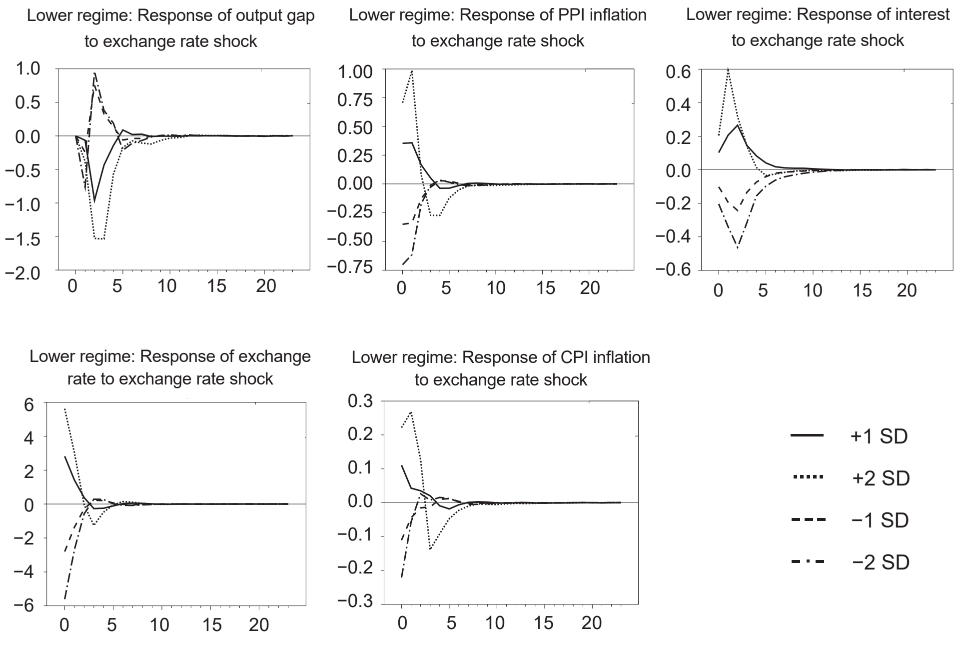
As for within the regime, there is no direction or size asymmetry in the lower regime; responses of both PPI inflation and CPI inflation to positive and negative shocks look like the mirror image of each other. A reasonable explanation for this might be that there is relative stability in the exchange rate in low exchange rate periods, and thus, shocks are not reflected as pricing behaviour, especially small shocks. As a result, such differentiation between positive and negative shocks may not occur. However, in the upper regime, this can only hold for small shocks; larger shocks create asymmetric responses. In the upper regime, CPI inflation gives nearly twice higher response to 2. s.d. positive exchange rate shocks than 2. s.d. negative ones, which indicates a clear direction asymmetry. In other words, the transmission of domestic currency depreciation to consumer prices is twice higher than appreciation. This result is consistent with the downward sticky price theory, according to which price-setting firms reflect positive movements in the exchange rate to inflation rather than negative ones during the periods of large exchange rate movements. Likewise, size asymmetry exists in a way that a 1 s.d. positive shock leads to a 0.30 positive response in CPI inflation while a 2. s.d. positive shock leads to a 0.80 positive response. Thus, pass-through increases asymmetrically with the magnitude of the shocks. These results suggest that asymmetric pass-through cannot be observed while the exchange rate is in the lower regime; however, when the exchange rate is in the upper regime, asymmetry can be observed between larger and small shocks and between negative and positive shocks. Overall, large and positive exchange rate movements have stronger effects on domestic prices during high exchange rate periods via the pass-through.

In a monetary policy context, exchange rate fluctuations may significantly affect the monetary policy stance. Especially within the framework of the inflation targeting regime, exchange rate pass-through may lead to distortion of inflation targets. To have credible targets we need to have a comprehensive understanding of the prevailing pass-through behaviour. In this sense, we investigated the response of monetary policy to exchange rate fluctuations across high and low exchange rate periods to evaluate monetary policy stance. According to Figures 4 and 5, both in upper and lower regimes, the response of interest rates to negative exchange rate shocks (domestic currency appreciation) are nearly the same, which shows that the central bank does not change its response to negative exchange rate shocks depending on the regime. However, there is a slightly higher response to positive shocks (domestic currency depreciation) in the upper regime than in the lower one. This suggests that in the upper regime, the central bank has a slightly greater propensity to respond to positive shocks, particularly large ones.

4.2 Nonlinear impulse responses with inflation rate as a threshold variable

Our findings so far reveal asymmetrical behaviour in the exchange rate pass-through to domestic prices in terms of both size and direction. Asymmetric responses of domestic prices are particularly visible in large and positive shocks. This section extends our scope by adding an inflationary environment to the pass-through mechanism. We used the inflation rate as a threshold variable to split our sample into high and low inflationary periods. Figures 6 and 7 show the nonlinear impulse response functions for lower and upper inflationary regimes, respectively. According to figures, after a positive 1 s.d. and 2 s.d. exchange rate shock, all variables give positive responses in both regimes except for the output gap. The output gap gives a negative response in both regimes. Conversely, after a negative 1 s.d. and 2 s.d. exchange rate shocks, all variables give negative responses, only the output gap gives a positive response.

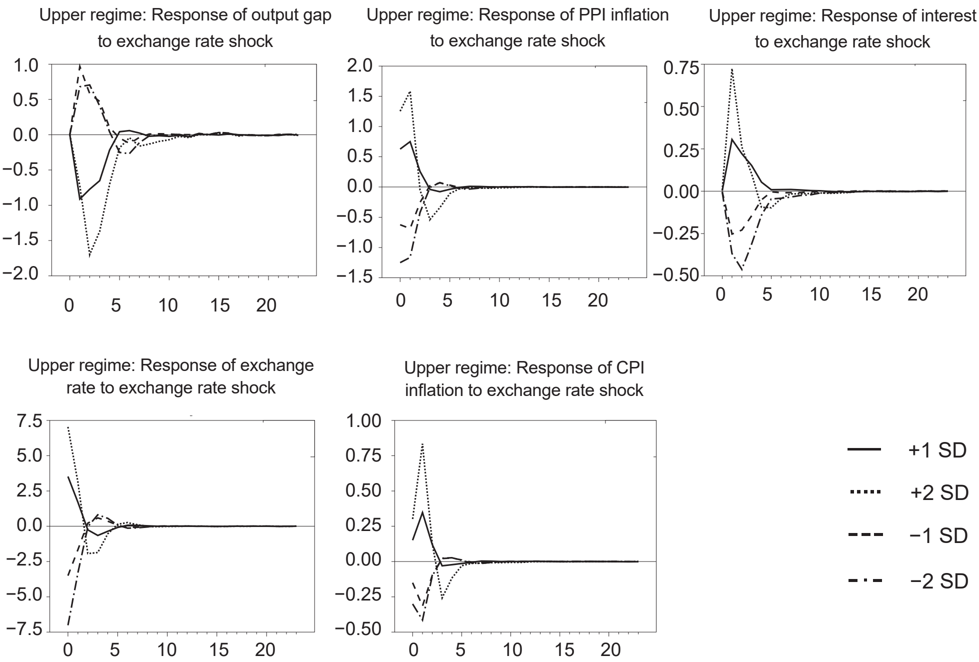
Figure 4: Response to exchange rate shocks in lower regime



Note: Impact of 1 and 2 standard deviation positive and negative shocks to exchange rate when the inflation rate is a threshold variable, in the lower regime, for 24 months.

Source: Authors

Figure 5: Response to exchange rate shocks in upper regime



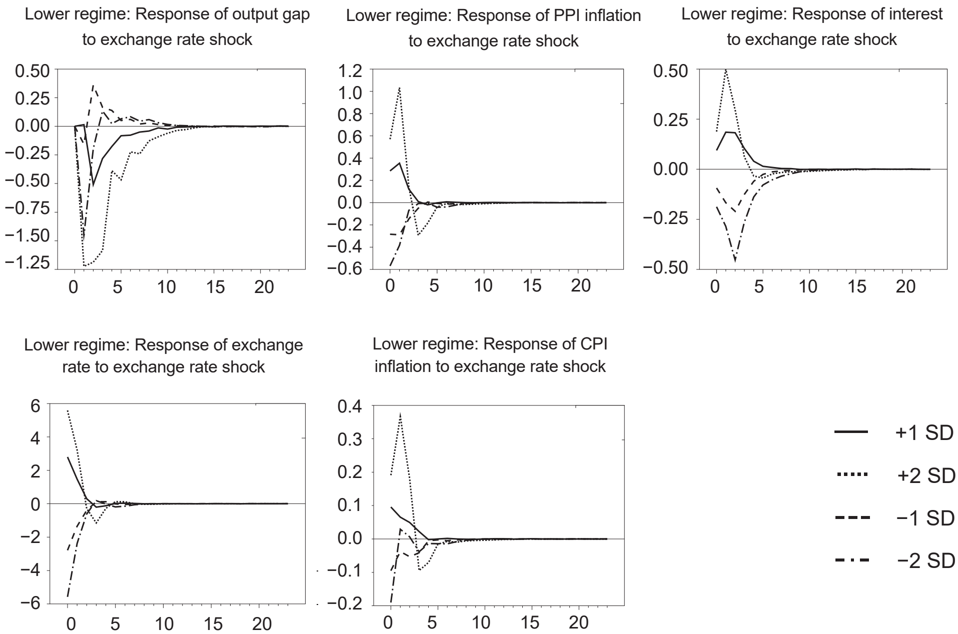
Note: Impact of 1 and 2 standard deviation positive and negative shocks to exchange rate when the inflation rate is a threshold variable, in the upper regime, for 24 months.

Source: Authors

In both regimes, production prices are more strongly affected by exchange rate shocks than consumer prices. The magnitude of responses increases with the size of shocks. As an indicator of the asymmetric behaviour in the exchange rate pass-through, the responses of both the PPI and the CPI to an exchange rate shock are nearly twice higher in the upper regime. These results are similar to the exchange rate threshold analysis but also provide evidence of a positive association between an inflationary environment and exchange rate pass-through. Our paper is in line with the proposition of Taylor (2000) and provides empirical evidence for relatively weaker pass-through in a low inflationary period. As for within-regime analysis, there is no asymmetrical response in the lower regime after positive and negative or small and large shocks. However, consumer prices give a stronger response in the upper regime after a large positive shock. Similar to exchange rate threshold analysis, transmission of a positive exchange rate shock to consumer prices is stronger than that of the negative shocks.

To examine the asymmetric behaviour of monetary policy stance when inflation is the threshold variable, we examined the response of interest rate to exchange rate fluctuations between high and low inflation periods. According to Figures 6 and 7, after 1. s.d. positive and negative exchange rate shocks, the interest rate gives roughly the same response in both regimes. However, the response of interest rate after 2. s.d. positive exchange rate shocks is slightly higher in the upper inflation regime, which indicates that the monetary authority is more sensitive to positive larger exchange rate shocks during high inflation periods. Overall, the stance of the policy authority is not seriously affected by the high inflation periods.

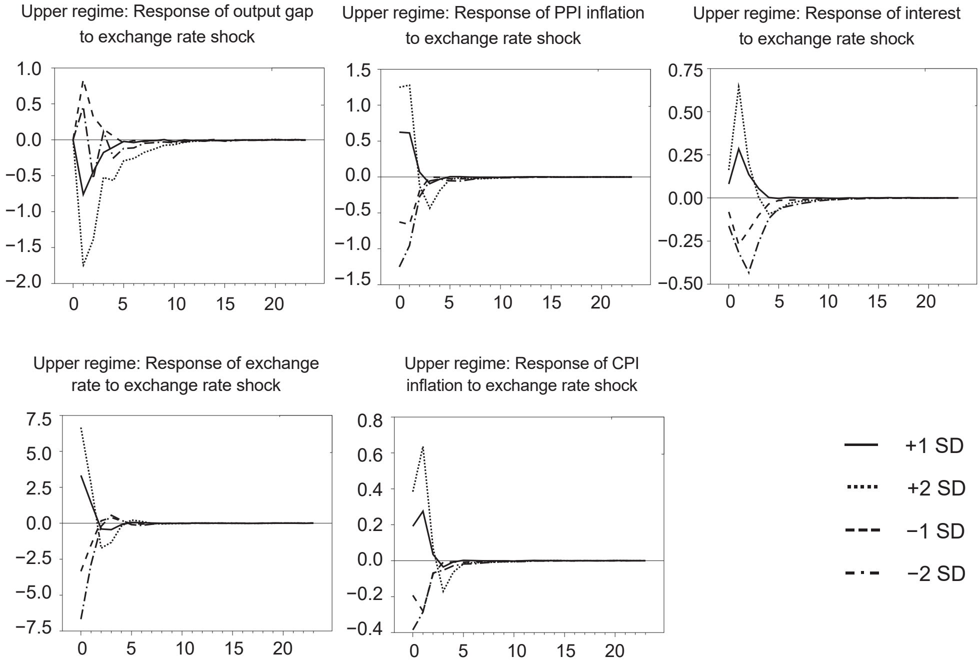
Figure 6: Response to exchange rate shocks in lower regime (inflation rate as threshold)



Note: Impact of 1 and 2 standard deviation positive and negative shocks to exchange rate when the inflation rate is a threshold variable, in the lower regime, for 24 months.

Source: Authors

Figure 7: Response to exchange rate shocks in upper regime (inflation rate as threshold)



Note: Impact of 1 and 2 standard deviation positive and negative shocks to exchange rate when the inflation rate is a threshold variable, in the upper regime, for 24 months.

Source: Authors

5. Conclusion

This paper examined the asymmetries in the exchange rate pass-through mechanism depending on size, direction and inflationary environment. A TVAR model was employed to capture asymmetries by splitting the sample into two different regimes based on threshold variables. The monthly nominal exchange rate and inflation rate were used as threshold variables alternatively. Values of the thresholds were determined endogenously. A monthly 1.04% inflation rate and 2.73% exchange rate depreciation were thresholds between the upper and lower regimes. According to our findings, rising inflation and exchange rate above these values significantly increase the pass-through effect. Responses of producer and consumer prices to exchange rate shocks are nearly twice higher in the upper regime. Also, there is a direction asymmetry between positive and negative shocks. Positive exchange rate shocks, especially large ones, cause a stronger impact on consumer prices in the upper regime. As a result, avoiding a 1.04% monthly increase in inflation and 2.73% monthly depreciation in the exchange rate is important for price stability. Price stability should be considered a primary objective of monetary policy and be assisted by a supportive fiscal policy. In a small and open economy, import price inflation is a major problem for price stability. Turkey should stabilize its import price inflation as well as follow policies that will reduce import dependence on energy.

Appendix

Estimation results of the TVAR model

	Lower regime ***er*** **(–1) ≤ 2.73**	**Upper regime** ***er*** **(–1) ≥ 2.73**	**Lower regime** ***cpi*** **(–1) ≤ 1.04**	**Upper regime** ***cpi*** **(–1) ≥ 1.04**
ygap **(–1)**	0.014 (0.052)	–0.101 (0.099)	0.010 (0.066)	–0.045 (0.058)
ygap**(–2)**	0.040 (0.045)	0.095 (0.129)	0.038 (0.052)	0.043 (0.070)
er **(–1)**	0.507*** (0.106)	0.199 (0.207)	0.412*** (0.135)	0.325** (0.146)
er **(–2)**	–0.092 (0.0977)	–0.562** (0.208)	–0.080 (0.125)	–0.486*** (0.137)
ppi **(–1)**	–0.012 (0.299)	1.522. (0.980)	–0.092 (0.343)	0.715 (0.546)
ppi **(–2)**	–0.278 (0.298)	–2.325* (1.183)	–0.361 (0.354)	–0.847 (0.582)
cpi **(–1)**	–0.548 (0.542)	–1.751 (1.412)	–0.144 (0.600)	–1.501 (0.946)
cpi **(–2)**	0.001 (0.492)	3.208 (1.929)	0.328 (0.646)	0.464 (0.854)
int **(–1)**	–0.444 (0.415)	0.102 (0.442)	–0.895* (0.480)	0.134 (0.342)
int **(–2)**	0.377 (0.404)	1.293** (0.510)	0.613 (0.467)	1.430*** (0.340)
Constant	1.364*** (0.480)	3.162* (1.595)	0.758 (0.605)	3.531*** (0.915)
Observations	157	41	122	76

Note:.*, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.
Values in the brackets are the standard errors.

Source: Authors

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