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Araştırma Makalesi ● Research Article

The Functioning of the Exchange Rate Channel in the Monetary Transmission Mechanism in Türkiye: A Comparison for the Periods of 2013-2017 and 2018-2025

Türkiye'deki Parasal Aktarım Mekanizmasında Döviz Kuru Kanalının İşleyişi: 2013-2017 ve 2018-2025 Dönemi için Bir Karşılaştırma

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ÖZ

Bu çalışma, Türkiye'de parasal aktarım mekanizmasında döviz kuru kanalının işleyişini, 2013–2017 ve 2018–2025 dönemlerini karşılaştırmalı olarak incelemeyi amaçlamaktadır. Çalışmada, aylık frekansta elde edilen faiz oranı, ihracat, reel efektif döviz kuru ve sanayi üretim endeksi değişkenleri kullanılarak oluşturulan Vektör Otoregresif modeli çerçevesinde Granger nedensellik testi, etki-tepki analizi ve varyans ayrıştırması yöntemleri uygulanmıştır. Elde edilen ampirik bulgular, 2013–2017 döneminde sanayi üretiminin faiz oranları ve ihracat üzerinde tek yönlü ve anlamlı bir etki oluşturduğunu, ancak döviz kurunun ihracat ve üretim üzerinde sınırlı bir etkiye sahip olduğunu göstermektedir. 2018–2025 döneminde ise, reel döviz kurunun ihracat üzerindeki yönlendirici etkisinin arttığı, sanayi üretiminin hem ihracat hem de faiz oranları üzerinde belirleyici hale geldiği, buna karşın ihracatın sanayi üretimi ve diğer makro değişkenler üzerinde sınırlı bir geri besleme sağladığı belirlenmiştir. Varyans ayrıştırması sonuçları da sanayi üretiminin büyük ölçüde içsel dinamiklerle açıklandığını, ancak reel döviz kuru şoklarının etkisinin zamanla anlamlı ölçüde arttığını ortaya koymuştur.

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ABSTRACT

This study aims to conduct a comparative analysis of the functioning of the exchange rate channel within the monetary transmission mechanism in Türkiye, focusing on two distinct periods: 2013–2017 and 2018–2025. The study employs Granger causality tests, impulse-response functions, and variance decomposition techniques, all within the framework of the Vector Autoregressive (VAR) model. The model is constructed using monthly data on interest rates, exports, the real effective exchange rate, and the industrial production index. The empirical findings reveal that, during the 2013–2017 period, industrial production had a unidirectional and significant effect on both interest rates and exports, while the exchange rate had a limited impact on exports and production. In contrast, during the 2018–2025 period, the influence of the real exchange rate on exports became more pronounced, industrial production emerged as a key determinant of both exports and interest rates, and exports provided only limited feedback to industrial production and other macroeconomic variables. Additionally, variance decomposition results indicate that while industrial production was primarily explained by endogenous dynamics, the impact of real exchange rate shocks grew substantially over time.

1. Introduction

Monetary policy is the process by which central banks use monetary aggregates such as interest rates, money supply, and bank credit as tools to stabilize macroeconomic indicators such as unemployment, inflation, and economic growth. Central banks implement monetary policies by considering monetary transmission mechanism channels to achieve the ultimate economic goals of sustainable growth, full employment, price stability, and a healthy balance of payments. These channels can be categorized as the traditional interest rate channel, asset price channel,

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exchange rate channel, credit channel, and expectations channel. Understanding the role of the exchange rate in the monetary transmission mechanism is crucial for conducting monetary policy under floating exchange rates. The timing and magnitude of the effects of a change in the exchange rate on output can differ significantly from traditional interest rate channels and, therefore, can influence optimal policy.

The exchange rate channel is defined as the process by which any monetary policy decision affects the real economy through exchange rates. As a result of an expansionary monetary policy (Ms ↑), when real domestic interest rates fall (ir ↓), the return on foreign currency assets will exceed the return on domestic currency assets, leading savers to hold assets denominated in foreign currency. Thus, the demand for national (domestic) currency will decrease, and the domestic currency will depreciate. The decline in the value of the domestic currency in terms of foreign currency (E ↓) will make national goods cheaper relative to foreign goods, thus increasing net exports (NX ↑). This, in turn, will lead to an increase in total production (Y ↑) (Mishkin, 2007, p. 598).

In an open economy with sticky prices, a tight monetary policy will cause the national currency to appreciate and, consequently, the exchange rate to depreciate significantly in real terms. Furthermore, when the risk premium is high, the exchange rate will continue to depreciate until it returns to long-term equilibrium. The appreciation of the domestic currency has two effects. First, the appreciation of the domestic currency will directly reduce the price of imported goods. In such a situation, a tight monetary policy would reduce the prices of imported consumer goods through consumer prices and limit firms' marginal costs by reducing the prices of imported intermediate goods. Second, the appreciation of the national currency would lead to a loss of competitiveness, shifting domestic and foreign demand to goods produced abroad, and resulting in a decline in domestic production. This decline in production would lead to a decline in net exports and further pressure on domestic prices (Smets and Wouters, 1999, p. 491).

The exchange rate channel can also influence aggregate output through income and wealth effects. Nowadays, households and firms can incur debt not only in the national currency but also in foreign currencies. This borrowing can be sourced either directly from foreign markets or through banks. In the event that banks' balance sheets lack foreign-currency-denominated assets to offset their foreign-currency-denominated liabilities, changes in the exchange rate will affect the net worth and debt-to-asset ratios of both firms and households. This, in turn, can alter the spending and borrowing decisions of these economic agents (Variçli, 2011, p. 36). As a result of an expansionary monetary policy, the value of the national currency in terms of foreign currency (E ↓) will decrease (depreciate). This leads to an increase in the burden of foreign-currency-denominated debt. Furthermore, if the assets corresponding to this debt burden are denominated in the domestic currency, it will cause a decline in net worth. This deterioration in the balance sheet reduces the supply of bank loans which lowers investment and ultimately leads to a decrease in aggregate output (Mishkin, 2001, pp. 7-8).

The effective functioning of the exchange rate channel is contingent upon the exchange rate regime adopted by a country. In an economy that has adopted a fixed exchange rate regime, the exchange rate is determined by the central monetary authority. Since the central bank lacks policy implementation autonomy under this exchange rate regime, the effectiveness of monetary policy through the exchange rate channel on the economy is diminished. In this case, the channel's efficacy is debatable. Conversely, in a free-floating exchange rate regime, exchange rates are shaped not by the central authority but by market conditions of foreign currency supply and demand. Under a floating regime, the central bank is independent in implementing monetary policy and can potentially enhance the effectiveness of monetary policy via the exchange rate channel (Taylor, 1995, p. 19). In addition to the type of regime, another factor influencing the effective operation of this channel is the mobility of financial capital across the world. In other words, the degree of openness and the size of the economy can also alter the effectiveness of the exchange rate channel. When examining the literature that investigates the impact of the exchange rate channel as a monetary transmission mechanism on the real economy, it is evident that the results are heterogeneous. Büyükakın, Cengiz, and Türk (2009); Cambazoğlu and Karaalp (2012); Mukhtarov, Yüksel, Ibadov, and Hamidov (2019); and Marques, Gelos, Harjes, Sahay, and Xue (2020) found the exchange rate channel to be effective, whereas Atgür and Altay (2017); Nagayasu (2007); Serel and Güvenoğlu (2018); and Yurtkur and Yalçın (2020) concluded that it does not function effectively.

Both the variety of results in the literature and the absence of studies considering the period characterized by intensified exchange the diversity of results in the existing literature, combined with the lack of studies specifically addressing the period of heightened exchange rate volatility, has necessitated this research. This study aims to obtain results regarding the role of the exchange rate in the monetary transmission mechanism in a relatively open economy by estimating a VAR model constructed from monthly data sets. Unlike other studies analyzing the Turkish economy, this article divides the sample period into two groups—2013:1-2017:12 and 2018:1-2025:5—using 2018, when exchange rate fluctuations intensified, as the basis for separation. Within this scope, the role of the exchange rate in identifying monetary policy shocks and the effects of policy on the real economy via the exchange rate channel will be investigated.

2. Literature Review

The importance of the exchange rate as an economic indicator for monetary policy has been steadily increasing, both globally and in Türkiye, driven by the growing openness of economies and the globalization of markets. Exchange rates are one of the most significant determinants of macroeconomic variables such as inflation, imports, exports, and consequently, production, particularly in open, developing economies. Especially in economies characterized by flexible exchange rates, as the significance of the exchange rate grows, central banks attempt to enhance the effectiveness of monetary policy by influencing the rates through policy implementation, thereby guiding macro variables such as imports, exports, and production. The extent to which monetary policy applications affect the real economy via the exchange rate channel has been the subject of numerous studies. Examples of research investigating the effects of exchange rates on the real economy include: Smets and Wouters (1999), Mishkin (2001), Arnostova and Hurnik (2005), Nagayasu (2007), Mehrotra (2007), Kasapoğlu (2007), Büyükakın et al. (2009), Tahir (2012), Cambazoğlu and Karaalp (2012), Akbaş, Zeren, and Özekicioğlu (2013), Perera and Wickramanayake (2013), Özcan (2016), Duman (2016), Atgür and Altay (2017), Mukhtarov et al. (2019), Yurtkur and Yalçın (2020), Marques et al. (2020), Li, Ni, Xu, and Zhan (2021), Özkaya and Alhuwesh (2023), and Duğru (2024).

One of the seminal studies investigating the effectiveness of the exchange rate channel is the work by Smets and Wouters (1999). This study analyzed the function of the exchange rate channel in the German economy over the 1975–1997 period using a Vector Autoregressive (VAR) model. The authors argued that the timing and magnitude of the exchange rate change's impact on output and inflation could differ significantly from those of the traditional interest rate channels, consequently affecting the optimal policy. The results from their analysis highlighted two key features. The study revealed that the monetary contraction policy implemented by Germany from 1975 to 1997 had an effect on the exchange rate, which, in turn, created a strong impact on net exports.

Another important contribution is the study by Mishkin (2001). Investigating the effectiveness of asset price channels within the monetary transmission mechanism, Mishkin (2001) found that the exchange rate has a greater impact on inflation and aggregate demand, especially in small, open economies, compared to other asset price channels. His research examined the effectiveness of numerous central banks, including the European Central Bank, in influencing the real economy through exchange rate channels. He concluded that despite the importance of asset prices in the conduct of monetary policy, central banks targeting asset prices would likely lead to worse economic outcomes and could even erode support for their independence.

There are often significant lags between a monetary policy implementation and its economic consequences. Therefore, understanding the transmission mechanism is crucial for monetary policy implementation. In this context, Arnostova and Hurnik (2005) examined the effectiveness of the monetary transmission mechanism channel in the Czech Republic from the first quarter of 1994 to the fourth quarter of 2004 using the most widely used empirical method, the VAR model. The analysis showed that an unexpected monetary policy tightening led to a decline in output, while prices remained stable for a certain period. The exchange rate reaction depends largely on the data sample used. In the Czech Republic, it was determined that the exchange rate fluctuations resulting from the interest rate cut policy were insignificant, and that the exchange rate depreciated as a result of this policy. Thus, the study concluded that the exchange rate channel affected the general price level in the Czech Republic during the relevant period. Nagayasu (2007) investigated the effectiveness of the exchange rate channel in Japan from the first quarter of 1970 to the first quarter of 2003. The research was conducted using the VAR model and the Johansen cointegration test. The analysis results concluded that monetary policy decisions in Japan affected the exchange rate, but the exchange rate channel did not operate at a level sufficient to affect output. Another study on Japan is by Mehrotra (2007). This study examined the functioning of the exchange rate channel for three countries, including Japan, using the Structural VAR model (SVAR). The study concluded that exchange rate shocks in Japan are important for price control and emphasized the significant role of the exchange rate channel in influencing the real economy in Japan.

Kasapoğlu (2007) investigated the effectiveness of the monetary transmission mechanism in Türkiye, examining the period from January 1990 to July 2006 using a VAR model. The research findings indicated that the exchange rate channel did not effectively determine production levels in Türkiye but did exert a significant influence on general price levels. Another study on the effectiveness of the exchange rate channel in Türkiye is the work by Büyükakın et al. (2009). The results from this study demonstrated that an exchange rate shock reduced output and that exchange rates held a crucial position in determining inflation. The paper highlighted that the exchange rate channel is effective in Türkiye. Tahir (2012) investigated the effectiveness of monetary transmission mechanisms in Chile, Brazil, and Korea, employing an SVAR model to analyze monthly data spanning the 1991–2009 period, which corresponds to when their central banks adopted inflation targeting. The study emphasized that with increasing globalization of the financial sector, the stock price and exchange rate channels became more important than other channels in the two countries excluding Korea. While arguing that exchange rate pass-through had decreased in the countries studied (excluding Korea), the author noted that the exchange rate channel was the most important channel influencing the

economy in these nations. The exchange rate channel was found to be operating effectively in Korea, Chile, and Brazil.

Cambazoğlu and Karaalp (2012) analyzed the functioning and effectiveness of the exchange rate channel in the Turkish economy for the period spanning 2003m1 to 2010m8, utilizing a VAR model. The researchers concluded that the exchange rate channel, which incorporates the effect of interest rates, leads to a weakening of interest rates following an increase in money supply, thereby positively affecting aggregate demand. Accordingly, they argued that the exchange rate channel operates effectively in Türkiye. In a separate study, Akbaş et al. (2013) analyzed the effectiveness of the exchange rate channel using monthly data for the 2005m1-2013m7 period via an SVAR model. Their analysis found that all exchange rate shocks in Türkiye affected industrial production. In this case, the exchange rate channel works effectively for Türkiye. Perera and Wickramanayake (2013) examined the effectiveness of monetary policy in Sri Lanka, the relative importance of different transmission channels, their distributional effects across various financial institutions, and structural changes in monetary transmission in Sri Lanka, using monthly and quarterly data. The empirical estimation results, obtained using both unrestricted and structural Vector Autoregression, revealed that monetary policy is quite effective in influencing the target variables of the Central Bank of Sri Lanka, namely output and prices. The results also indicated that monetary policy changes affect the target variables through intermediate transmission channels such as exchange rates, asset prices, and bank credit.

The study by Özcan (2016) analyzed the effectiveness of monetary transmission mechanisms in Türkiye during the 1991q1-2008q2 period using a VAR model. The findings from the analysis indicated that the exchange rate channel had no effect on Türkiye's real economy but did influence the general price level. Duman (2016) investigated the effectiveness of the exchange rate channel for the Turkish economy. In this context, the study utilized quarterly data from 2003 to 2015 and employed a VAR model. This research claims that the exchange rate channel is effective on the general price level and, consequently, on inflation in Türkiye. A similar study was conducted by Atgür and Altay (2017). They analyzed quarterly data for Türkiye, Mexico, and Indonesia between 2002 and 2016 using a VAR model. The analysis concluded that the exchange rate channel partially operated as an intermediate mechanism in Türkiye, but not in Indonesia and Mexico. Mukhtarov et al. (2019) aimed to examine whether the exchange rate channel was effective in Azerbaijan. To this end, the study performed analyses using the VAR method with data spanning the period from 2001:01 to 2017:02. The findings from the analysis demonstrated that the exchange rate channel is highly significant for the Azerbaijani economy, meaning it operates across the aggregate output and price dimensions. Therefore, the study also recommended that the central bank should take necessary measures for the effective utilization of the exchange rate channel to contribute to industrial production and employment.

Another study suggesting the insignificant effect of the exchange rate channel on the general price level in Türkiye is the work by Yurtkur and Yalçın (2020). In this research, the authors investigated whether the monetary transmission mechanism channels were effective in the Turkish economy during the 2011:01–2018:09 period. To this end, they conducted analyses using an SVAR model with monthly data. The results concluded that the credit and interest rate channels were effective during the period examined, while exchange rate shocks in Türkiye did not affect inflation; therefore, the exchange rate channel was not operating effectively in Türkiye. Central banks in emerging and developing economies are modernizing their monetary policy frameworks and frequently shifting towards inflation targeting. However, questions regarding the strength of monetary policy transmission from interest rates to inflation and output often impede progress. Within this scope, Marques et al. (2020) conducted an empirical analysis to investigate the effectiveness of monetary transmission mechanisms in 40 emerging and developing countries, including Türkiye. The analysis found that increases in interest rates reduced real output growth and inflation. Thus, the study concluded that the exchange rate channel was effective in the sampled countries.

In their article, Li et al. (2021) examined the individual impact of monetary transmission channels in China (asset price channel, credit channel, interest rate channel, and exchange rate channel) using the Impulse Response Separation Vector Autoregression (IRSVAR) technique. The analysis revealed that despite China's market-oriented reform being pursued for many years, the role of the neoclassical interest rate channel in the overall effect of monetary policy is still relatively low (31%). Conversely, although the relative role of the credit channel has decreased, it remains the most significant transmission channel on average (42%). Furthermore, the relative marginal role of asset price channels has substantially increased (20%) overall, primarily due to the rapidly increasing wealth effect on households from China's stock and real estate markets. Finally, since the exchange rate is strictly controlled, the role of the exchange rate channel has always been more negligible (7%). Özkaya and Alhuwesh (2023) aimed to investigate the effectiveness of the exchange rate channel as a monetary transmission mechanism in Yemen between 1991 and 2018, utilizing the Vector Autoregression (VAR) modeling technique with auxiliary tools such as impulse response analysis and variance decomposition. The analysis results were consistent with theoretical expectations regarding the exchange rate's effect on net exports, real economic growth, and the inflation rate. In summary, the exchange rate channel plays a significant role in transmitting the impact of monetary policy decisions to growth and CPI in the Yemeni economy. The effectiveness of the exchange rate channel in influencing both GDP and CPI was demonstrated due to its

crucial role in affecting economic activity in Yemen. The study by Duğru (2024) examined the critical role of the exchange rate channel for monetary policy effectiveness in economies with an open and flexible exchange rate regime, such as Türkiye. Using a Vector Autoregressive (VAR) model with data from the 2006:q1 to 2019:q4 period, the author investigated the dynamic effects of exchange rate shocks on aggregate output and inflation using variance decomposition and impulse response analyses. The results indicated that the exchange rate transmission mechanism, although not very strong in effectiveness, is operational and effective in achieving monetary policy goals.

The national and international literature reviewed above has demonstrated that the effectiveness of the exchange rate channel can vary across countries and over different time periods. It has been observed that the results can differ even within the same country. For instance, alongside studies suggesting that the exchange rate channel operates effectively in the Turkish economy (Büyükakın et al. 2009; Cambazoğlu and Karaalp, 2012; Akbaş et al. 2013; Marques et al. 2020), there are also studies proposing that it is not effective (Atgür and Altay, 2017; Serel and Güvenoğlu, 2018; Yurtkur and Yalçın, 2020).

3. Empirical Analysis

This study offers a comprehensive assessment of the exchange rate channel within the monetary transmission mechanism in Türkiye, a country that has undergone significant changes in its economic and financial sectors. VAR models are employed to determine the importance of the monetary authorities' target variables, namely the impact of monetary policy on the level of output. This section will first present the data set and the analysis methodology, followed by the presentation of the analysis results.

3.1. Data Set and Methodology

To conduct the empirical analysis of the study, monthly data covering the periods 2013:01-2017:12 and 2018:01-2025:05 were utilized. Monthly data were preferred over quarterly data to allow the impact of exchange rate volatility experienced during the 2003–2025 period to emerge more clearly. Given the occurrence of exchange rate shocks in the economy after the third quarter of 2018, the 2013–2025 period was divided into two sub-groups for examination. The second reason for splitting the sample period into two distinct groups is the desire to test the effectiveness of the monetary transmission mechanism before 2018 and the effectiveness of post-2018 policies, as there was no regime change concerning exchange rates, inflation, or monetary base targeting prior to 2018. All data used in the empirical analysis were obtained from the official website database of the Central Bank of the Republic of Türkiye (CBRT). The data employed in the analyses include the real exchange rate, the interest rate, exports, and the industrial production index. Information regarding the variables is provided in Table 1.

Table 1: Variables Used in the Analysis

Variable	Description	Source
RER	Real Exchange Rate	CBRT
IR	Interest Rate	CBRT
EXP	Exports	CBRT
IPI	Industrial Production Index	CBRT

The Vector Autoregression (VAR) method is a useful tool for the empirical analysis of the monetary transmission mechanism. This approach is fundamentally based on the concept of Granger causality and relates the endogenous variables of the model to their own lagged values and the lagged values of other variables over a certain period. This dynamic relationship between variables makes it possible to simulate the short-term responses to a potential shock. Greene (1993) argues that the VAR method is more effective than other methods for analysing dynamic relationships between factors. The method was first developed by Sims (1980). Its major advantage over other techniques is that it avoids the difficulty of determining which variables are endogenous or exogenous. In this context, a standard VAR model with two distinct variables can be presented as follows. Considering the series Y_t and X_t, the VAR model is:

$$Y_t = \mathrm{a}_1 + \sum_{i=1}^{p} (b_{1i})\, Y_{t-i} + \sum_{i=1}^{p} (b_{2i})\, X_{t-i} + \nu_{1t}$$

$$X_t = \mathrm{c}_1 + \sum_{i=1}^{p} (d_{1i})\, Y_{t-i} + \sum_{i=1}^{p} (d_{2i})\, X_{t-i} + \nu_{2t}$$

In these equations:

- Y_t ve X_t represent the variables in the model.
- a_1 and c_1 denote the constant (intercept) terms.
- b and d represent the coefficients to be estimated.
- p denotes the lag length.
- ν_t denote the white-noise error terms.

3.2. Results

The variables included in the study using the Vector Autoregression (VAR) model are the monthly average deposit interest rate (IR), exports (EXP), the real effective exchange rate (RER), and the industrial production index (IPI). These variables were ordered considering the operational mechanism of the exchange rate channel.

For the VAR analysis to be conducted, the variables in the model must undergo certain procedures. First, the logarithmic transformation of the variables was applied to bring them to a comparable level (and to achieve the same order of integration). In the next stage, since the variables included in the VAR model must be stationary, the stationarity of the variables was tested using the Zivot-Andrews (ZA) test. The Zivot-Andrews Test is a method that provides more reliable results in time series stationarity analysis by accounting for a single unknown structural break. According to the ZA test results, all variables were

found not to contain a unit root (i.e., they are stationary) in both sample periods (Table 2).

Table 2: Unit Root Test Result

Panel A: 2013–2017 Period					
Variables	Break Date	Test Statistic	1% Critical Value	5% Critical Value	Conclusion
RER	2016:11	-7.9464	-5.3475	-4.8598	Stationary
DIR	2014:11	-6.9791	-5.3475	-4.8598	Stationary
IPI	2017:07	-6.2858	-5.3475	-4.8598	Stationary
EXP	2016:09	-8.5513	-5.3475	-4.8598	Stationary
Panel B: 2018–2025 Period					
Variables	Break Date	Test Statistic	1% Critical Value	5% Critical Value	Conclusion
RER	2021:09	-5.3791	-5.7191	-5.1757	Stationary
DIR	2022:07	-5.6932	-5.7191	-5.1757	Stationary
IPI	2020:04	-8.79967	-5.7191	-5.1757	Stationary
EXP	2020:08	-11.2866	-5.7191	-5.1757	Stationary

Note: The test applied is the Zivot-Andrews (ZA) Unit Root Test, which allows for one unknown structural break. The null hypothesis (H0) is that the series contains a unit root (is non-stationary). The conclusion of "Stationary" means the null hypothesis is rejected at the respective critical values.

To estimate the VAR model, the optimal lag length must first be determined. The results of the lag order selection test for the established VAR models are presented in Table 3. The Akaike Information Criterion (AIC), Final Prediction Error (FPE), Likelihood Ratio (LR), and Hannan-Quinn Information Criterion (HQ) criteria all suggest an optimal lag length of 2 for the VAR models spanning the 2013:01-2017:12 and 2018:01-2025:05 periods.

Table 3. Optimal Lag Length for the VAR Model

Panel A: 2013–2017 Period					
Lag	LR	FPE	AIC	SC	HQ
0	NA	2.63e-12	-15.31436	-15.16837	-15.25791
1	295.5295	1.28e-14	-20.64313	-19.91319*	-20.36086
2	37.91071*	1.01e-14*	-20.88546*	-19.57157	-20.37737*
3	17.86555	1.21e-14	-20.72901	-18.83117	-19.99510
4	19.07008	1.38e-14	-20.64904	-18.16725	-19.68931
5	11.79684	1.88e-14	-20.41419	-17.34844	-19.22864
Panel B: 2018–2025 Period					
Lag	LR	FPE	AIC	SC	HQ
0	NA	2.74e-10	-10.66628	-10.54804	-10.61884
1	533.4051	3.64e-13	-17.28971	-16.69849*	-17.05250
2	47.05262*	2.82e-13*	-17.54815*	-16.48395	-17.12118*
3	15.53125	3.36e-13	-17.38149	-15.84432	-16.76476
4	22.04490	3.58e-13	-17.33088	-15.32073	-16.52438
5	24.52808	3.62e-13	-17.34462	-14.86149	-16.34836

Note: AIC: Akaike Information Criterion, SC: Schwarz Information Criterion, HQ: Hannan-Quinn Information Criterion, FPE: Final Prediction Error, and LR: Sequential Modified LR Test Statistic (each test at the 5% level.

The fact that the inverse roots of the characteristic equation lie inside the unit circle indicates that the VAR model constructed with the selected lag length of two is stable (Figure 1). Furthermore, this chosen lag length is the one at which the autocorrelation problem is eliminated.

The presence of autocorrelation among the error terms obtained after estimating the VAR model was investigated using the LM test. According to the results of the LM test, no autocorrelation was found at the examined lag length of 2. Thus, the error terms are constant for the entire sample, and because the probability values are greater than 0.05, the model is statistically significant (Table 4).

Table 4: Results of the LM Test

Panel A: 2013–2017 Period		
Lag	LM-Statistic	Probability
1	17.11686	0.3781
2	24.28479	0.0835
3	13.71991	0.6196
Panel B: 2018–2025 Period		
Lag	LM-Statistic	Probability
1	12.88654	0.6810
2	26.12071	0.0624
3	11.10414	0.8030

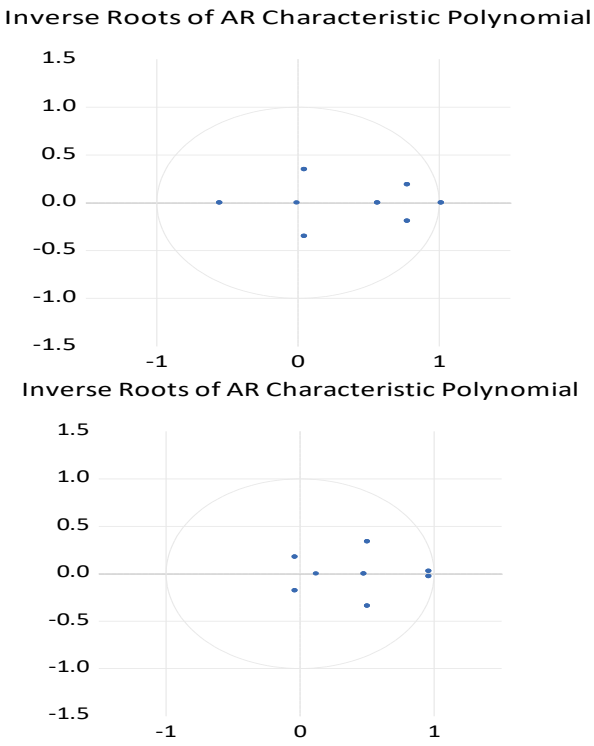

Figure 1: VAR Model Stability Graph for the Period 2013-2017 (Up) and the Period 2018-2025 (Down)

The White test was applied to detect the problem of heteroscedasticity (Table 5). The probability values of the model are greater than 0.05 This indicates that there is no problem of heteroscedasticity in the model

Table 5: Results of the White Test

Chi-Square	Degrees of Freedom	Probability Value (p)	Period
167.5883	160	0.3246	The 2013-2017 Period
161.1880	160	0.4256	The 2018-2025 Period

Under the VAR assumptions, the results of the standard Granger causality test are presented in Table 6 and Table 7. The Granger Causality analysis results for the 2013-2017 period indicate that the industrial production (IPI) variable establishes a significant unidirectional causality on both exports (EXP) and interest rates (IR); specifically, the past values of IPI provide a significant contribution to predicting the future values of these two variables (with p=0.0009 and p=0.0224, respectively). In contrast, no significant causality relationship is found between IPI and the real exchange rate (RER). On the other hand, the real exchange rate exhibits a weak but significant unidirectional causality on exports (p=0.0078) and interest rates (p=0.0511); and a weak effect of interest rates on exports is also observed (p=0.0769). No bidirectional causality was detected, implying an absence of mutual cause-and-effect relationships among the variables. These findings, in light of the economic conditions of the period, reveal that industrial production played a determining role over export and interest rate decisions, while exchange rate and interest rate policies had a limited and unidirectional effect on export dynamics. However, it should be considered that Granger causality only measures statistical predictability and does not directly imply true economic causality.

Table 6: Results of the Granger Causality Analysis (2013-2017 Period)

Null Hypothesis:	F-Statistic	Prob.
RER does not Granger Cause IPI	1.02397	0.3662
IPI does not Granger Cause RER	1.31547	0.2770
EXP does not Granger Cause IPI	1.87125	0.1640
IPI does not Granger Cause EXP	8.08833	0.0009***
IR does not Granger Cause IPI	0.43858	0.6473
IPI does not Granger Cause IR	4.08547	0.0224**
EXP does not Granger Cause RER	1.19119	0.3119
RER does not Granger Cause EXP	5.32530	0.0078***
IR does not Granger Cause RER	0.30095	0.7414
RER does not Granger Cause IR	3.14740	0.0511**
IR does not Granger Cause EXP	2.69405	0.0769*
EXP does not Granger Cause IR	0.57454	0.5664

Note: ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

The results of the Granger causality analysis for the 2018–2025 period reveal the directional interactions among exports (EXP), the real exchange rate (RER), industrial production (IPI), and the interest rate (IR) in the Turkish economy. The analysis demonstrates that the real exchange rate holds a significant and unidirectional Granger causality over exports, indicating that exchange rate shocks play a critical role in forecasting export performance (Prob. = 0.0227). Similarly, industrial production strongly influences exports (Prob. = 0.0001), while the power of exports to influence production or the exchange rate was found to be limited. Furthermore, the finding that industrial production has a significant causality on interest rates (Prob. = 0.0059) suggests that the real economy shapes interest rate decisions, which deviates from the traditional monetary policy transmission mechanism. These findings suggest that export growth in Türkiye during the 2018–2025 period was largely supported by competitive exchange rate policies and production-oriented structural strategies; however, the guiding influence of exports on macroeconomic indicators remained limited. The absence of a significant causality between the interest rate and exports indicates that the impact of the interest rate channel on foreign trade dynamics is weak. In conclusion, while the exchange rate and production capacity are the determining factors in Türkiye's export performance, it is emphasized that the contribution of exports to domestic growth is indirect and limited.

Table 7: Results of the Granger Causality Analysis (2018-2025 Period)

Null Hypothesis:	F-Statistic	Prob.
EXP does not Granger Cause RER	0.33415	0.7169
RER does not Granger Cause EXP	3.96374	0.0227***
IR does not Granger Cause RER	0.81160	0.4477

RER does not Granger Cause IR	1.01662	0.3663
IPI does not Granger Cause RER	1.99407	0.1427
RER does not Granger Cause IPI	2.43593	0.0938
IR does not Granger Cause EXP	2.10769	0.1281
EXP does not Granger Cause IR	2.14314	0.1238
IPI does not Granger Cause EXP	9.98949	0.0001***
EXP does not Granger Cause IPI	1.16311	0.3176
IPI does not Granger Cause IR	5.47355	0.0059**
IR does not Granger Cause IPI	0.47828	0.6216

Note: ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively.

Following the Granger causality analysis, the aim was to determine the response of the variables to any potential shock in exchange rates in order to evaluate the effectiveness of the exchange rate channel in Türkiye. For this purpose, impulse response functions were calculated for 10 quarters (2.5 years) using Monte Carlo simulations (for ± 2 standard errors) based on the Cholesky decomposition method. The obtained results are presented in Figure 2 and Figure 3. The 2018-2025 period represents a phase characterized by intense exchange rate volatility. Therefore, the exchange rate channel of the monetary transmission mechanism is expected to have a higher degree of influence on the real economy after 2018, compared to the 2013-2017 period. An impulse response analysis was conducted among the relevant variables to test this expectation.

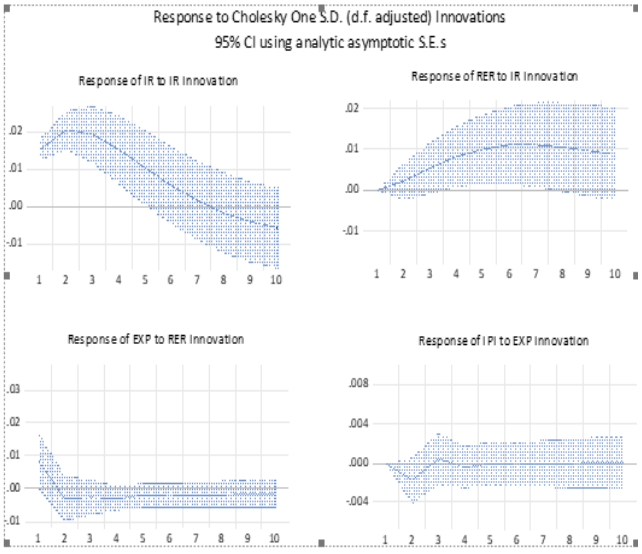

Figure 2: Operation of the Exchange Rate Channel in the 2013-2017 Period

In the analysis conducted for the 2013-2017 period, an unexpected increase (shock) in interest rates (IR) was observed to have a statistically significant and positive impact during the first two periods, indicating that the rise in interest rates was persistent in the short run. However, this effect dissipated around the 6th period and was found to be insignificant in the long run. The impact of the same interest rate shock on the real exchange rate (RER) was found to be statistically insignificant across all periods, as the confidence interval encompassed the zero line, suggesting no discernible change in the real exchange rate. The effect of a shock to the real exchange rate on exports (EXP), while slightly positive in the initial period, became significantly and persistently negative from the 2nd period onwards. This indicates that a real appreciation of the national currency negatively affected exports. Finally, the effect of an unexpected increase in exports on the industrial production index (IPI) was found to be statistically insignificant across all periods, leading to the conclusion that the increase in exports did not significantly influence industrial production.

Overall, these findings suggest that the effectiveness of the monetary and foreign trade channels was limited throughout the period, highlighting weaknesses in the guiding power of macroeconomic policy components over the real economy. Although interest rate shocks maintained their effect on interest rates, a significant deviation from the classical interest rate-exchange rate relationship was identified, as an interest rate increase led to a depreciation rather than an appreciation in the real exchange rate. Concurrently, the effects of real exchange rate shocks on exports, and export shocks on industrial production, quickly faded and became insignificant. This suggests that foreign trade is dependent on structural factors, and the overall effectiveness of the monetary and foreign trade channels on the real economy remained constrained during this period.

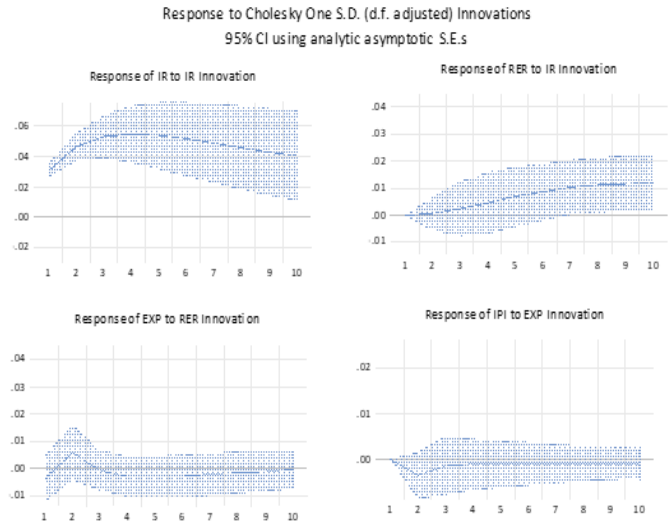

Figure 3: Operation of the Exchange Rate Channel in the 2018-2025 Period

The results of the impulse response analysis between variables for the 2018–2025 period are shown in Figure 3. The impulse response analysis, based on Cholesky decomposition for the 2018–2025 period, indicates that a shock to interest rates (IR) generates a statistically significant and persistently positive effect throughout all 10 periods. This suggests that interest rate hikes created long-lasting effects on the economy during this period. Although the impact of interest rate shocks on the real exchange rate

(RER) shows a positive trend starting from the 3rd period, this effect is concluded to be statistically insignificant as the confidence interval spans the zero line across all periods. The effect of a shock to the real exchange rate on exports (EXP) is positive in the initial period but turns negative in subsequent periods; however, this effect fails to cross the significance threshold throughout all periods. Consequently, the impact of the real exchange rate on exports is uncertain during this period. Finally, the effect of an export shock on the industrial production index (IPI) generates only a limited positive response in the first period, but this effect lacks persistence; the effects become statistically insignificant from the 2nd period onwards.

Overall, the analysis for this period reveals that interest rate shocks are persistent, yet the effects of variables such as the real exchange rate and exports are more uncertain and statistically weaker compared to the previous period. The variance decomposition findings for the 2018–2025 period suggest that the variance of Turkish industrial production is largely explained by internal structural factors. The analyses indicate that the explanatory power of external exchange rate shocks on industrial production increases over time, while the influence of other macroeconomic variables, such as exports and interest rates, remains limited. These results underscore the necessity of long-term structural reforms to strengthen the production structure, beyond short-term instruments, to enhance the effectiveness of monetary and foreign trade policies on industrial production.

The VAR model is evaluated through the combined use of impulse response analysis and variance decomposition analysis. Following the impulse response analysis, a variance decomposition analysis was performed to determine the relationship among the variables included in the VAR model.

According to the variance decomposition analysis results for the 2013-2017 period, the volatility in the IPI variable is largely explained by its own internal shocks; in the first period, the entire variance (100%) is attributed to these shocks, and this ratio remains at 87.24% even in the 10 th. period. This suggests that industrial production is highly dependent on its internal dynamics. Nevertheless, the contribution of shocks originating from external variables increases over time; specifically, the RER variable constitutes the highest external impact at 6.64% in the 10 th. period. The effect of the IR variable remains more limited at 5.32%, while the contribution of EXP is negligible at 0.80%. These results indicate that the variance in IPI is predominantly determined by internal factors, but the influence of shocks from external macroeconomic variables such as the real exchange rate and the interest rate relatively increases over time. Although the time structure on which the analysis is based is not explicitly stated, the findings are valid for a 10-period forecast horizon, revealing that external effects gain importance, particularly in the long run.

Table 8: Variance Decomposition Analysis for the 2013–2017 Period

Variance Decomposition of IPI:				
Period	IPI	RER	EXP	IR
1	100.0000	0.000000	0.000000	0.000000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
2	93.71962	2.427868	3.274161	0.578346
	(5.77847)	(2.83291)	(4.51469)	(1.47965)
3	94.29038	2.300553	2.315630	1.093434
	(5.20992)	(2.71902)	(3.37034)	(2.39551)
4	92.87404	3.387848	1.985924	1.752186
	(6.82573)	(4.05838)	(3.61036)	(3.79484)
5	92.16670	3.929758	1.602441	2.301104
	(7.66138)	(4.82502)	(3.49773)	(4.83903)
6	90.97984	4.712702	1.372864	2.934598
	(9.01557)	(6.06783)	(3.69099)	(5.90154)
7	90.02330	5.265493	1.171695	3.539508
	(10.0471)	(6.93099)	(3.73982)	(6.75439)
8	88.99963	5.818576	1.020683	4.161106
	(11.2530)	(7.93832)	(3.89076)	(7.53406)
9	88.09504	6.255566	0.897146	4.752252
	(12.2515)	(8.68228)	(3.97245)	(8.17139)
10	87.23796	6.643645	0.797610	5.320781
	(13.2666)	(9.43316)	(4.09619)	(8.73898)

The variance decomposition results obtained from the Vector Autoregressive (VAR) model for the Industrial Production Index (IPI) for the 2018–2025 period reveal that industrial production in Türkiye is largely determined by its own internal dynamics. Specifically, the majority of the variance in the IPI variable originates from its own shocks across all periods, remaining at a high level of 83.46% even in the 10 th. period. This suggests that factors such as production-focused incentive policies implemented after 2018, domestic-demand-driven structural orientations, and supply chain disruptions reinforced the internal independence of industrial production.

Among the external variables, shocks to the real exchange rate (RER) create a pronounced effect on industrial production that increases over time, reaching a contribution of 14.27% in the 10 th. period. This highlights the impact of exchange rate shocks on production costs and investment decisions. In contrast, the contributions of export (EXP) and interest rate (IR) shocks remained limited; the maximum contribution of export shocks was confined to 2.27%, while the contribution of interest rate shocks did not even exceed 0.3%. These findings suggest that the influence of these variables on industrial production is limited due to the import dependence of exports, uncertainties in foreign demand, and the weak functioning of the interest rate channel. Consequently, this points to the necessity of long-term structural reforms that go beyond monetary and foreign trade policies for the sustainability of industrial production in Türkiye.

Table 9: Variance Decomposition Analysis for the 2018–2025 Period

Variance Decomposition of IPI:				
Period	IPI	RER	EXP	IR
1	100.0000	0.000000	0.000000	0.000000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
2	97.44955	0.001913	2.275878	0.272659
	(3.00535)	(0.97220)	(2.59290)	(1.11804)
3	96.47871	0.790132	2.420423	0.310736
	(4.82157)	(2.56583)	(3.55468)	(1.99868)
4	94.26823	3.122729	2.335234	0.273806
	(6.05793)	(4.24001)	(3.96756)	(2.52404)
5	91.34495	6.162301	2.239303	0.253447
	(6.97142)	(5.78398)	(4.06233)	(2.79548)
6	88.66494	8.919787	2.164126	0.251146
	(7.67309)	(6.94072)	(4.10548)	(2.97478)
7	86.63447	11.00163	2.116981	0.246920
	(8.22024)	(7.75936)	(4.16159)	(3.16342)
8	85.21006	12.46397	2.090728	0.235248
	(8.67421)	(8.37353)	(4.22790)	(3.38856)
9	84.20580	13.49790	2.075420	0.220882
	(9.07995)	(8.87743)	(4.29272)	(3.65642)
10	83.45660	14.26991	2.064266	0.209226
	(9.45827)	(9.31554)	(4.34968)	(3.97179)

4. Conclusion

The monetary transmission mechanism is the process through which monetary policy decisions influence the economy in general and the general price level in particular. This mechanism is often characterized by time lags that can be protracted, variable, and uncertain, making it difficult to predict the effect of monetary policy applications on the real economy. This study aimed to provide a comparative analysis of the operation of the monetary transmission mechanism through the exchange rate channel in Türkiye for the periods 2013–2017 and 2018–2025. Within the framework of a VAR model constructed using monthly data, Granger causality, Impulse Response, and Variance Decomposition analyses were performed. The findings reveal that the exchange rate channel in the Turkish economy possesses a structure with significant temporal differences.

The analysis results for the 2013–2017 period indicate a unidirectional and statistically significant causality running from industrial production to exports and interest rates. Conversely, the effect of the exchange rate on the real economy was found to be limited and short-lived. Impulse response analyses also showed that interest rate shocks generated responses in the exchange rate that were inconsistent with classical expectations, and export shocks failed to transmit significant and permanent effects to industrial production. In this context, the impact of the monetary transmission mechanism on the real sector through the interest rate and exchange rate channels remained weak, with industrial production being largely determined by internal dynamics. This finding is consistent with the work of Kasapoğlu (2007) and Özcan (2016). The 2018–2025 period suggests a structure where the exchange rate effect is more pronounced. In this period, the exchange rate had a significant and directional effect on exports, while the effect of exports on industrial production or interest rates remained limited. Industrial production was determined to be a decisive variable influencing both interest rates and exports. Variance decomposition results also revealed that industrial production is primarily explained by its own internal shocks, though the influence of exchange rate shocks increases over time. This suggests that production capacity, domestic demand structure, and implemented structural policies play a fundamental role in determining industrial production.

Generally, across both periods, the effect of exports on industrial production remained limited. This can be attributed to structural issues in Türkiye's foreign trade structure, such as high dependency on imported inputs and uncertainties in foreign demand. The interest rate channel within the monetary transmission mechanism was also found to be operating weakly, with real variables such as industrial production and the exchange rate becoming more decisive, especially in the post-2018 period. In line with the empirical findings, ensuring confidence, predictability, and transparency in monetary policy should be the primary priority to enhance the effectiveness of the monetary transmission mechanism and support sustainable growth in Türkiye. This necessitates strengthening the effectiveness of the interest rate channel and coordinating monetary policy with fiscal and income policies. Regarding the exchange rate channel, precautionary policies should be implemented to reduce currency volatility, thereby limiting the impact of real exchange rate shocks on industrial production. Furthermore, greater emphasis should be placed on structural transformation strategies that support high domestic value-added production to reduce reliance on imported inputs. Considering the structure of industrial production, which relies on internal dynamics, technology-focused investments that enhance production capacity and productivity should be encouraged. Finally, the impact of the outward-oriented growth strategy on domestic demand and production should be increased through policies that strengthen the sectoral distribution of exports and promote localization in supply chains.

In conclusion, the role of the exchange rate channel in the monetary transmission mechanism in Türkiye exhibits temporal variation. The exchange rate effect, which remained limited during the 2013–2017 period, became more significant in the post-2018 period through its impact on exports and production. However, ensuring the sustainability of this effectiveness and maintaining economic stability requires not only the efficient use of monetary policy instruments but also comprehensive policy sets that prioritize structural transformations.

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