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Araştırma Makalesi

Investigation of Real and Nominal Exchange Rates in Turkiye Under Economic Shocks Using the SVAR Method

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Abstract

Numerous studies in the economic literature demonstrate that real and nominal shocks affect real and nominal exchange rates in the short or long term. Therefore, it was deemed worthwhile to investigate whether real and nominal shocks have contributed to the recent increase in Turkiye's exchange rates. To this end, three separate time series were created for the American dollar, based on the real exchange rate derived from the consumer price index, the real exchange rate derived from the producer price index, and the nominal exchange rate. These were calculated using 379 monthly observations from 01/01/1994 to 01/06/2025. The first Structural Vector Autoregression model was estimated with the real exchange rate based on the consumer price index and the nominal exchange rate as endogenous variables. The second Structural Vector Autoregression model was estimated with the real exchange rate based on the producer price index and the nominal exchange rate as endogenous variables. Both estimation models were accepted after the necessary assumptions were satisfied and the models passed diagnostic tests. According to the results of the accepted models, it was concluded that real shocks have a permanent effect on real and nominal exchange rates in the long term for both models, while nominal shocks do not have a significant effect on real and nominal exchange rates in the long term.

Key Words: Exchange Rate, Real and Nominal Shocks, SVAR

Jel Codes: C32, F31, F41

SVAR Yöntemiyle Türkiye'de Ekonomik Şoklar Altında Reel ve Nominal Döviz Kurlarının Araştırılması

Öz

Ekonomi literatüründe reel ve nominal şokların kısa veya uzun dönemde reel ve nominal döviz kurları üzerinde etkilerinin devam ettiğini kanıtlayan pek çok çalışma bulunmaktadır. Bundan dolayı reel ve nominal şokların son yıllarda Türkiye'de döviz kurlarında yaşanan yükselişlerde etkisinin olup olmadığı araştırmaya değer görülmüştür. Bunun için tüketici fiyat endeksi bazlı reel döviz kuru, üretici fiyat endeksi bazlı reel döviz kuru ve nominal döviz kuru olarak Amerikan Doları için ulaşılan en eski tarih olan 01/01/1994 yılı ve 01/06/2025 yılına kadar aylık 379 gözlemden elde edilen üç ayrı zaman serisi oluşturulmuştur. Sonrasında tüketici fiyat endeksi bazlı reel döviz kuru ve nominal döviz kurunun içsel değişkenler olarak yer aldığı birinci Yapısal Vektör Otoregresyon modeli ve üretici fiyat bazlı reel döviz kuru ile nominal döviz kurunun içsel değişkenler olarak yer aldığı ikinci Yapısal Vektör Otoregresyon modeli tahmin edilmiştir. Her iki tahmin modeli gerekli varsayımları sağlayarak ve diagnostik testleri geçerek kabul edilmiştir. Kabul edilen model sonuçlarına göre her iki model için uzun dönemde reel şokların reel ve nominal döviz kurları üzerinde olan etkisinin kalıcı olduğuna ve nominal şokların ise

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uzun dönemde reel ve nominal döviz kurları üzerinde kayda değer bir etki göstermediği yönünde karar verilmiştir.

Anahtar Kelimeler: Döviz Kurları**,** Reel ve Nominal Şoklar, SVAR

Jel Kodları: C32, F31, F41

1. Introduction

There are two main theories in the literature that explain fluctuations in exchange rates. The first is the "unequilibrium view", which was developed by Mussa (1986). The second is the "equilibrium view", which was introduced to the literature by Lucas (1982) and Svensson (1985). Based on the work of Mundell (1962), Fleming (1962) and Dornbusch (1976), the imbalance view argues that volatility in the real exchange rate stems from disruptions in financial markets — primarily foreign exchange markets — i.e. nominal shocks. Therefore, the effects of shocks in the nominal exchange rate are considered permanent. In contrast, the equilibrium view argues that fluctuations in the real exchange rate stem from real shocks, which mitigate the effects of nominal exchange rate shocks. When these two views are compared, the imbalance view is seen to protect the real economy against nominal shocks under a fixed exchange rate regime. In contrast, the equilibrium view suggests that countries abandoning a free exchange rate regime will have to bear the cost of maintaining the stability of their real economic size.

The most frequently used method in the literature for investigating fluctuations in exchange rates is the Structural Vector Autoregression (SVAR) model, which was developed by Blanchard and Quah (1989) to address long-term constraints. Among the first studies to apply this method to exchange rates, Lastrapes (1992) and Clarida and Gali (1994) concluded that real shocks affect both real and nominal exchange rates in the long term, whereas nominal shocks only affect the nominal exchange rate. Similar results were obtained by Chen and Wu (1997) and Enders and Lee (1997), who found that real shocks affect the real exchange rate in the long term (Alper, 2011: 36).

In light of the continuous rise in exchange rates observed in Turkiye in recent years, which is considered to be directly related to the subject of the research, it is important to investigate the effects of real and nominal shocks on exchange rates.

The study will first examine theoretical explanations of the relationship between economic shocks and real and nominal exchange rates, reviewing previous national and international literature on the subject. Subsequently, statistical information on the variables to

be used in the study will be presented, and research hypotheses will be formulated based on these variables. The next step will involve presenting theoretical explanations of the methods to be applied in the analysis section. Finally, the hypotheses will be tested based on the results obtained in the analysis section.

2. Real And Nominal Exchange Rates In Turkiye

The nominal exchange rate is the weighted average of the Turkish lira (TL), calculated using a basket of currencies from countries that account for the largest share of Turkiye's foreign trade. The real exchange rate is obtained by adjusting the nominal exchange rate to account for relative price effects.

$$RER = \prod_{i=1}^{N} \left[\frac{P_{Tur}}{P_i * e_{i,TUR}}\right]^{w_i} \quad (1)$$

Equation (1) shows the formula used to calculate the real exchange rate, which is obtained from the weighted average of Turkiye's price level as calculated by the Central Bank of the Republic of Turkiye (TCMB) and the price levels of Turkiye's trading partners. In the equation, w_i represents the weight of country *"i"* in Turkiye's real exchange rate index; p_{Tur} represents Turkiye's index; p_i represents the price index of country "i"; $e_{i,Tur}$ represents the exchange rate value of the currency of country *"i"* in Turkish lira; and *N* represents the number of countries. According to the equation, an increase in the real exchange rate indicates that the Turkish lira has appreciated in real terms, meaning that the price of domestic goods has increased relative to foreign goods.

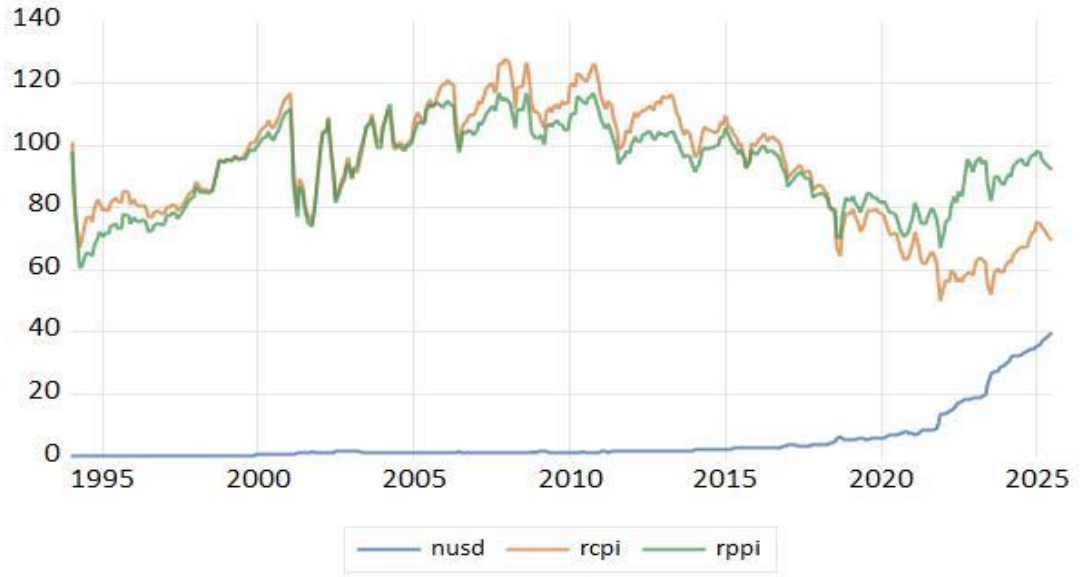
$$RER_t = RER_{t-1} \prod_{i=1}^{N} \left[\frac{\frac{P_{t,TUR}}{P_{t,i} * e_{t,i,TUR}}}{\frac{P_{t-1,TUR}}{P_{t-1,i} * e_{t-1,i,TUR}}}\right] \quad (2)$$

Equation (2) illustrates the chain index method employed by the Central Bank of the Republic of Turkiye for calculating real exchange rate indices. This method is based on commercial data from two-year periods between 1994 and 2023, encompassing sixty countries, as compiled by the European Central Bank (ECB) and the Bank for International Settlements (BIS). The calculation is performed using country weights for each period. In this equation, *t* represents the current month and *t-1* represents the previous month. $w_{t,i}$ represents the weight of country "i" in the current month and RER_{t-1} represents the real exchange rate for the previous month (Kocakale & Toprak, 2015). In the study, the nominal exchange rate is represented by nusd, which is the Turkish lira equivalent of one US dollar. Meanwhile, the real exchange rates

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are represented by rcpi, which is the consumer price index-based real exchange rate, and rppi, which is the producer price index-based real exchange rate.

Figure 1: Graph of Nominal and Real Exchange Rates (1994–2025)



Source: TCMB (2025).

Figure 1 shows the monthly nominal and real exchange rates in Turkiye between 1994 and 2025. During the study period, the real exchange rate based on the consumer price index ranged from a minimum of 50.28 TL to a maximum of 107.71 TL. Meanwhile, the real exchange rate based on the producer price index ranged from a minimum of 60.75 TL to a maximum of 116.95 TL, exhibiting a pattern of decline and subsequent increase. In contrast, the nominal exchange rate is observed to have followed a steady upward trend throughout the period, ranging from a minimum of 0.01 TL to a maximum of 39.41 TL.

3. Theoretical Framework

To explain the effects of real and nominal shocks on real and nominal exchange rates, Enders and Lee (1997) expanded upon Dornbusch's (1976) model for open and small economies. In this model, *m* represents the logarithmic form of the domestic money supply; *p*, the logarithmic form of domestic prices; *y*, the logarithmic form of domestic economic output; *i*, the domestic interest rate; *e*, the logarithmic form of the nominal exchange rate, indicating the value of the domestic currency against the foreign currency; and *d*. pressure from excess demand on domestic goods; *g*: the logarithmic value of real public expenditure; *t*: sub-values

of time; and E_t: the expectations operator for information available up to time *t*. The superscript symbol (*) represents variables related to the foreign economy. The model consists of five equations, of which:

$$m_t = p_t + y_t - \lambda i_t , \quad \lambda > 0 \tag{3}$$

Equation (3) assumes that the domestic money supply and demand are equal and have positive relationships with domestic production and prices, and negative relationships with interest rates.

$$i_t = i_t^* + E_t [e_{t+1} - e_t] \tag{4}$$

Equation (4) expresses integrated interest rate parity, whereby the domestic interest rate is added to the expected depreciation rate of the domestic currency against the foreign interest rate.

$$d_t = \tau y_t + \delta [e_t + p_t^* - p_t] + g_t - \sigma i_t - y_t , \quad 0 < \tau < 1 ; \ \delta, \sigma > 0 \tag{5}$$

Equation (5) shows that, when the excess demand pressure, expressed as the difference between domestic production [$\tau y_t + \delta (e_t + p_t^* - p_t) + g_t - \sigma i_t$] exceeds demand pressure, there is a positive correlation between domestic production, public expenditure, and the real exchange rate, and a negative correlation between the domestic interest rate and the same factors.

$$p_{t+1} - p_t = \pi d_t , \quad \pi > 0 \tag{6}$$

Equation (6) illustrates the process of price adjustment, indicating an increase in excess demand pressure and, consequently, a rise in domestic prices.

$$r_t \equiv e_t + p_t^* - p_t \tag{7}$$

Equation (7) represents the real exchange rate, showing that an increase in this rate results in depreciation of the local currency.

Four assumptions were made in order to determine the time paths of the external variables included in the model. These assumptions involve the variables $\in_{yt+1}$, $\in_{gt+1}$ and $\in_{mt+1}$, which represent real shocks in economic output, real shocks in public spending and nominal money shocks, respectively.

$$m_{t+1} = m_t + \in_{mt+1} \tag{8}$$

$$y_{t+1} = y_t + \in_{yt+1} \tag{9}$$

$$g_{t+1} = g_t + \in_{gt+1} \tag{10}$$

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These assumptions imply that the shocks likely to occur consist only of permanent components, as shown by equations (8), (9) and (10).

$$p^{*}_{t+1} = p^{*}_{t} = \ldots = 0 \quad (11)$$

The final assumption in equation (11) suggests that foreign prices will not change over time and will stay at zero.

As with many models in the economic literature, it is defined as the relative magnitude of variables belonging to the domestic and foreign economies under the assumption of two open economies in the world economy, with behavioural parameters (λ, δ, σ, π and τ) that are equal for these countries. This renders equation (11) unnecessary, as it represents the differences between the m_t, y_t, i_t and p_t variables.

$$e_t = \beta_0 (\beta_1)^t \; p_0 + \beta_0 (1- \beta_1) \Sigma_{k=1}^{t} (\beta_1)^{k-1} [m_{k-1} + y_{k-1}] + (1- \beta_0) m_t + \beta_2 y_t - g_t / \delta \quad (12)$$

$$r_t \equiv e_t - p_t = (\beta_0 - 1) (\beta_1)^t p_o + (\beta_0 - 1) (1- \beta_t) \Sigma_{k=1}^{t} (\beta_1)^{k-1} [m_{k-1} - y_{k-1}] + (1- \beta_0) m_t + \beta_2 y_t - g_t / \delta \quad (13)$$

The initial relative price is expressed as p_o, and the time path represented by equations (12) and (13) is obtained using equations (3) to (10). Here, equations (14) and (15) are used.

$$\beta_0 = (1/2) \{ (1 + \sigma / \lambda\delta) - [(1 + \sigma / \lambda\delta)^2 + 4 / \pi \lambda\delta]^{1/2} \} < 0 \quad (14)$$

$\beta_1 = 1 + 1 / \lambda \beta_0$; $\beta_2 = (1 - \tau) / \delta + \sigma / \lambda\delta + 1 / \beta_0 \pi \lambda\delta$, assumption $|\beta_0|<1$ ve $|\beta_1|<1$ is accepted. (15)

Thus, the time paths of the real and nominal exchange rates, as obtained from equations (12) and (13), enable the effects of real and nominal shocks to be measured.

$$de_t / dm_t = dr_t / dm_t = (1- \square_0) > 1 \quad (16)$$

When an increase in the money supply is treated as a nominal shock in equation (16), it is demonstrated that such shocks affect both nominal and real exchange rates in the short term.

$$\lim \square \to \infty \quad de_{t+j} / dm_t = \square_0 (1- \square_1) \Sigma \square = 1 \infty \; \square_1^{k-1} + (1- \square_0) = 1 \quad (17)$$

$$\lim_{j \to \infty} dr_{t+j} / dm_t = (\beta_0 - 1) (1- \beta_1)) \Sigma_{k=1}^{\infty} \beta_1^{k-1} + (1- \beta_0) = 0 \quad (18)$$

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Furthermore, equations (17) and (18) show that, in the long term, the effect of nominal shocks on the real exchange rate disappears, while their effect on the nominal exchange rate continues.

$$de_t / dy_t = dr_t / dy_t = \beta_2 \quad (19)$$

When income shocks are considered in equation (19) to represent real shocks, it is demonstrated that the short-term impact of these shocks on real and nominal exchange rates is equivalent to β_2.

$$\lim_{j\to\infty} de_{t+j} / d\epsilon_{yt} = (1 - \tau) / \delta - 1 \quad (20)$$

$$\lim_{j\to\infty} dr_{t+j} / d\epsilon_{yt} = (1 - \tau) / \delta > 0 \quad (21)$$

Additionally, equations (20) and (21) demonstrate the ongoing impact of income shocks on long-term real and nominal exchange rates.

$$de_t / dm_t = \lim_{j\to\infty} de_{t+j} / d\epsilon_{gt} = -1 / \delta \quad (22)$$

$$dr_t / dg_t = \lim_{j\to\infty} dr_{t+j} / d\epsilon_{gt} = -1 / \delta \quad (23)$$

Finally, when public expenditure shocks are considered as one type of real shock, it can be seen that they have the same effect on real and nominal exchange rates in both the short and long term, as shown in equations (22) and (23). Based on this, it can be concluded that both real and nominal shocks affect real and nominal exchange rates in the short term. However, in the long term, nominal shocks continue to affect the nominal exchange rate, while losing their effect on the real exchange rate (Enders & Lee, 1997: 239–242).

4. Literature Review

Listed below are previous studies on this research topic that have been carried out at national and international levels.

Erlat and Erlat (1998) conducted a cointegration analysis using the SVAR method for Turkiye, the United States, Saudi Arabia, France, Italy, the Netherlands, Japan and the United Kingdom. They found that real shocks had a dominant effect on real exchange rates in all countries except Italy.

Chowdhury (2004) used the VAR method to analyse data from Chile, Colombia, Malaysia, Singapore, South Korea and Uruguay between 1980 and 1996. He concluded that

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real shocks had a greater impact on exchange rates than nominal shocks in all of the countries examined.

Using the SVAR method, Inoue and Hamori (2009) revealed the driving force of real shocks on real and nominal exchange rates in India between 1999 and 2009.

Ok et al. (2010) applied the SVAR method to data from Cambodia and Laos between 1995 and 2008. They found that real shocks caused depreciation in both real and nominal exchange rates, while nominal shocks caused depreciation in nominal exchange rates in the long term, but appreciation in real exchange rates in the short term.

Using cointegration models and the SVAR method, Alper (2011) examined Turkiye between 1987 and 2010. He found that nominal shocks affect the real exchange rate in the long term, while real shocks affect the nominal exchange rate.

Using the SVAR model, Nasir and Malik (2011) found that real shocks had an effect on both real and nominal exchange rates in Pakistan between 2000 and 2009, while nominal shocks had a permanent effect on nominal exchange rates and a temporary effect on real exchange rates.

Using the SVAR method, Huh and Kwon (2015) concluded that long-term changes for all G7 countries between 1991 and 2012 were caused by nominal shocks. They explained that, based on this finding, real exchange rates were affected by nominal shocks in the long term.

Using the SVAR method, Sarker et al. (2016) demonstrated that the real shock had persistent long-term effects on real and nominal exchange rates in Bangladesh between 2003 and 2014.

Using the SVAR method, Ganbayar (2021) concluded that real exchange rate movements in Mongolia between 1994 and 2021 were driven by real shocks in the long term, while nominal shocks were significant in explaining nominal exchange rates in both the short and long term.

Using cointegration and error correction models for the period 2008–2019, Baghestani (2022) demonstrated that the real exchange rates for Mexico, Canada, and the United States are in equilibrium in the long term and exhibit a cointegration relationship.

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Using the SVAR method, Kamalov et al. (2024) found that real shocks had a longer-lasting effect on both real and nominal exchange rates in Canada and the United States than nominal shocks did, between 1972 and 2023.

Considering the time dimension and relevance of the research, as can be understood from the studies in the literature, it is believed that this study will contribute to the literature in terms of the variables used.

5. The Data Set And Research Hypotheses

As the study will be conducted using time series analysis, time series were created from the data for the nusd, rcpi and rppi variables. These time series consist of 379 observations and have secondary data characteristics. They use monthly data from 01/01/1994 (the earliest date available for all variables) up to 01/06/2025 (TCMB, 2025).

Table 1: Summary Statistics of Raw Data

Variable	Obs.	Mean	Std. dev.	Min.	Max.
nusd	378	4.788466	8.314195	.01	39.41
rcpi	378	93.1263	18.93998	50.28	127.71
rppi	378	93.54005	13.00336	60.75	116.95

Table 1 presents the summary statistics for the time series derived from the raw data of the variables. The X-11 filtering method was employed to eliminate seasonal effects from the monthly data series.

Table 2: Process-Ready Summary Statistics

Variable	Obs.	Mean	Std. dev.	Min.	Max.
lnnusd	378	.4366823	1.682675	-4.669974	3.673123
lnrcpi	378	4.511641	.2161317	3.934893	4.84856
lnrppi	378	4.528294	.1431196	4.099152	4.76089

In addition, a logarithmic transformation was applied to each series to give the time series of the variables a linear form, preparing them for processing. Table 2 shows the summary statistics for the transformed variables.

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Figure 2: Graph of Processed Variables



Figure 2 shows the graph of the series belonging to the variables prepared for time series analysis in the application section. It is possible to do the following with these series:

H_1: In the long term, the real exchange rate based on the consumer price index continues to respond to the real shock.

H_2: In the long term, the real exchange rate based on the consumer price index has not continued to respond to real shocks.

H_3: In the long term, the real exchange rate based on the consumer price index continues to respond to the nominal shock.

H_4: In the long term, the real exchange rate based on the consumer price index does not continue to respond to nominal shocks.

H_5: In the long term, the real exchange rate, as measured by the producer price index, continues to react to real economic shocks.

H_6: In the long term, the real exchange rate based on the producer price index does not persist in the face of real shocks.

H_7: In the long term, the real exchange rate based on the producer price index continues to respond to nominal shocks.

H_8: In the long term, the real exchange rate based on the producer price index does not persist in the face of nominal shocks.

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H_9: In the long term, the nominal exchange rate continues to react to real economic shocks.

H_{10}: In the long term, the nominal exchange rate no longer responds to real shocks.

H_{11}: In the long term, the nominal exchange rate continues to be affected by nominal shocks.

H_{12}: In the long term, the nominal exchange rate no longer responds to nominal shocks.

A total of twelve research hypotheses were formulated for testing in the application section.

6. Methodology

The study's hypotheses will be tested in the application section using time series analysis. The methodology section therefore includes theoretical explanations of the time series analyses to be used in sequence: These are the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, SVAR analysis and, finally, SVAR model impulse response analysis.

6.1. ADF and PP Tests

In the field of time series analysis, Dickey and Fuller (1979) and (1981) developed unit root tests for detecting stationarity in variables.

$$\varepsilon_t = \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots\ldots + \theta_3 \varepsilon_{t-3} + \varepsilon_t \quad (24)$$

Equation (24) represents the initial model developed by Dickey and Fuller. However, it has been proven that this equation cannot be used when autocorrelation appears in the error term due to the presence of a *p*-order relationship between the error terms. Consequently, new models have been developed.

$$\Delta Y_t = \beta_1 Y_{t-1} + \sum_{i=1}^{k} \lambda_i \, \Delta Y_{t-1} + \varepsilon_t \quad (25)$$

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \sum_{i=1}^{k} \lambda_i \, \Delta Y_{t-1} + \varepsilon_t \quad (26)$$

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 trend + \sum_{i=1}^{k} \lambda_i \, \Delta Y_{t-1} + \varepsilon_t \quad (27)$$

Of these newly developed models, equation (25) is the first without a constant coefficient or trend; equation (26) is the second with only a constant coefficient; and equation (27) is the final model with both a constant and a trend.

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Another unit root test was developed as an alternative to the ADF unit root test. This was developed by Phillips and Perron (1988).

$$Y_t = \alpha Y_{t-1} + \varepsilon_t \quad (28)$$

$$Y_t = \mu + \alpha Y_{t-1} + \varepsilon_t \quad (29)$$

$$Y_t = \mu + \beta \left(t - \frac{1}{2}\lambda\right) + \alpha Y_{t-1} + \varepsilon_t \quad (30)$$

In this test, the first model is the none model, which does not include a constant coefficient or trend in equation (28). The second model is equation (29), which includes only a constant coefficient. The third model is equation (30), which includes both a constant coefficient and a trend.

For both unit root tests, the null hypothesis is that the series contains a unit root, while the alternative hypothesis is that the series is stationary. If the calculated statistical value is greater than the critical value *z(t)* in the test statistic table, the null hypothesis is rejected and the series is deemed to be stationary (Endres, 1995: 225).

6.2. SVAR Model

The Structural Vector Autoregression model is essentially derived from the Vector Autoregression (VAR) model, which includes two internal variables.

$$x_t = \mu_t + \sum_{i=1}^{k} A_i x_{t-i} + u_t \quad (31)$$

Equation (31) illustrates the basic VAR model, which consists of two endogenous variables.

$$A_0 x_t = \sum_{i=1}^{k} A *_i x_{t-i} + A_0 u_t \quad (32)$$

As shown in equation (32), simultaneous relationships between variables can be included in the SVAR model using the classical VAR model equation. Here, the assumption of self-repetition is made to determine the instantaneous relationships, where $A_i^* = A_0 A_i$, $i = 1, \ldots, k$. In other words, the first variable, x_{1t}, is affected only by the innovations and lagged values in the first equation, while the second variable is affected by the innovations in the first equation and the innovations and lagged values in the second equation. In the model, $A_0 = P^{-1}$ and $\Sigma_u = PP'$ represent the triangular matrix calculated using the P Cholesky decomposition. In this case, the model's results now depend on the order of the variables in x_t.

$$A(L)x_t = u_t, \quad A(L) I_p - A_1 L - \ldots - A_k L^k \quad (33)$$

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Equation (33) is a more general model, including the iterative structure found in the previous equation. In this model, $L^i x_t = x_{t-1}$ defines the delay operator, while I_p defines the p-dimensional matrix.

$$AA\,(L)x_t = Au_t, \quad Au_t = Be_t, \quad e_t \sim N\,(0, I_p) \tag{34}$$

The model structure has now been transformed into the AB model, as referred to by Amisano and Giannini (1997). This assumes that $A_{ut}=B_{et}$ when $A=A_0$ in equation (33) is multiplied by the representation (34).

$$\mathcal{L}\,(A, B) = c + \frac{T}{2} log\,(|A|^2) - \frac{T}{2} log\,(|B|^2) - \frac{T}{2} tr\,(A'\,B'^{-1}B^{-1}A\hat{\Sigma}_u)$$

$$= c + \frac{T}{2} log\,(|K|^2) - \frac{T}{2} tr\,(K'\,K\,\hat{\Sigma}_u)\,, \tag{35}$$

According to the estimation technique shown in equation (35), the model parameters are estimated in two steps. In the first step, the reduced form of equation (33) is estimated using the least squares method. In the second step, the $2p^2$ coefficients in A and B are determined by imposing a constraint of at least $p(p+1)/2$ (non-linear). The remaining free parameters (at most $2p^2–p(p+1)/2$) are estimated by maximising the log-likelihood function. Here, T denotes the sample size, $K = B^{-1} A$ *and* $c = -(Tp / 2) ln (2 \pi)$). Furthermore, $\hat{\Sigma}_u$ denotes a consistent estimator of Σ_u.

$$\left.\begin{array}{l} R_a\,vec\,A = d_a \\ \} \quad or \end{array}\right. \qquad \begin{bmatrix} R_a & 0 \\ 0 & R_b \end{bmatrix} \begin{bmatrix} vec & A \\ vec & B \end{bmatrix} = \begin{bmatrix} d_a \\ d_b \end{bmatrix}, \tag{36}$$

$$R_b\,vec\,B = d_b$$

Equations (36) and (37) provide a shortened version of the above definition. In the equation, the Vec operator combines the columns of a matrix into a single column vector. R and $(\gamma.\ x\ p^2)$ are full row-ordered matrices, d and $(\gamma\ x\ 1)$ are vectors, and γ_a and γ_b indicate the number of constraints on A and B, respectively.

$$vec\,A = S_a + \gamma_a + s_a$$

$$\} \ or \quad \begin{bmatrix} vec & A \\ vec & B \end{bmatrix} = \begin{bmatrix} S_a & 0 \\ 0 & S_b \end{bmatrix} + \begin{bmatrix} \gamma_a \\ \gamma_b \end{bmatrix} + \begin{bmatrix} s_a \\ s \end{bmatrix} \tag{37}$$

$$vec\,B = S_b + \gamma_b + s_b$$

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In addition, the constraints S and (p^2 x ℓ) are full column-ordered matrices and S and $(p^2 \; x \; 1)$ are vectors. $\ell_a = p^2 - \gamma_a$ and $\ell_b = p^2 - \gamma_b$, respectively, indicate the freely estimated coefficients of A and B (Holtemöller, 2002: 8–10).

6.3. SVAR Model Impact Response Analysis

As mentioned in the previous section, the impulse response function for the SVAR model will be considered according to Amisano and Giannini (1997).

$$\theta_0 = K^{-1} = (B^{-1}A)^{-1} = A^{-1}B, \quad \theta_i = J M^i \theta_0, \quad i = 1, 2, \ldots \tag{38}$$

An impulse response function for the SVAR model is created based on equation (38) using the variables in the equation.

$$M = \begin{bmatrix} A_1 & A_2 & \cdots & A_{k-1} & A_k \\ I_p & 0 & \cdots & 0 & 0 \\ 0 & I_p & \cdots & 0 & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & \cdots & I_p & 0 \end{bmatrix}, \qquad J = [\, I_p \;\; 0 \;\; \ldots \;\; 0 \,], \tag{39}$$

Equation (39) shows the combined matrix representation, which consists of the M $(pk \; x \; pk)$ and J $(p \; x \; pk)$ matrices belonging to the effect-response function.

$$\theta_i = \Phi_i \,.\, \theta_0, \quad \Phi_0 = I_p, \quad \Phi_i = \sum_{j=1}^{i} \Phi_{i-1} A_j, \quad i = 1, 2, \ldots, \tag{40}$$

In equation (40), the effect response function is estimated by replacing the theoretical variables with the relevant estimators when $A_i = 0$ for $i > k$.

$$\sum_K = [I_p \otimes B^{-1} \mid -(A' B') \otimes B'^{-1}] \sum_{ab} \begin{bmatrix} I_p \otimes B'^{-1} \\ -(B^{-1}A) \otimes B'^{-1} \end{bmatrix} \tag{41}$$

$$\sum_{\ominus}(0) = \sum_{K^{-1}} = (K'^{-1} \otimes K^{-1}) \sum_K (K^{-1} \otimes K'^{-1}) \tag{42}$$

Equation (41) and Equation (42) use the same notation for theoretical and estimated effect response responses. Here, the effect-response responses in vec $[\theta_0, \theta_1, \ldots, \theta_H]$ over the horizon H are unbiased and asymptotically normally distributed with covariance matrix $\frac{1}{T}\Sigma_\theta(H)$, while the calculation of $\Sigma_\theta(H)$ requires some preliminary calculations.

$$\sum_{\ominus}(H)_{ij} = G_i \sum_{vec[A_1,\ldots Ap]} G'_j + [I_p \otimes (J M^i J')] \sum_{\ominus}(0) [I_p \otimes (J M^i J')]', \qquad i, j = 1,..,H, \tag{43}$$

$$G_0 = 0, \qquad G_i = \sum_{n=0}^{i-1} ([\ominus'_0 \; J \; (M')^{i-1-n}] \otimes [J \; M^n \; J']), \qquad i > 0 \tag{44}$$

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In equations (43) and (44), the $\Sigma_\theta(H)$ matrix is obtained from the *(H + 1) (H + 1)*) block denoted by *H*, where $\Sigma_\theta(H)_{ij}$, $i = 0,\ldots, H$ and $j = 0,\ldots H$, and the representation of the $\Sigma_\theta(H)_{ii}$ block corresponding to the covariance matrix of vec $\ominus_i$ is given (Holtemöller, 2002: 10).

7. Analysis And Empirical Findings

The study will be divided into two sections for analysis. First, the time series of the variables relating to the research topic will undergo tests to determine their suitability for analysis. If these tests are passed, SVAR models will be estimated: the first using the lnrcip and lnnusd variables, and the second using the lnrppi and lnnusd variables.

7.1. Time Series Analyses of Variables

The prevailing view in the literature is that real and nominal exchange rates can be accurately predicted using the autocorrelation function and unit root process. To achieve this, the autocorrelation function must demonstrate gradual decay and at least one of the series associated with the variables must exhibit I(1) stationarity (Corbae & Oulairis, 1988; Enders, 1988; MacDonald & Taylor, 1993). The tests applied to the time series consist of two stages. The first test investigates the autocorrelation function of the series, while the second test determines the stationarity status and levels of the series.

Table 3: Autocorrelation Results for Variables

p(k)	*k*=1	2	3	4	5	6	7	8	9	10	11	12
(A) Without First Differencing												
lnnusd	.98	.96	.94	.93	.92	.90	.89	.88	.86	.85	.82	.82
lnrcpi	.98	.96	.94	.92	.91	.90	.89	.87	.86	.84	.83	.82
lnrppi	.97	.92	.88	.85	.82	.79	.77	.74	.71	.69	.67	.65
(B) With First Differencing												
lnnusd	.38	.03	.07	.02	.04	.07	.04	.07	.11	.09	.03	-.05
lnrcpi	.31	-.07	-.15	-.11	-.08	.00	.08	.02	.00	-.05	-.01	-.02
lnrppi	.02	-.00	-.13	-.10	-.05	.00	.03	-.02	-.02	-.08	-.07	-.20

k: the number of lags.

Table 3 shows the results of determining the autocorrelation status of the series at level and first difference. According to the table, the autocorrelation function for all three variables shows a slow deterioration over twelve lag lengths, indicating that the necessary condition is met.

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Table 4: Unit Root Test Results

Variable	test statistic	ADF Test		PP Test	
		Intercept	Intercept & Trend	Intercept	Intercept & Trend
lnnusd	1%	-3.447627	-3.982786	-3.447487*	-3.982588*
	5%	-2.869050	-3.421885	-2.868988**	-3.421788**
	10%	-2.570838	-3.133758	-2.570805***	-3.133701***
	Z(t)	(-1.685466)	(-1.937847)	(-3.579118)	(-4.170623)
	p (Value)	.4379	.6325	.0066	.0054
Δlnnusd	1%	-3.447627*	-3.982786*	-3.447534*	-3.982653*
	5%	-2.869050**	-3.421885**	-2.869009**	-3.421820**
	10%	-2.570838***	-3.133758***	-2.570816***	-3.133720***
	Z(t)	(-11.74879)	(-11.74299)	(-12.68695)	(-12.86495)
	p (Value)	.0000	.0000	.0000	.0000
lnrcpi	1%	-3.447580	-3.982720	-3.447487	-3.982588
	5%	-2.869029	-3.421853	-2.868988	-3.421788
	10%	-2.570827	-3.133739	-2.570805	-3.133701
	Z(t)	(-1.641149)	(-2.135502)	(-1.365654)	(-1.606756)
	p (Value)	.4605	.5238	.5995	.7889
Δlnrcpi	1%	-3.447580*	-3.982720*	-3.447534*	-3.982653*
	5%	-2.869029**	-3.421853**	-2.869009**	-3.421820**
	10%	-2.570827***	-3.133739***	-2.570816***	-3.133720***
	Z(t)	(-14.23161)	(-14.25094)	(-14.57719)	(-14.96122)
	p (Value)	.0000	.0000	.0000	.0000
lnrppi	1%	-3.447534	-3.982653	-3.447487	-3.982588
	5%	-2.869009**	-3.421820	-2.868988	-3.421788
	10%	-2.570816***	-3.133720***	-2.570805***	-3.133701
	Z(t)	(-3.156237)	(-3.139943)	(-2.611486)	(-2.623770)
	p (Value)	.0235	.0986	.0915	.2699
Δlnrppi	1%	-3.447580*	-3.982720*	-3.447534*	-3.982653*
	5%	-2.869029**	-3.421853**	-2.869009**	-3.421820**
	10%	-2.570827***	-3.133739***	-2.570816***	-3.133720***
	Z(t)	(-13.17988)	(-13.16791)	(-15.20053)	(-15.24556)
	p (Value)	.0000	.0000	.0000	.0000

*%1, **%5, ***%10 indicate a stable level of significance. The test statistic value is denoted by ().

Table 4 presents the results of the ADF and PP tests, which were applied to examine the stationarity status and degrees of freedom of the series. According to the table, the values calculated for the constant coefficient of the log-returns-to-use (lnnusd) variable and for ADF models including both the constant and trend *(at the significance levels α = 0.01 and α = 0.10)* are lower than the test statistic value ($t_{cal} < Z(t)$ and $p > 0.05$). The values calculated at the α = 0.05 and α = 0.10 significance levels are lower than the test statistic value ($t_{cal} < Z(t)$ and $p > 0.05$), indicating that the series has a unit root. In the models included in the PP test (*at the α = 0.01, 0.05 and 0.10 significance levels*), the calculated values were higher than the test statistic value ($t_{cal} > Z(t)$ and $p < 0.05$), indicating that the series are stationary at level I(0). For another variable (lnrcpi), the values calculated for all models belonging to both the ADF and PP tests (*at the α = 0.01, 0.05 and 0.10 significance levels*) were lower than the test statistic value ($t_{cal} < Z(t)$ *and* $p > 0.05$), indicating that the series has a unit root. For the final variable (lnrppi), the ADF and PP tests applied to the model with a constant term *(at significance levels α = 0.05 and α = 0.10)* yielded values higher than the test statistic value ($t_{cal} > Z(t)$ *and* $p < 0.05$),

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indicating that the series are stationary I(0) in the difference. In the other models of the tests *(at significance levels α = 0.01, 0.05 and 0.10)*, the calculated values were lower than the test statistic value *(t_{cal} < Z(t) and p > 0.05)*, indicating that the series has a unit root. The ADF and PP tests, applied to the first difference of all the variables *(α = 0.01, 0.05 and 0.10 significance levels)*, resulted in values higher than the test statistic value *(t_{cal} > Z(t) and p < 0.05)*. This indicates that the series are stationary at I(1) in the first difference (Wooldridge, 2013). Following the application of tests to the time series of the variables, it was concluded that the series of each variable met the conditions required for estimating the SVAR model, having evaluated their degrees of stationarity.

7.2. SVAR Models

Predictions for the SVAR models will be made in two stages. First, the model including both the lnrcpi and lnnusd variables will be estimated, followed by the model including the lnrppi and lnnusd variables. Diagnostic tests will then be applied to the estimated models. If the models pass these tests, they will be accepted, and impact response and variance decomposition analyses will be applied to them.

7.2.1. First SVAR Model

To determine the appropriate lag length for the first model, a two-lag vector autoregression (VAR) model was estimated using the two endogenous variables included in the model.

Table 5: Suitable Latency Length for the VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1483.947	NA	1.11e-06	-8.032232	-8.011035	-8.023812
1	1529.168	89.70624	8.91e-07	-8.255651	-8.192061	-8.230390
2	1540.000	21.37091	8.58e-07	-8.292682	-8.186698	-8.250580
3	1569.691	58.25674	7.47e-07	-8.431932	-8.283555*	-8.372989*
4	1571.936	4.378723	7.54e-07	-8.422415	-8.231644	-8.346631
5	1581.001	17.59131*	7.33e-07*	-8.449872*	-8.216708	-8.357248
6	1583.287	4.410495	7.40e-07	-8.440581	-8.165024	-8.331116
7	1587.689	8.445327	7.39e-07	-8.442758	-8.124807	-8.316452
8	1591.331	6.948376	7.40e-07	-8.440817	-8.080473	-8.297671

Table 5 shows the values of the information criteria used to determine the appropriate lag length for the two-lag VAR model estimated in Table 5. According to the Schwarz Criterion (SC) and Hannan Quinn (HQ) information criteria, it was decided that the appropriate lag length was three.

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Table 6: Three-Lag VAR Model Results

Variables	D(LNRCPI)	D(LNNUSD)
D(LNRCPI(-1))	.401687	-0.290864
	(.07452)	(.09931)
	[5.39004]	[-2.92884]
D(LNRCPI(-2))	-.147958	.145529
	(.06632)	(.08838)
	[-2.23103]	[1.64671]
D(LNRCPI(-3))	-.003311	.224487
	(.06199)	(.08261)
	[-.05341]	[2.71759]
D(LNNUSD(-1))	.071473	.195409
	(.05476)	(.07297)
	[1.30528]	[2.67799]
D(LNNUSD(-2))	.055502	-.055211
	(.04314)	(.05749)
	[1.28648]	[-.96032]
D(LNNUSD(-3))	.027033	.223636
	(.03803)	(.05067)
	[.71091]	[4.41329]
C	-.003086	.011823
	(.00201)	(.00268)
	[-1.53531]	[4.41445]
Test Statistics		
R^2	.153234	.166547
Adj. R^2	.139390	.152921
Sum sq. resids	.357528	.634904
S.E. equation	.031212	.041593
F-statistic	11.06895	12.22282
Log likelihood	769.4900	662.1035
Akaike AIC	-4.077487	-3.503227
Schwarz SC	-4.004038	-3.429778
Mean dependent	.000168	.019341
S.D. dependent	.033645	.045192

Having determined the appropriate lag length for the first model, a three-lag VAR model was estimated. Table 6 shows the results of this estimation. The autocorrelation test, the first of the diagnostic tests, was then applied to this model.

Figure 3: Autocorrelation Plot of the Three-Lag VAR Model

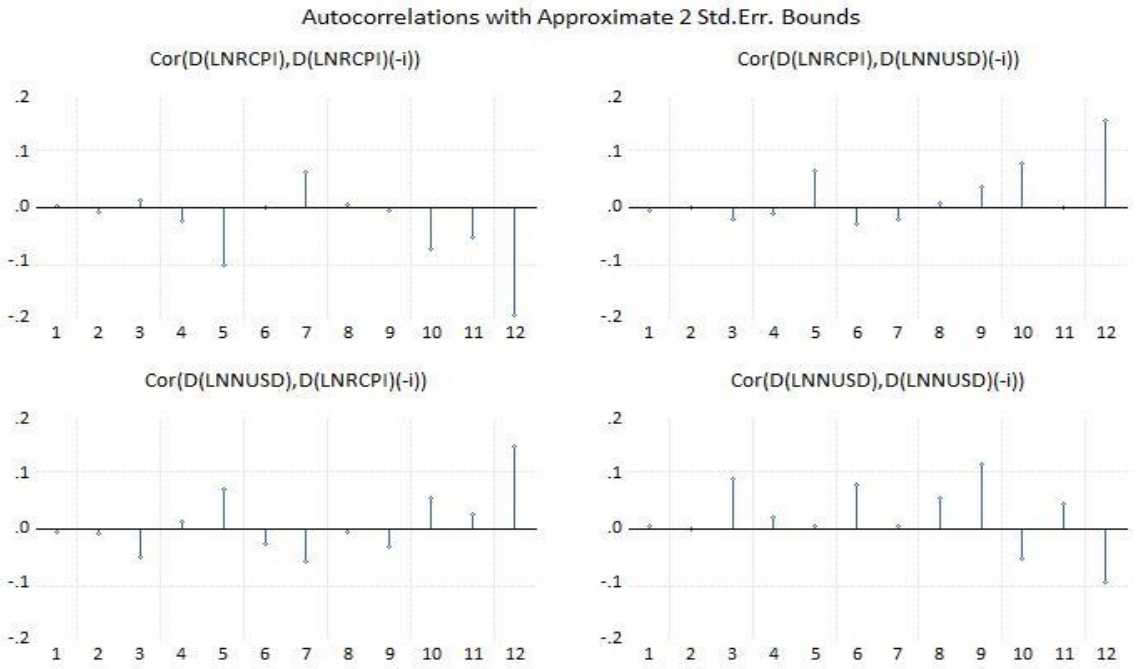
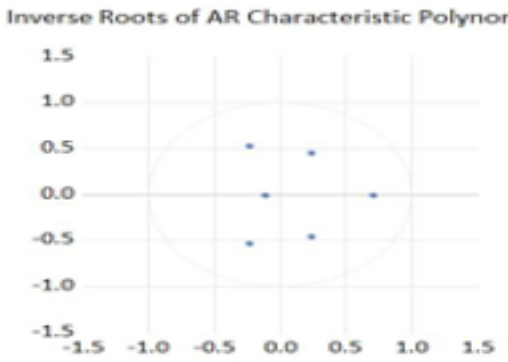


Figure 3 shows the results of the autocorrelation test applied to the estimated three-lag VAR model. According to the graph, all the model's values are outside the autocorrelation and

instability regions, meaning they do not exceed the standard error band intervals. Therefore, it was concluded that there is no autocorrelation problem in the estimation model. The second diagnostic test examined the stationarity of the estimated VAR model (King, Plosser, Stock and Watson, 1991).

Figure 4: Graph of AR Polynomials for a Three-Lags VAR Model



Root	Modulus
.707085	.707085
-.233173 - .534694i	.583324
-.233173 + .534694i	.583324
.233150 - .450610i	.507354
.233150 + .450610i	.507354
-.109943	.109943

Figure 4 shows the graph of the inverse roots of the AR polynomials belonging to the estimated three-lag VAR model, alongside the corresponding eigenvalues. As can be seen from the graph, all the inverse roots of the AR polynomials lie within the unit circle and the inverse root eigenvalues are less than one. Based on these results, the estimated three-lag VAR model satisfies the stationarity condition. After applying diagnostic tests, the three-lag VAR model was accepted and used to estimate the SVAR model.

Table 7: Estimated SVAR Model Results for the First Model

Model:	e = Phi*Fu where E[uu']=I			
Matrix				
F=	C(1)	0		
	C(2)	C(3)		
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C(1)	.033723	.001233	27.34958	.0000*
C(2)	-.030871	.003069	-10.06045	.0000*
C(3)	.055182	.002018	27.34958	.0000*
Statistic				
Log likelihood	1576.502			
Estimated Matrixs				
Estimated S matrix:				
	.030033	-.008498		
	-.022308	.035105		
Estimated F matrix:				
	.033723	.000000		
	-.030871	.055182		

*%1, **%5, ***%10 indicate a stable level of significance. The test statistic value is denoted by ().

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Table 7 shows the estimated output of the SVAR model for the first model. The 'F matrix' section at the bottom of the table represents the structural matrix. As expected, the element of the matrix representing nominal shocks has a zero value. Additionally, the coefficients of the other matrix elements are statistically significant at the α=0.01 level, as can be seen in the table. Based on these results, the estimated SVAR model for the first model has been accepted. The next step involved performing other time series analyses using the accepted SVAR model.

Figure 5: SVAR Model Impulse Response Graph for the First Model

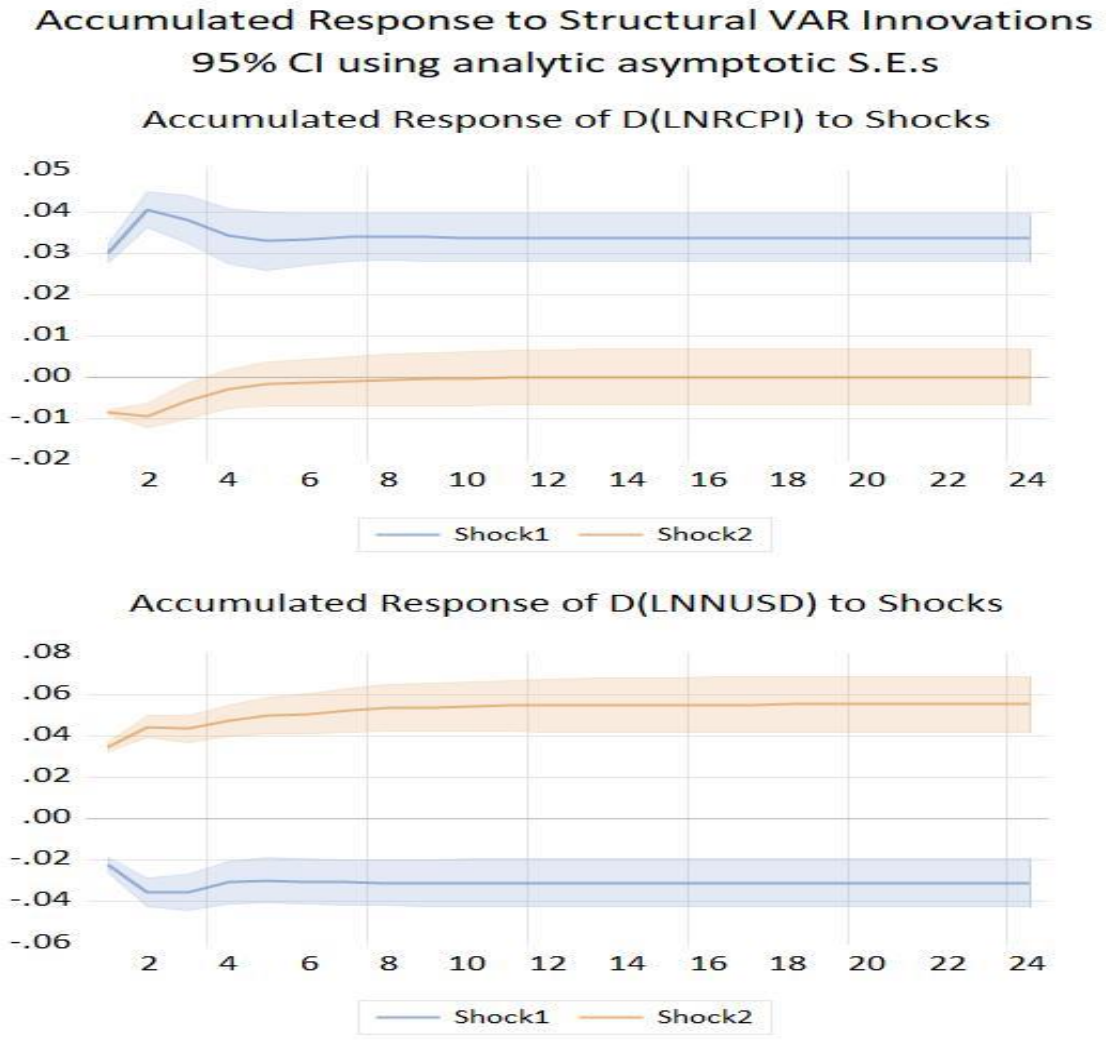


Figure 5 shows the results of an impulse response analysis conducted over twenty-four periods, based on the SVAR model estimated for the first model. The graph at the top represents the real exchange rate and the graph at the bottom represents the nominal exchange rate. The term 'shock1' in the figure represents the real shock and 'shock2' represents the nominal shock.

According to the top graph, the initial response of the real exchange rate to the real shock is 3%, rising to 4% in the second period, before returning to the 3–4% range in the fourth period and continuing in this manner in the long term. In the same graph, the initial -1% response of the real exchange rate to the nominal shock is no longer evident by the second period, instead following a stable trend in the long term. The second graph shows that the initial response of the nominal exchange rate to the real shock, which was in the range of 2–4%, rose to the range of 4–6% until the eighth period, continuing in this range in the long term. In this graph, the initial -2% response of the nominal exchange rate to the nominal shock declines to -2% and -4% by the fourth period, continuing in this range in the long term.

Table 8: SVAR Model Variance Decomposition Results for the First Model

Model 1	[Δr	Δr]	[Δe	Δe]
Shock/Mounth	r	e	r	e
1	92.58637	7.413632	28.76625	71.23375
2	93.26570	6.734302	33.64901	66.35099
3	92.25964	7.740358	33.62898	66.37102
4	91.64908	8.350915	34.07846	65.92154
5	91.55298	8.447025	34.02495	65.97505
6	91.54253	8.457471	34.03173	65.96827
7	91.53820	8.461800	33.98930	66.01070
8	91.53175	8.468253	33.97178	66.02822
9	91.52620	8.473804	33.96978	66.03022
10	91.52328	8.476721	33.96713	66.03287
11	91.52223	8.477773	33.96519	66.03481
12	91.52179	8.478210	33.96472	66.03528

Δr: real exchange rate, Δe: nominal exchange rate, r: real shock and e: nominal shock

Table 8 shows the results of the variance decomposition analysis for the first model. According to the table, real shocks explain 92.58% of short-term changes in the real exchange rate, while nominal shocks explain 7.41%. In the long term, real shocks account for 91.52% of changes in the real exchange rate, while nominal shocks account for 8.47%. The table also shows that, in the short term, real shocks explain 28.76% of changes in nominal exchange rates, while nominal shocks explain 71.23%. In the long term, real shocks account for 33.96% of changes in nominal exchange rates, while nominal shocks account for 66.03%.

7.2.2. Second SVAR Model

The second model is an SVAR model, which includes the lnrppi and lnnusd variables as endogenous variables. First, a two-lag VAR model was estimated to determine the appropriate lag length for a VAR model incorporating both endogenous variables.

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Table 9: Suitable Latency Length for the VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1489.624	NA	1.08e-06	-8.063002	-8.041805	-8.054581
1	1539.615	99.16903	8.42e-07	-8.312275	-8.248685	-8.287014
2	1547.242	15.04739	8.25e-07	-8.331934	-8.225950	-8.289832
3	1571.764	48.11427	7.38e-07	-8.443166	-8.294789*	-8.384223*
4	1574.136	4.628001	7.45e-07	-8.434341	-8.243571	-8.358558
5	1581.441	14.17504	7.32e-07*	-8.452256*	-8.219092	-8.359632
6	1584.011	4.958522	7.37e-07	-8.444504	-8.168947	-8.335039
7	1586.962	5.661503	7.42e-07	-8.438817	-8.120866	-8.312511
8	1592.987	11.49519*	7.34e-07	-8.449794	-8.089449	-8.306647

Table 9 shows the information criterion values for selecting the appropriate lag length based on the two-lag VAR model estimated in Table 9. According to the table, three lags are considered appropriate in terms of the SC and HQ information criteria.

Table 10: Three-Lag VAR Model Results

Variables	D(LNRPPI)	D(LNNUSD)
D(LNRPPI(-1))	.323922	-.164725
	(.06764)	(.09888)
	[4.78924]	[-1.66599]
D(LNRPPI(-2))	-.038838	.059858
	(.06092)	(.08905)
	[-.63757]	[.67216]
D(LNRPPI(-3))	-.019270	.224654
	(.05810)	(.08494)
	[-.33167]	[2.64498]
D(LNNUSD(-1))	.062709	.277903
	(.04731)	(.06916)
	[1.32558]	[4.01838]
D(LNNUSD(-2))	.080638	-.114128
	(.03803)	(.05560)
	[2.12039]	[-2.05284]
D(LNNUSD(-3))	.038783	.213172
	(.03506)	(.05125)
	[1.10628]	[4.15951]
C	-.002897	.011558
	(.00187)	(.00274)
	[-1.54709]	[4.22195]
Test Statistics		
R^2	.128403	.147514
Adj. R^2	.114153	.133577
Sum sq. resids	.303869	.649403
S.E. equation	.028775	.042065
F-statistic	9.011022	10.58428
Log likelihood	799.8996	657.8811
Akaike AIC	-4.240105	-3.480647
Schwarz SC	-4.166656	-3.407199
Mean dependent	.001170	.019341
S.D. dependent	.030572	.045192

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Table 10 shows the results of the three-lag VAR model estimation. The estimated three-lag VAR model was then subjected to diagnostic tests.

Figure 6: Autocorrelation Plot of the Three-Lag VAR Model

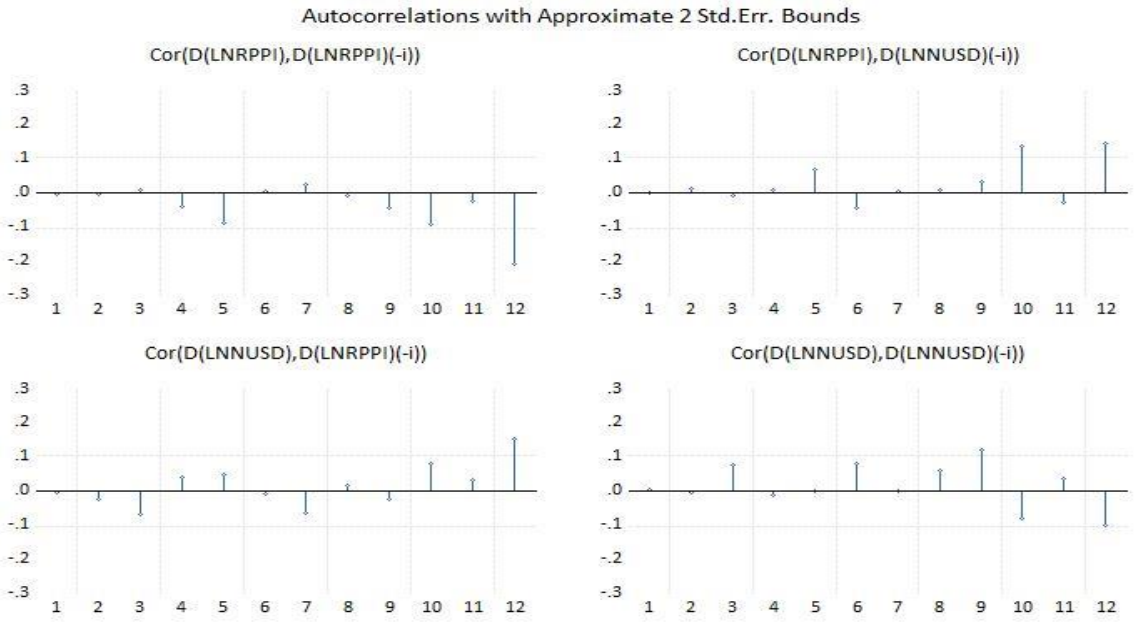
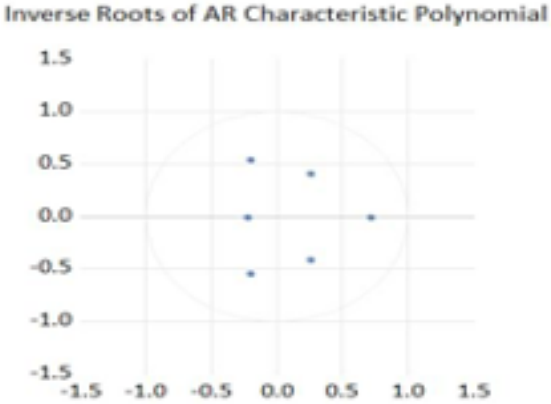


Figure 6 shows the autocorrelation graph of the estimated three-lag VAR model. As can be seen from the graph, the values of the estimated model are within the standard error band intervals and there is no evidence of autocorrelation.

Figure 7: Graph of AR Polynomials for a Three-Lags VAR Model



Root	Modulus
.717099	.717099
-.200923 - .537617i	.573936
-.200923 + 0.537617i	.573936
.257004 - .415435i	.488505
.257004 + .415435i	.488505
-.227436	.227436

Figure 7 shows the graph of the inverse roots of the AR polynomials of the estimated three-lag VAR model, alongside their respective eigenvalues. As can be seen, all the inverse roots of the AR polynomials lie within the unit circle and all the eigenvalues are less than one.

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After applying diagnostic tests, the three-lag VAR model was accepted. The estimation stage of the SVAR model was then performed based on this model.

Table 11: Estimated SVAR Model Results for the Second Model

Model:	e = Phi*Fu where E[uu']=I			
Matrix				
F=	C(1)	0		
	C(2)	C(3)		
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C(1)	.031221	.001142	27.34958	.0000*
C(2)	-.019185	.003314	-5.788910	.0000*
C(3)	.062640	.002290	27.34958	.0000*
Statistic				
Log likelihood	1582.061			
Estimated Matrixs				
Estimated S matrix:				
	.026416	-.011409		
	-.015693	.039028		
Estimated F matrix:				
	.031221	.000000		
	-.019185	.062640		

*%1, **%5, ***%10 indicate a stable level of significance. The test statistic value is denoted by ().

Table 11 shows the results of the SVAR model estimated for the second model. As expected, the values of the nominal shocks in the F matrix are zero, while the other elements of the matrix are statistically significant at a significance level of α=0.01. Therefore, the estimated SVAR model was accepted for the second model, and other time series analyses were performed based on this model.

Figure 8: SVAR Model Impulse Response Graph for the Second Model

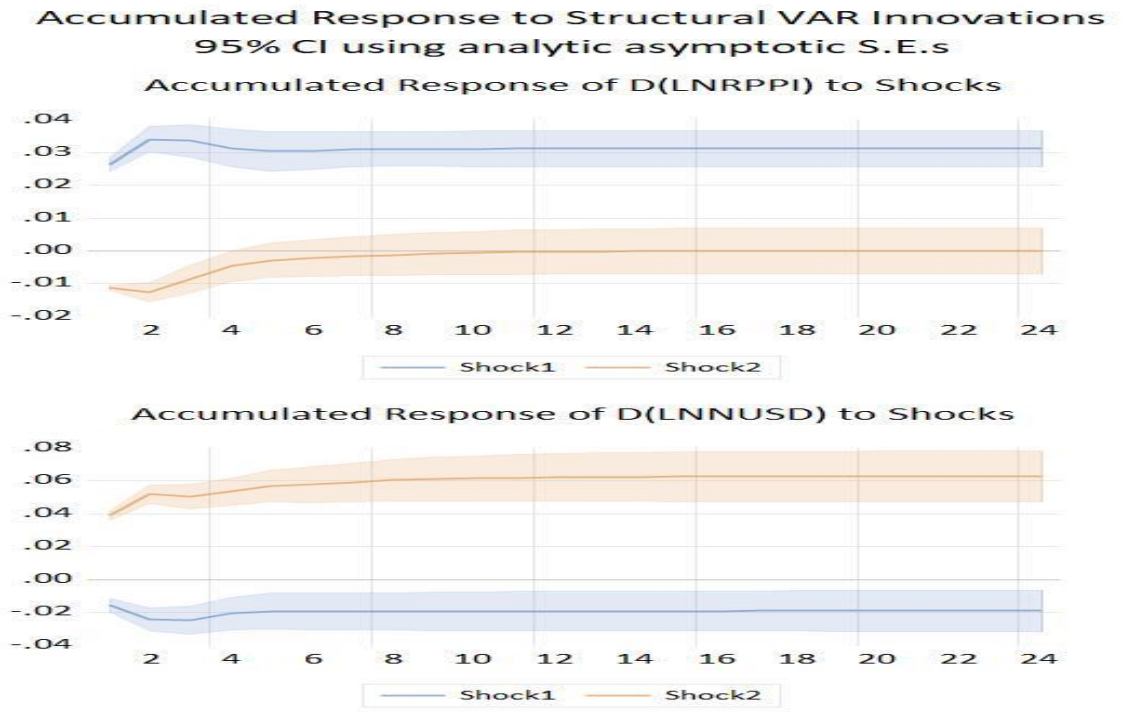


Figure 8 shows the impulse response analysis graph for the SVAR model estimated for the second model. According to this graph, the initial response of the real exchange rate to the real shock (2–3%) increased to 3–4% by the fourth period. After this, it fell to 3%, remaining at this level in the long term. The same graph shows that the initial -1% effect of the nominal shock on the real exchange rate increased until the eighth period, reached zero and remained ineffective in the long term. The graph below shows that the initial 4–6% response of the nominal exchange rate to the real shock increased to 6% by the eighth period and remained at this level in the long term. In this graph, the initial impact of the nominal shock on the nominal exchange rate (between 0% and -2%) continued to decline until the fourth period, reaching -2%. After this, it remained stable at this rate in the long term.

Table 12: SVAR Model Variance Decomposition Results for the Second Model

Model 2	[Δr	Δr]	[Δe	Δe]
Shock/Mounth	r	e	r	e
1	84.28012	15.71988	13.91815	86.08185
2	85.14854	14.85146	16.05066	83.94934
3	83.65417	16.34583	16.03878	83.96122
4	82.28787	17.71213	16.62463	83.37537
5	82.03456	17.96544	16.62234	83.37766
6	81.98829	18.01171	16.61544	83.38456
7	81.96686	18.03314	16.59721	83.40279
8	81.95304	18.04696	16.58363	83.41637
9	81.94290	18.05710	16.58128	83.41872
10	81.93593	18.06407	16.58031	83.41969
11	81.93276	18.06724	16.57931	83.42069
12	81.93144	18.06856	16.57886	83.42114

Δr: real exchange rate, Δe: nominal exchange rate, r: real shock and e: nominal shock

Table 12 shows the results of the variance decomposition analysis applied to the second SVAR model. According to the table, real shocks explain 84.28% of short-term changes in the real exchange rate, while nominal shocks explain 15.71%. In the long term, real shocks account for 81.93% of changes in the real exchange rate, while nominal shocks account for 18.06%. Conversely, in the short term, real shocks account for only 13.91% of changes in the nominal exchange rate, whereas nominal shocks account for a much higher 86.08%. In the long term, real shocks account for 16.57% of changes in the nominal exchange rate, while nominal shocks account for 83.42%.

7.3. Evaluation of Hypotheses

The research application was completed and time series analyses were conducted on two models created from the research variables. The research hypotheses were then tested based on the obtained results.

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Table 13: Research Hypotheses and Results

Hypotheses	Reason	Decision	
		First Model	Second Model
H_1	Figure 5	Accepted √	-
H_2	Figure 5	Denied X	-
H_3	Figure 5	Denied X	-
H_4	Figure 5	Accepted √	-
H_5	Figure 8	-	Accepted √
H_6	Figure 8	-	Denied X
H_7	Figure 8	-	Denied X
H_8	Figure 8	-	Accepted √
H_9	Figure 5 & Figure 8	Accepted √	Accepted √
H_{10}	Figure 5 & Figure 8	Denied X	Denied X
H_{11}	Figure 5 & Figure 8	Accepted √	Accepted √
H_{12}	Figure 5 & Figure 8	Denied X	Denied X

Table 13 presents the twelve hypotheses developed based on both models and to be tested in the application section of the study, alongside the rationale for testing them. Following the analyses, six of the twelve hypotheses were rejected and the other six were accepted.

8. Conclusion

In today's world of rapid globalisation, the volume of global trade is increasing alongside it. As a result of this increase, fluctuations in exchange rates have begun to be observed due to the internal dynamics of countries and external factors. These fluctuations are explained by real and nominal shocks. In this context, economic literature offers two perspectives. The first, the equilibrium view, argues that nominal shocks are responsible for exchange rate fluctuations. The second, the imbalance view, argues that real shocks are responsible.

In light of the adverse trends observed in macroeconomic indicators and the steady increase in exchange rates in the Turkish economy in recent years, this study aims to investigate the impact of real and nominal shocks on exchange rate fluctuations. To this end, time series were constructed using the real exchange rate based on the consumer price index (CPI), the real exchange rate based on the producer price index (PPI), and the nominal exchange rate based on the US dollar. The first SVAR model was estimated first, including the consumer price index-based real exchange rate and nominal exchange rate as endogenous variables. This was followed by the second SVAR model, which included the producer price index-based real exchange rate and nominal exchange rate as endogenous variables. Both models were accepted as valid, meeting the necessary assumptions and passing diagnostic tests. According to the

results of the first model, real shocks continue to affect real and nominal exchange rates in the long run, whereas nominal shocks have no significant effect. The results of the second model show that, in the long run, real shocks continue to affect real and nominal exchange rates, while nominal shocks have no significant effect. The results of both models show that real shocks have a dominant effect on real and nominal exchange rates in the long term. These findings contradict the conclusions of Ok et al. (2010) and Huh and Kwon (2015), but are consistent with the results of Erlat and Erlat (1998) and Inoue and Hamori (2009), and fully support the conclusions of Chowdhury (2004), Nasir and Malik (2011), Sarker et al. (2016) and Kamalov et al. (2024).

This study examines the impact of real and nominal shocks on real and nominal exchange rates in Turkiye over the past thirty years. The findings show that nominal shocks have no significant long-term effect on either, while real shocks impact both in the long term, with the effect persisting. In this regard, it is recommended that the Central Bank and the government implement incentives and policies that enable Turkiye's real sector to produce high-value goods and increase its competitiveness in international trade. This would strike a balance between the financial and real sectors, rather than prioritising monetary policies that expand the financial sector.

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Investigation of Real and Nominal Exchange Rates in Turkiye Under Economic Shocks Using the SVAR Method

Extended Summary

There are two main theories in the literature that explain fluctuations in exchange rates. The first is the "disequilibrium view", which was developed by Mussa (1986). The second is the "equilibrium view", which was introduced to the literature by Lucas (1982) and Svensson (1985). Based on the work of Mundell (1962), Fleming (1962) and Dornbusch (1976), the imbalance view argues that volatility in the real exchange rate stems from disruptions in financial markets — primarily foreign exchange markets

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— i.e. nominal shocks. Therefore, the effects of shocks in the nominal exchange rate are considered to be permanent. In contrast, the equilibrium view argues that fluctuations in the real exchange rate stem from real shocks, which mitigate the effects of nominal exchange rate shocks. In this context, the imbalance view is considered to protect the real economy against nominal shocks under a fixed exchange rate regime, whereas the equilibrium view suggests that countries abandoning a free exchange rate regime will incur a cost to maintain the stability of their real economic size.

In light of the views expressed in the literature, it was deemed worthwhile to investigate whether real and nominal shocks have impacted the rise in exchange rates in Turkiye in recent years. To this end, three separate time series were created for the US dollar (USD), based on the real exchange rate derived from the consumer price index, the real exchange rate derived from the producer price index, and the nominal exchange rate. These were calculated using 379 monthly observations from the earliest available date, 01/01/1994, to the latest available date, 01/06/2025. Using these series, the following was determined:

H_1 In the long term, the real exchange rate, as measured by the consumer price index, continues to react to real economic shocks.

H_2: In the long term, the real exchange rate based on the consumer price index has not continued to respond to real shocks.

H_3: In the long term, the real exchange rate based on the consumer price index continues to respond to the nominal shock.

H_4: In the long term, the real exchange rate based on the consumer price index does not continue to respond to nominal shocks.

H_5: In the long term, the real exchange rate, as measured by the producer price index, continues to react to real economic shocks.

H_6: In the long term, the real exchange rate based on the producer price index does not persist in the face of real shocks.

H_7: In the long term, the real exchange rate based on the producer price index continues to respond to nominal shocks.

H_8: In the long term, the real exchange rate based on the producer price index does not persist in the face of nominal shocks.

H_9: In the long term, the nominal exchange rate continues to react to real economic shocks.

H_{10}: In the long term, the nominal exchange rate no longer responds to real shocks.

H_{11}: In the long term, the nominal exchange rate continues to be affected by nominal shocks.

H_{12}: In the long term, the nominal exchange rate no longer responds to nominal shocks.

A total of twelve research hypotheses were formulated for testing in the application section.

The first SVAR model, which includes the real exchange rate based on the consumer price index and the nominal exchange rate as endogenous variables, and the second SVAR model, which includes the real exchange rate based on the producer price index and the nominal exchange rate as endogenous variables, were then estimated. Both models were accepted after the necessary assumptions were satisfied and the diagnostic tests were passed. The results of the accepted models indicated that, in the long run, the effect of real shocks on real and nominal exchange rates is permanent, and that nominal

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shocks do not significantly affect real and nominal exchange rates. Therefore, hypotheses H1, H4, H10 and H12 were accepted for the first model and H5, H8, H9 and H11 for the second model.

In conclusion, it has been determined that nominal shocks did not significantly affect real and nominal exchange rates in the long term for Turkiye during the period under consideration. However, real shocks did affect nominal and real exchange rates in the long term, and this effect has continued. It is therefore recommended that the Central Bank and governments focus on implementing incentives and policies that enable Turkiye's real sector to produce high-value outputs and increase its competitiveness in international trade. This would maintain a balance between the financial and real sectors, rather than prioritising monetary policies that expand the financial sector.

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