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The effects of trade openness and some macroeconomic variables on exchange rate volatility in Iran

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Abstract

The present study aimed to investigate the relationship between trade openness and exchange rate volatility in Iran. To this end, we estimated our model through the autoregressive distributed lag (ARDL) method using data from 1979 to 2019. Findings indicated the positive effect of money supply and government expenditures and the negative and favorable effects of trade openness, economic growth, currency system, and oil prices on exchange rate volatility in the short and long term. Even though the impact of economic growth and government expenditures were insignificant, increasing the money supply had the highest adverse effect on the foreign exchange market, and increasing trade openness and the Fixed Exchange Rate System decreased the exchange rate volatility. The currency system and monetary discipline of the Central Bank, along with the trade openness policy can have significant effects on reducing exchange rate volatility and economic stability in Iran.

Keywords: trade openness, exchange rate, economic growth, Money Supply (MS), Autoregressive Distributed Lag (ARDL)
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1 Introduction

Due to fundamental changes in the currency system of the world economy in the 1970s, monetary officials and researchers searched for the causes of these widespread changes and determinants of exchange rate volatility. In the same years, it was found that unforeseen monetary policy shocks might relatively cause huge exchange rate volatility, and thus the determinants of exchange rate volatility were classified into two groups: monetary and non-monetary factors. Trade openness is an important macroeconomic variable that is obtained by dividing total exports and imports by GDP, and the lower ratio indicates that the country has a smaller trade and less trade potential. Trade openness can potentially increase economic growth in the long term through access to goods and services, achievement of efficiency in resource allocation, and improving total productivity of all factors through the dissemination of technology and knowledge, and this flow can stabilize financial markets, especially the foreign exchange market. A strong domestic exchange rate prevents the country's export volume and makes the import price inexpensive. Therefore, an increase in the exchange rate reduces imports and increases exports, and a decrease in the exchange rate can have the opposite effect. Since exports cause the import of currency and imports cause the currency to leave the country, the volumes

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of exports and imports cause changes in the exchange rate. The volume of foreign trade can affect exchange rate volatility; hence, the present study sought to investigate the interaction of these two variables.

Due to the determination, notification, and implementation of forced interest rates in most Middle Eastern countries, including Iran, this variable cannot have any significant effect on exchange rate volatility and the exchange rate is not usually included in the models of these studies [10]. The results of studies on the degree of trade openness mainly indicate that open economies with a higher degree of trade are more stable in terms of prices and foreign exchange markets [31]. Therefore, increasing the trade openness can have a significant effect on reducing exchange rate volatility. Farzam et al. [17] found that the higher trade openness, the greater the country's decision-making power, and it is considered a great pioneer in trade. Therefore, the country determines the prices and its trade volume will not face serious volatility in case of change in world prices. Therefore, it causes stability in the national exports and imports and prevents exchange rate volatility. In this case, the supply and demand of foreign exchange are far from volatility, resulting in lower exchange rate volatility. Furthermore, reducing trade openness decreases the national trade potential and it will be considered a negligible country in terms of trade. Changes in world prices disrupt the foreign trade order of countries, affect the import and export of foreign exchange, and cause volatility in the supply and demand of foreign exchange and, consequently, the exchange rate. Increasing trade openness requires financial infrastructures and purposive development of financial markets; otherwise, the high volume of international exchanges will not be possible, especially in the long term. Calderon and Kubota (2018) hold that open economies generally have high export diversity and the price volatility of export commodities globally overlap, ultimately inhibiting foreign exchange earnings and exchange rate volatility. The effect of inflation, as the most important monetary variable, has been studied in numerous studies and it has been found that countries, which can control the general level of their prices, have been more stable and less volatile in terms of the foreign exchange market. Therefore, the effect of inflation as a monetary variable on exchange rate volatility has been increasingly taken into consideration. Therefore, the present study aimed to explain the effects of monetary and non-monetary variables, especially the degree of trade openness on exchange rate volatility in Iran from 1979 to 2019 and it sought to answer the main question of whether increasing the degree of trade openness could reduce exchange rate volatility in Iran?

2 Theoretical principles and research background

In the middle of the twentieth century, Milton Friedman (1912-2006) stated that if we had price stickiness in a floating exchange rate system, the nominal exchange rate could protect the economy from widespread and long-term volatility in the case of a shock. Friedman holds that if the economy faces a real shock, it can only have a milder affectability if its relative prices change rapidly because the rate of relative price adjustment will be strongly dependent on exchange rate regimes in the presence of price stickiness. In a floating and flexible exchange rate system, relative market prices are adjusted more rapidly by nominal exchange rate changes compared to a fixed exchange rate system, but nominal price adjustments go through the government channel and take a long process in fixed exchange rate systems. Friedman studied exchange rate volatility based on different exchange systems and also in the field of trade openness [20]. Based on the theory of purchasing power parity (PPP), it is found that changes in exchange rates over a period should be proportional to changes in relative prices of both countries in the same period [22]. Dornbush and Fisher [12] theoretically believe that if monetary shocks are not forecasted, they can cause volatility in the foreign exchange market and affect the balance of payments and the volumes of exports and imports through the exchange rate jump. They indicate that the slow pace of adjustment of the goods and services market compared to financial markets causes monetary shocks to have a stronger effect on the exchange rate in the short term, but this effect has long-term effects on foreign trade volume and trade openness. In countries, which are dependent on underground resources such as oil and gas, rising prices and revenues from the sale or export of oil and gas have a significant impact on calculating the degree of trade openness. In these countries, rising oil prices and revenues cause foreign exchange earnings from rising oil prices or sales in the country's economy to increase more than before. The lack of productive infrastructure mainly increases inflation in society and this domestic increase in the total level of prices has a direct effect on the real exchange rate [16]. Sendza and Diaba [34] state that increasing the foreign exchange earnings enhances the value of exports and trade openness. Therefore, the rate and direction of this volatility depend on the rates of changes in prices and increase in the currency supply. Since consumer goods constitute a large portion of imports in these countries, such countries have dependent economies and they usually become more dependent on imported goods, and their degrees of trade openness increase during the period of increasing oil revenues. Therefore, global changes in oil prices, directly and indirectly, affect the volume of foreign trade and exchange rate volatility.

Different views have been expressed on the effect of government expenditures on exchange rate volatility. Kawai and Zilcha [21] indicate that the continuous increase of government expenditures causes a regular increase in the exchange rate and leads to a net increase in foreign assets in the long term. Increasing government expenditures can

increase the real exchange rate in the short term by increasing the demand of the whole economy, but increasing government expenditures have more destructive effects on the reduction of the national currency value in the long term. Alagidede and Ibrahim [2] do not accurately confirm the relationship between government expenditures and exchange rate volatility and hold that since government expenditures carry an additional tax burden, they cause asymmetric changes in real interest rates, and such changes in other interest rates affect financial markets. Due to the different efficiency of financial markets in different countries, government expenditures have different effects on the foreign exchange market and exchange rate volatility in the short and long term.

2.1 Degree of trade openness and exchange rate volatility

Several theories have emerged about the relationship between trade openness, economic growth, and exchange rates in recent years. Neoclassical growth theory holds that trade openness can lead to capital formation, increase efficiency, improve resource allocation, and facilitate the quality of economic growth. Therefore, it increases foreign direct investment which simultaneously strengthens the national currency and reduces the exchange rate in the long term. According to Romer (1986) and Robert (1988) and based on the new theory of growth, trade openness significantly enhances the quality of economic growth by accelerating technical progress and increasing the productivity of production factors. This flow again strengthens exports and improves the balance of payments, and has positive and decreasing effects on exchange rate volatility. According to Adu-Gamfi et al. [1], countries with sustainable growth for more than two decades emphasize increasing their foreign trade in their long-term programs. Therefore, the economic growth of these countries stabilizes the foreign exchange market and reduces exchange rate volatility by increasing the degree of trade openness. Kong et al. [23] indicate that the degree of trade openness integrates and improves the quality of economic growth in the short and long term, and lower volatility improves the stability of financial markets and reduces exchange rate volatility. Rodrik (1988) and Helpman (1985) hold that trade openness is an important factor of economic growth, meaning that trade openness can facilitate the improvement of the quality of economic growth. Furthermore, sustainable economic growth will lead to the stabilization of financial markets and reduction of price volatility in the market, and the foreign exchange market will be safe from severe volatility.

2.2 Research background

The nominal and real exchange rates experienced severe instability in mid-1973 and at the same time as the collapse of the fixed exchange rate system. Thereafter, numerous studies investigated the determinants of exchange rate volatility in different countries with developed and developing economies [17]. In these studies, variables were investigated and analyzed into two separate categories, the monetary and non-monetary variables. Tasan et al. [35] conducted a study titled "The study on the role of trade openness in improving the lives of the poor in Iran" and found that increasing the degree of openness of trade through the inclusion of technology improved productivity and led to the more efficient allocation of resources in addition to creating economic growth and improving the foreign exchange market and could improve the poor's status. Mohammadpour et al. [27] examined the relationship between the degree of trade openness and economic growth in certain, and MENA countries. Abolhassan-Beigi et al. [20] evaluated the effect of instability of oil revenues on the relationship between exchange rate and trade balance in Iran. Rahimi and Khodaveisi [29] examined globalization and the degree of an exchange rate change to consumer prices: an application of the Panel Smooth Transition Regression (PSTR) modeling. Mohammadi et al. [26] investigated the effect of real exchange rate uncertainty on foreign trade in agricultural products in Iran. Abbasnejad et al. [15] examined the effect of trade openness and government size on macroeconomic volatility in Iran. Azizi and Azizi [6] studied the effect of export diversity and trade openness on economic volatility with an emphasis on the effect of foreign trade. Farzam et al. [17] examined the short-term and long-term effects of exchange rates on trade between Iran and European and Asian partners. Aziznejad and Komeijani [7] examined exchange rate changes and their effect on the volatility of certain macroeconomic variables in Iran. Nanforoush and Dizaji [28] investigated the effect of government size and trade openness on the financial development of certain countries in the world. Fattahi et al. [18] studied the stability of the exchange rate, the independence of monetary policy, and the openness of financial markets in the Iranian economy. Kazerouni et al. [22] explained monetary and non-monetary factors affecting real exchange rate instability by emphasizing the degree of trade openness. Alessandria and Choi [3] studied the relationship between the dynamics of the US trade balance and the real exchange rate. Zhao [37] examined the affectability of trade openness by emphasizing the role of the bond market in China's exchange rate and foreign exchange earnings. Aslan [5] presented an econometric analysis of the relationship between economic liberalization and the real exchange rate. Adu-Gamfi et al. [1] examined the affectability of trade openness, inflation, and GDP growth based on evidence in West African countries. Kong et al. [23] examine the effect of trade openness on the quality of economic growth in China. Bahmani-Oskooee et al. [9] studied the asymmetric effects of exchange rates on the volume of foreign trade.

Longe et al. [25] investigated oil prices, trade openness, current account balances, and the official exchange rate in Nigeria. Randa et al. [30] examined economic openness under the influence of money supply and inflation in Indonesia. Santana et al. [33] studied the relationship between international trade, exchange rate regimes, and financial crises. Kyophilavong et al. [24] identified the relationship between exchange rates and trade balance. Oskoee and Gellan [8] examined the effect of exchange rate volatility on international business performance. Gantman and Dabos [19] examined the effect of the degree of trade openness on exchange rate volatility. Davalos (2018) studied the impact of trade openness on changes in the nominal and real exchange rates. Romeli et al. [32] investigated the effect of trade openness on the current account and exchange rate volatility. In their paper, Badinger (2018) studied the dynamic trade balance and exchange rates using the J curve approach. Calderon and Kubota (2018) examined the effects of trade openness and the development of financial markets in 82 countries.

3 Research methods and models

We begin our discussion with an inter-temporal household utility function.

$$U_t^j = \sum_{s=t}^{\infty} \beta^{s-t} \left[\phi \ln C_{T,S}^J + (1-\phi) \ln C_{N\ ,S}^j + \frac{x}{1-\varepsilon} \left(\frac{M_s^j}{P_S}\right)^{1-\varepsilon} \frac{k}{2} Y_{N,S}^2 \right] \tag{3.1}$$

where $\beta \in [0,1]$, $\phi, k > 0$, and C_T represents the consumption of tradable goods, and C_N represents the combination of non-tradable goods.

$$C_N = \left[\int_0^1 C_N(Z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}} \tag{3.2}$$

P is the base consumption price index (defined as the minimum purchase cost of an additional unit of actual consumption) of $C_T^{\gamma} C_T^{1-\gamma}$

$$P_N = \left[\int_0^1 P_N(Z)^{1-\theta} dz \right]^{\frac{1}{1-\theta}} \tag{3.3}$$

$P_N(Z)$ refers to prices of non-tradable goods of Z and represents tradable bonds by r, indicating the global net interest rate on tradable goods, and $\beta(r+1) = 1$. The fixed nominal household budget is an example of period j:

$$\begin{aligned} P_{T\ ,t} F_{t+1}^j + M_t^j = {} & P_{T,t}(1+r) F_t^j + M_{t-1}^j \ + P_{N,t}(j) Y_{N,t}(j) \\ & + P_{T\ ,t} \overline{Y}_{T,t} - P_{N,t} C_{N,t}^j - P_{T\ ,t} C_{T,t}^j - P_{T,t} T_t \end{aligned} \tag{3.4}$$

where F_t refers to real bonds (in units of tradable goods) that represent the per capita tax in terms of tradable goods with a real return r and T_t. Apart from government expenditures, we assume that the government has a budget balance in each period (in tradable units).

$$\frac{M_t - M_{t-1}}{P_t} + T_t = 0. \tag{3.5}$$

Finally, producers of non-tradable goods show the demand curve as follows:

$$Y_{N,t}^d = \left[\frac{P_{N,t}(j)}{P_{N,t}} \right]^{-\theta} C_N^A \tag{3.6}$$

where C_N^A is the total household consumption of non-tradable goods. By solving the optimization, we maximize Equation (3.1) according to the constraints on Equations (3.1) and (3.4) and (3.6).

$$C_{T,t+1} = C_{T,t} \tag{3.7}$$

$$\frac{\phi}{P_{T,t} C_{T,t}} = x \frac{P_{T,t}}{P_t} \left(\frac{M_t}{P_t}\right)^{-\varepsilon} + \beta \frac{P_{T,t}}{P_{T,t+1}} \left(\frac{\emptyset}{C_{T,t+1}} \right) \tag{3.8}$$

$$\frac{C_{N,t}}{C_{T,t}} = \frac{1-\phi}{\phi} \left(\frac{P_{N,t}}{P_{T,t}}\right)^{-1} \tag{3.9}$$

$$Y_{N,t}{}^{\frac{\theta+1}{\theta}} = \left[\frac{(\theta-1)(1-\phi)}{\theta k} \right] C_{N,t}{}^{-1} (C_{N\ ,t}^A)^{\frac{1}{\theta}} \tag{3.10}$$

Equation (3.7) shows Euler's equation or smoothing for optimal inter-temporal consumption of commercial goods. The assumption of $\beta(1+r)=1$ is a means of obtaining the answer version of the Hall result. Equation (3.8) presents the maximization of the utility of exchange between expenditures on commercial goods in a t period, and a combination of one-period money retention and consumption expenditures in a t+1 period. Equation (3.9) shows the final substitution rate between commercial and non-commercial goods and must remain constant over time. In the new order of this equation, the degree of economy openness is defined as $\phi = \frac{P_T C_T}{P_T C_T + P_N C_N}$. Equation (3.10) represents the balance of supply of non-commercial goods. This equation fulfills the condition of the pricing strategy for monopolistic competition firms in optimization. Therefore, the demand for the real balance of money is obtained by placing equation (3.7) in equation (3.8).

$$\frac{M_t}{P_t} = \frac{x}{\gamma} \frac{C_{T,t} \frac{P_{T,t}}{P_t}}{(1-\beta \frac{P_{T,t}}{P_{T,t+1}})}. \tag{3.11}$$

Given that demand depends on the consumption of commercial goods, changes in prices of commercial goods, and real prices of commercial goods, the ARDL model is used to investigate the effect of trade openness on exchange rate volatility. The model then uses an approximate solution, and finally, the following equation is obtained:

$$\ln\left(\frac{x_{j,k}+m_{j,k}}{GDP_j}\right) = \beta_0 + \beta_1 \ln D_{j,k} + \beta_2 \ln S_j + \beta_3 \ln S_k + \varepsilon_{j,k} \tag{3.12}$$

where $m_{j,k}$ and $x_{j,k}$ represent exports and imports and bilateral trade between countries j, k, GDP_j is the level of economic activity of country j. S_j and S_k are sizes of countries, and $D_{j,k}$ is the distance between those countries. The following production equation is obtained by performing linearization and logarithmization:

$$Q_{it} = P_{it} \Bigg/ \left\{ (s_{it}/s_{i0}) \prod_{k=1}^{n} \left[\frac{P^*_{kt}}{S_{kt}} \Big/ \frac{P^*_{k0}}{s_{k0}} \right]^{\omega_k} \right\} \tag{3.13}$$

where the dependent variable of the RER model is equal to the exchange rate volatility, and Q_{it} is the real effective exchange rate index for country i in period t and and S_{it} is the nominal exchange rate of country i in period t and P_{it} is the consumer price of country i in period t, and S_{kt} is the trading partner of country k in period t. After logarithmization, we derivate from exchange rate volatility to the degree of trade openness and we will have:

$$\frac{\partial \mathrm{Vol}(q_{it})}{\partial TO_{it}} = \lambda_0 + \lambda_1 TO_t + \lambda_2 M_t + \lambda_3 G_t + \lambda_4 Y_t + \lambda_5 \boldsymbol{Z}_t + \varepsilon_t \tag{3.14}$$

The model of this study is written based on the model in the article by Calderon and Kubota (2018) and is modified and localized for the Iranian economy according to domestic studies and the conditions of the Iranian economy and the relevant theoretical principles. Based on the theoretical principles, the foreign exchange system governing the foreign exchange market is an important factor to stabilize the foreign exchange market. On the contrary, the multiple exchange rate system can cause volatility and disorder in the foreign exchange market. Due to the strong dependence of the Iranian economy on oil revenues, oil prices play decisive roles in the exchange rate volatility in increases and decreases in world oil prices [16]. Therefore, the final model of this study is as follows:

$$ERV = \alpha_0 + \alpha_1 \cdot TO + \alpha_2 \cdot M + \alpha_3 \cdot G + \alpha_4 \cdot Y + \alpha_5 \cdot Z + U \tag{3.15}$$

where ERV is the dependent variable of the model, indicating the exchange rate volatility and the independent variables are TO (trade openness), M (money supply), G (government expenditures), Y (economic yield rate), PL (global petroleum price), and Z (dummy variable) respectively. The dummy variable was used to separate the years, where the exchange rate was multiple, from the years where the exchange rate was fixed, and the model was estimated based on annual statistics from 1979 to 2019. We utilized the GARCH method to find the exchange rate volatility. The GARCH methods solve the problem of heteroskedasticity. In such cases, the maximum likelihood function in the general case of its q-order is as follows:

$$\begin{aligned} & y_t \big| \psi_{t-1} N(x_t \beta, h_t) \\ & \sigma^2_{t+1|t} = h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \hat{\varepsilon}^2_{t-i} + \nu_i \end{aligned} \tag{3.16}$$

HOU interprets this condition as the equity of the final utility of an additional unit of non-commercial goods with the non-utility of the final utility of an additional unit of production based on the $\theta/(1-\theta)$ markup method added by monopolistic competition firms.

The realized volatility index or the variance volatility index can be used by the frequent data. The daily exchange rate series is first collected and the exchange rate volatility is extracted after estimating the relevant time series. To calculate the annual index, we first calculate the average period based on the daily exchange rate, and then measure the annual mean squares and use it as an annual volatility index and place it in the model. The following equation indicates the results of estimating the conditional mean of the exchange rate time series by the generalized GARCH method to calculate the exchange rate volatility, in which R_t is the exchange rate of the current period and R_{t-1} is the exchange rate of the previous period:

$$R_t = \underset{(6.04)}{11.34} + \underset{(2.06)}{0.61}\ R_{t-1} + \underset{(21.2)}{1.39}\ AR(1), \quad R^2 = \%84.1 \tag{3.17}$$

Based on the results, the model has high power and the coefficients are confirmed considering the z-statistic. The values obtained from Equation (3.4) are used as exchange rate volatility and placed in the final model.

4 Findings, model estimation, and results

The first step in estimating the model is to examine the stationarity of the variables in the model. To this end, we must make sure that the model variables do not have a degree of cointegration greater than 1, i.e. $I(1)$ because if the variables have cointegration greater than 2, i.e. $I(2)$, the F-statistic will no longer be reliable for accurate examination of the long-term behavior of the variables [14]. The failure year was considered endogenous and the Zivot & Andrews unit root test was used to simultaneously investigate the stationarity status and the effect of the structural failure year on the behavior of the variables. The results of the stationarity test indicated that economic growth, trade openness, and government expenditures were stationary at the level and other variables were stationary after one differentiation. Given that some series were stationary at zero and some were stationary at the first degree, it should be checked to ensure whether we are facing a false regression or not. We have to use the cointegration test to realize that the cointegration is obtained with 95% confidence and there is no false regression.
We performed the optimal lag determination test based on Akaike Criterion (AIC), Schwarz Criterion (SC), and the Hannan-Quinn Criterion (HQC) to estimate the optimal model, and thus the optimal lag number of the model was obtained based on the results. Given the need for a long-term relationship, we used a test by Banerjee, Dolado, and Master. We can find the existence or non-existence of a long-term relationship between model variables by comparing the calculated t-statistic quantity in Equation 18 and the critical quantity at the desired confidence level [4].

$$t = \frac{\sum_{i=1}^{n} \hat{\beta}_i - 1}{\sum_{i=1}^{n} Se(\hat{\beta}_i)} \tag{4.18}$$

To this end, we estimated the model based on the obtained coefficients and it was found that the absolute value was greater than the critical value presented by Dolado and Master at a 95% confidence level; hence, the hypothesis H based on the lack of long-term relationship was rejected and the existence of the long-term relationship between variables was confirmed. Given the confirmation of the long-term relationship between the variables and since some stationary variables were from zero degree and others were from the first degree, we estimated our model by the ARDL method, as shown in Table 1.

Table 1: Results of long-term model estimates

Variable name	Coefficient value	t-statistic	Significance level	Model characteristics
ERV(-1)	1.57	6.59	99%	
ERV(-2)	-0.71	-8.24	99%	
TO	-0.38	-2.31	95%	
M	1.22	3.08	95%	
G	0.19	0.67	—	$R^2 = 98.8\%$
Y	-0.49	-0.19	—	
Z	-1.13	-2.67	95%	
PL	-0.27	-1.99	95%	

Source: Research Findings

Table 1 presents the negative effect of trade openness, economic growth, foreign exchange system, and oil prices on exchange rate volatility, but the effect of the economic growth coefficient was not significant. The effects of money supply and government expenditures were positive, but the effect of the government expenditures coefficient was not

significant. In this regard, the money supply had the greatest effect on increasing exchange rate volatility. On the other hand, the model had high power and we did not have any autocorrelation according to the Durbin-Watson statistics.

According to the results of model estimation, the effect of the money supply was positive on exchange rate volatility. Based on the estimated coefficient, increasing the money supply was the main factor in increasing volatility in the foreign exchange market. Therefore, the lack of financial discipline and short-term decisions and policies cause the most damage to the foreign exchange market. On the contrary, the study of oil prices and their negative and significant effects indicated that the Iranian economy has experienced serious problems and a volatile foreign exchange market during the global oil price decline due to a sharp reduction in foreign exchange earnings and the lack of foreign exchange supply. The existence of a fixed exchange rate system against a multiple exchange rate system is a key factor in economic policy and can help reduce exchange rate volatility due to increasing market transparency and decreasing problems for decision-making and investment. The coefficient of increase in trade openness was equal to -0.27 which had a favorable and significant effect on the reduction of exchange rate volatility in the research period. The severe volatility in economic growth caused the insignificant and ineffective impact of economic growth on exchange rate volatility, despite having the desired effect. The increase in government expenditures also increased exchange rate volatility, but this effect was not significant mainly due to the multiplicity of decisions and policies, and the lack of a regular long-term plan by different governments.

The results of estimating the models by the error correction model indicated that the error correction coefficient was equal to -0.29 for the model and since it was negative and significant and less than 1, this coefficient was acceptable and indicated a relatively good adjustment rate. In other words, about 30% of the imbalance of exchange rate volatility was adjusted in each period and we needed three periods to achieve a long-term equilibrium. This re-confirms the existence of a long-term relationship. Table 2 summarizes the results of the short-term estimation.

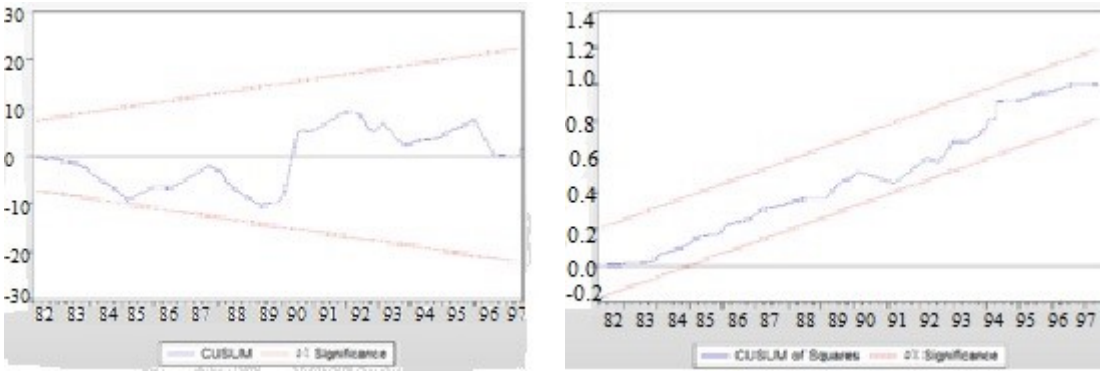
Table 2: Results of short-term model estimates

Variable name	Coefficient value	t-statistic	Significance level	Model characteristics
$D(ERV_{(-1)})$	-0.56	-5.83	95%	
$D(TO)$	-0.35	-3.15	95%	
$D(M)$	1.59	3.31	95%	
$D(G)$	0.22	0.59	—	$R^2 = 99.1\%$
$D(Y)$	-0.78	-0.17	—	$F = 267.9$
$D(Z)$	-0.91	-0.74	—	
$D(PL)$	-0.41	-2.18	95%	
$EMC(-1)$	-0.29	4.21	95%	

Source: Research Findings

The study of signs indicated that the direction of signs was consistent with long-term coefficients, but the effects of money supply and economic growth on exchange rate volatility were greater in the short-term than long-term, and thus changes in the two variables decreased over time and the shock decreased slightly over time, but both had brought an unfavorable shock to the foreign exchange market in the short term. The effect of the exchange rate system was not significant in the short term, indicating that such policies were effective when they continued in the long term. After estimating the model, diagnostic tests were performed to ensure the reliability of the estimates. Based on the Lagrange Multiplier (LM) coefficient and F-statistics of the models, they did not have problems of error term autocorrelation and the functional form of the model did not have any problem, and there was not any heteroscedasticity problem. The results of all tests were reviewed and confirmed at a 95% confidence level.

We used the Cumulative Sum (CUSUM) and Cumulative Sum of Squared (CUSUMSQ) statistics for the stability of the model parameters to examine the coefficient stability test. The Cumulative Sum test was used to examine systematic changes in the estimated coefficient and the latter test was used to examine sudden and random changes in the stability of the coefficients. Figures 1a and 1b show the results of the Cumulative Sum (CUSUM) and Cumulative Sum of Squared (CUSUMSQ) tests respectively. The hypothesis of parameter stability was not rejected since the drawing line was located between the dotted border lines:



(a) (b)

Figure 1: Source: Research Findings

We utilized the Cumulative Sum of Squared (CUSUMSQ) statistics to examine the existence of sudden and random changes in the stability of coefficients. Since the desired trend does not deviate from the range set by the dashed line in Figure 1b, the hypothesis of stability is not rejected and the parameters have the necessary stability and there are no sudden and random changes that can threaten the stability of the parameters during the period.

5 Conclusion

The present study investigated the effect of trade openness on exchange rate volatility from 1979 to 2019 using the ARDL method and an econometric model. The results indicated that an increase in money supply and government expenditures increased the exchange rate volatility even though the effect of government expenditures was not significant. Increasing the degree of trade openness, economic growth, type of exchange rate system, and oil prices decreased the exchange rate volatility, while the effect of economic growth was insignificant due to the lack of stability in growth and development, and lack of uniform planning and management in the research period. The adverse effect of a higher money supply on exchange rate volatility was greater in the short term than in the long term, in other words, the effect of money supply shock decreased over time and the national economy was adapted to the new situation over time. The effect of the type of exchange rate system governing the market was less significant only in the long term and it was higher in the long term than short term, indicating that such policies have a positive and significant effect on the foreign exchange market if they last in the long term.

Since the increase in the money supply and the type of currency system enhances the exchange rate volatility, the government is suggested to take serious measures and policies to improve financial discipline and reduce volatility while restoring stability in the money market using scientific management.
Given the favorable effect of trade openness on reducing the foreign exchange market volatility, policymakers are suggested to take serious steps to liberalize trade and provide preparations for Iran's membership in important and reputable international organizations. In this regard, reducing bureaucracy, stabilizing the market through stabilization of customs tariffs and establishment of long-term trade laws, changing foreign policy, finding new markets, and serious and scientific encouragement for non-oil exports and industrial exports are particularly important.

Regarding the negative effects of world's oil prices on foreign exchange market volatility, given the strong dependence of the Iranian economy on oil revenues and the direct effect of oil prices on the Rial value of exports and oil revenues, and destructive effects, especially during the falling oil prices, it is suggested to reduce dependence on oil revenues and oil prices by emphasizing non-oil exports and creating a long-term roadmap. We also suggest preventing unreasonable entry of oil revenues, and the affectability of the Iranian economy and its foreign exchange market from oil prices by restoration of the National Development Fund.

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