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Effects of Exchange Rate Volatility On Seaborne Import Volume In Iran

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ABSTRACT

Purpose: The exchange rate is a key variable in the economy. Given the recent currency fluctuations, which profound consequences on a country's trade, especially in the maritime sector. The objective of this study is to examine the effects of exchange rate volatility on maritime trade (import) in Iran.
Design/methodology/approach: The study used the EGARCH modeling technique to analyze the exchange rate volatility and used quart data from 1380- 1403 to analyze the effects of USD/RIAL exchange rate volatility on seaborne import volume. The results of an autoregressive distributed lag (ARDL) analysis indicate that exchange rate volatility has a statistically significant negative influence on Iran's seaborne import volume.
Findings: The results of estimating the long-term equilibrium equation through cointegration relationships indicated that a 1% increase in real income led to a 0.014% increase in import volume, and increases in the real effective exchange led to a 0.018% decrease in import volume. On the other hand, an increase of 1% in world commodity prices, which secured statistical significance, led to an increase of 0.12% in import volume. Moreover, the results of a vector error correction model (VECM) analysis found that the exchange rate volatility exhibited short-term unidirectional causality on import volume and real income. It was recommended that the government should diversify the economy and encourage the domestic production of goods that are currently imported as this will revitalize the real sector and stabilize the exchange rate.

Keywords: Seaborne Import Volume (Unloaded Port Cargo), Exchange Rate Volatility (EGARCH), ARDL, VECM.

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1. Introduction

According to The Trade and Development Organization (2022), more than 90% of global trade relies on maritime transportation, and the economic prosperity of nations is pivoted significantly on the performance of maritime trade in the global market (Oyeduntan, 2022). Maritime transport plays a vital role in stabilizing global markets. Shipping trade is a vital component of the economy, accounting for a significant portion of foreign trade and foreign exchange earnings. The sector encompasses activities such as imports, exports, shipping and port operations. It relies heavily on international transactions conducted in various currencies which necessitates the role of exchange rate (Oken, et al., 2023). The exchange rate plays a vital role in determining the prices of goods and services in international trade and has experienced significant fluctuations over the years driven by various domestic and international factors such as oil price fluctuation, government policies, and global economic conditions. Fluctuations in the exchange rate have profound consequences on a country's trade, especially in the maritime sector (Boddy et al., 1398). The increase in exchange rate volatility leads to uncertainty, which has a negative effect on trade flows. This fluctuation in the exchange rate has created severe macroeconomic disequilibrium and reduce trade volumes which led to balance of payment deficit and foreign direct investment, as well as slow economic growth (Oken, et al., 2023). While it is evident that changes in exchange rate can have far-reaching consequences on maritime activities, including shipping costs, investment decisions, and trade competitiveness, there is a scarcity of comprehensive empirical studies that quantitatively examine the impact of exchange rate volatility fluctuations on IRAN's maritime trade. This study seeks to investigate how effects of exchange rate volatility impact the maritime trade sector performance, unraveling the potential challenges, vulnerabilities, and opportunities within this complex interaction. By addressing this problem, the research aims to provide valuable insights for policymakers, businesses, and stakeholders to develop informed strategies that enhance the resilience and sustainable development of the maritime trade sector in Iran (Oken, et al., 2023). Meanwhile, import has close links with export in securing stable raw materials and capital goods in Iran. Moreover, seaborne import flow plays a large role in securing port competiveness and ensuring regional economic growth in Iran. Sea-discharge or unloaded port cargo volume which cosist of (Import, Transit, Cabotage, transshipment) accounted for approximately 50% (average of yearly data from 1380 to 1403) of total seaborne trade volume (Port and maritime organization, 1403). This article considers three key aspects in assessing the impact of exchange rate (USD/RIAL[i]) fluctuations on (throughput) of sea-discharged goods in Iran, which are different from existing studies. First, this study investigate the influence of exchange rate volatility on the Sea-discharge volume (there after IMPORT). Second, this study analyses the extent of the long-term and short-term direction and magnitude of exchange rate volatility on import volume. Third, it applies autoregressive distributed lag (ARDL[i]) which takes into account level variables and difference variables to analyze dynamic causal linkages (DCL) (KIM, 2017). Against this backdrop, this paper uses quartly data from 1380Q1 to 1402Q4 to select real income, the real effective exchange rate of Iranian Rials per USD, world commodity prices, and exchange rate volatility as determinants of seaborne import volume. It then analyses the long-term and short-term influence and dynamic causality of exchange rate volatility on seaborne import volume.This thesis is structured as follows. In section 2, Theoretical Framework. In section 3, literature review. In section 4 methodology and findings and in section 5 the conclusion and policy implications are proposed.

2. Theoretical Framework

The economic and trade developments in the world shows that International maritime trade is growing and becoming more prosperous and has become a serious necessity. Global maritime trade is largely determined by developments in the global economy and trade (Jugovic et al., 2015). Maritime trade is the loaded cargos (loading by any type of vessel, the components of loading are: export, transit[i] , cabotage[i] [i]and transship[v] [iv]) and goods unloaded (loading from any type of vessel, the components of unloading are: import, transit, cabotage and transship). International maritime trade has grown significantly, from 6 billion tons in 2000 to more than 11 billion tons in 2018. The growth of seaborne trade stopped in 2019 and in 2020 it reached its lowest level (Covid-19 pandemic) since the 2008 crisis. In 2021, it grew by 3.2% to 12,072 million tons. The volume of international maritime trade decreased by 0.4% in 2022 to 12,027 million tons (UNCTAD[v] , 2023). [i]

The International maritime transport plays a very important role in terms of geographical characteristics, connectivity with trade, reducing foreign currency expenditure, and its relationship with other industries. Given the importance of the shipping industry, understanding the variables that influence seaborne trade volume is essential for establishing competitive strategies for port and infrastructure plans of transportation and logistics (Kim, 2017). In Iran, due to its institutional and economic structure, the field of international trade is much more prominent than in other developing countries. Iran's share of the world's total maritime cargo capacity is 0.91 percent (World Economy, 2022). The total goods unloaded and loaded in ports (government-owned) has grown from 150 million tons in 2019 to about 130 million tons in 2020, with a growth of 14 percent to 149 million tons in 2021 and to 159 million tons in 2023. This represents the unused capacities of Iranian ports. The total volume of sea-discharge with negative growth in 2020 was about 56 million tons in 2020 and it was about 69 million tons in 2022 and about 71 million tons in 2023, and 67 million tons in 2024 in Iranian ports. More than 85 percent of the country's maritime trade activities are concentrated in just two ports: Shahid Rajaee and Imam Khomeini, and the share of other ports is only 15 percent (Statistics of The Ports and Maritime Organization, 1402).

This industry plays a vital role in facilitating the movement of goods, oil, and other resources to and from Iran. The Maritime sector is a neglected goldmine that possesses the potentials and could serve as a significant driver of economic growth and long-term development if proactive measures are taken to improve its efficiency (Ikenna and Paul, 2021). The maritime industry faces several challenges, including: Insufficient infrastructure, security issues and corruption (Oken, et al., 2023). Previous studies selected income, price, and exchange rate volatility as the main factors that influence international trade and empirically analyzed the effects of exchange rate volatility on trade flows in a variety of ways (kim, 2017) Exchange rate plays a key role in international trade and one of the most influential variables in determining the price of imports and exports, which also a key vulnerability factor, leading to crises in the economy (Chi, 2019). A large body of literature has investigated the relationship between international trade and exchange rate (e.g., Bahmani-Oskooee and Wang, 2007; Marquez and Schindler, 2007; Chi, 2014 and 2016; Hooy et al., 2015). The exchange rate volatility is the risk of exchange rates and it has some implications for external trade. Exchange rate fluctuations have significantly affected shipping trade directly through the economic instability and uncertainty, and indirectly through the production system, investment and national policy (Nyunt, L.K. 2019).The fluctuation of exchange rate can cause currency appreciation or depreciation and this fluctuation makes it difficult for countries to trade. (Oken et al., 2023). A series of studies claimed that exchange rate volatility leads to a contraction in international trade (e.g, Oskooee and Gelan (2018); Kim (2017); Aftab et al. (2017); Chi and Cheng (2016); Bahmani-Oskooee and Hanafiah (2011); Baum and Caglayan (2010); Coric and Pugh (2010); Grier and Smallwood (2007); Chowdhury (2005); Aristotelous (2001); Arize et al. (2000); Mackenzie (1999) and Asseery and Peel (1991)), while other studies argued that exchange rate volatility leads to an expansion in international trade (e.g., Hooy et al., (2015); Kasman and Kasman (2005); Bahmani-Oskooee and Wang, (2007); Mckenzie and Brooks (1997); Broll and Eckwert (1999) and Dellas and Zilberfarb (1993)) (chi , cheng 2016).

The central controversy of the impact of exchange-rate volatility on trade flows rests on how exactly to predict the behavior of traders. From one point of view, traders with risk-averse behavior respond pessimistically to unanticipated change in exchange-rate such that total output and trade flows would be reduced as a result. Another reason for the negative relationship is that exchange rate volatility may have an indirect effect through its impact on output structure, investment, and government policy (Ekanayake et al., 2021). This occurs even if there are factors that mitigate the impacts, such as a financial market that enables foreign exchange hedging (Kim, 2017). Other studies conjecture the prospect of traders with a profit maximizing motive to be more preserving and would increase their trade volume in order to offset any decrease in future revenue resulting from exchange-rate instabilityviA series of studies point to the inconclusive empirical result regarding the impact of exchangerate volatility on trade volume as traders tend to respond to unlike source of risk or volatility in a different way (Bahmani-Oskooee and Gelan, 2018). Furthermore, a small number of studies observed that exchange rate volatility had either a very slight effect on international trade or no statistically significant effect at all (Bahmani-Oskooee et al., 2013; Haile and Pugh, 2013). Some of the reasons for contradictory results by different studies include: the differences in the way exchange rate volatility was measured; the various types of sample data that were used such as aggregate export data or sectoral export data; the use of different timeframes; and the use of different econometric methods (Ekanayake et al., 2021). The work of Aghion et al. (2009), and Grier and Small (2007), among others, offers a fourth line of empirical study validating the proposition that the exchange rate volatility impact on real macroeconomic variables has quite different results depending on whether countries are considered developed or less developed. More specifically, they have shown that in countries with relatively low levels of financial development, the exchange rate volatility reduces growth significantly. In contrast, in financially advanced countries the exchange rate volatility has no effect (Bahmani-Oskooee and Gelan, 2018).

Despite previous studies having improved understanding of the effects of exchange rate changes on international trade flows, several unresolved issues remain in existing literature. First, relatively little attention has been paid to the asymmetric effects of exchange rate changes on the bilateral trade flows. Most previous studies assumed the symmetric effects of exchange rate, implying that the impact of a currency appreciation (rising exchange rate volatility) is of the same magnitude and move in the opposite direction of the effect of a currency depreciation (falling exchange rate volatility). This may be too restrictive since risk-averse traders may be more sensitive to their losses than their gains from currency value changes. For example, exporters and importers can respond differently when exchange rates are more volatile as compared to when they are less volatile. Recent empirical literature also supported that the effect of exchange rate volatility is in a nonlinear fashion (Aye et al., 2015; Bahmani- Oskooee and Aftab, 2017; Sharma and Pal, 2018). Second, there is a lack of information on exchange rate asymmetries by transport mode. It is possible that the asymmetric effects of exchange rate fluctuations can vary by transport mode, such as rail, water, truck and air, due to the characteristics of trading commodities. For instance, US. vehicles and electrical machinery are transported by truck, while US. crude oil and petroleum products are mostly transported by pipeline. The exchange rate elasticities of demand for these imported commodities can differ in Canada which may lead to a different magnitude of asymmetric effects of exchange rate on the trade flows for these two transport modes. Bahmani-Oskooee and Ratha (2007) found that exchange rate elasticities vary by commodity groups between US and its major trading partners. Chi (2014) also supported that exchange rate elasticities of demand for US-Canada bilateral trade flows vary among transportation modes. It is necessary to further investigate exchange rate asymmetries to help policymakers and shippers advance understanding of the bilateral trade flows associated with exchange risks and develop a strategic plan for transportation infrastructure investment and service expansion (chi, 2020).

Recent studies show that the empirical literature in this field is so extensive that today every country needs its own study, and our country is no exception. Studies have mainly focused on analyzing the effects of exchange rate volatility on the value of exports or export volume, and there is little literature that analyzes the effects of volatility on the value of imports and import volume. Meanwhile, imports are closely related to exports, and this relationship is even greater in the supply of raw materials, intermediates, and sustainable and advanced capital cargo in a dependent country.

3. Literature review

In this section, we provide a summary of studies that explore the relationship between exchange rate volatility and trade.

Jovwo and Ibenta (2023) examined Effects of Exchange Rate Volatility on Maritime Trade Sector in Nigeria. The findings of the study indicate that exchange rate volatility has no significant effect on maritime trade volume both in the short run and longrun and it was recommended that the government of Nigeria should diversify the economy and encourage the domestic production of goods that are currently imported as this will revitalize the real sector and stabilize the exchange rate.

Ekanayake and Dissanayake analyzes (2022) the effects of real exchange rate volatility on the United States' exports to BRICS. Two measures of exchange rate volatility are used in this study. According to their findings, the levels of foreign economic activity have a positive effect on exports while the real exchange rate has a negative effect on exports. In addition, exchange rate volatility has a negative effect on exports in the long run in all five countries. However, the effects of exchange volatility are found to yield mixed results in the short run regardless of which measure of exchange rate volatility was used.

Chi (2020) performed a study to investigate the possible asymmetric exchange rate effects on cross-border freight flows between the United States and Canada. Evidence has been found that both exchange rate volatility and currency value affect the freight flows of US and Canada in an asymmetric manner. The findings of this study suggested that asymmetric effects of exchange rate on cross-border freight flows are misled by the conventional linear specification.

Yunusa (2020) examined the effect of volatility of exchange rate on Nigerian crude oil export to its trading partners. The results of the study showed that the exchange rate volatility between Nigeria and its trading partners is crucial in deciding crude oil exportation volume made by Nigeria to its trading partners. Finally, the results suggested that exchange rate volatility significantly influenced crude oil exportation in Nigeria.

Chen et al. (2020) to investigate the impact of uncertainty of economic policies on volatility of exchange rates in China utilizing data from 2001 to 2018. Quantile regression was used for the analysis. The results of the study showed an asymmetric and heterogenic relationship between economic policy uncertainty and exchange rate volatility in China.

Smallwood (2019) assessed the impact of exchange rate uncertainty on bilateral export growth for China's ten export markets (1994-2019). Flexible multivariate DCC-GARCH model was used in the study. It was found that exchange rate uncertainty has no impact on U.S. trades, while there is impact for all remaining countries.

Bahmani-Oskooee and Gelan (2018), using data for twelve African countries, investigated the effect of real exchange rate volatility on their imports and exports. The bounds testing approach was utilized for the analysis. The results found that trade flows of many countries are affected by exchange rate volatility in the short term, but only a few countries are affected in the long term in both imports and exports.

Kim (2017) performed a study to analyze the effects of the volatility of exchange rate on seaborne import volume in Korea. The Autoregressive Distributed Lag (ARDL) model was used to analyze the data. The results of the study showed that a statistically significant negative influence existed between USD/KRW exchange rate volatility and Korea's seaborne import volume. Further, it was found that the volatility of exchange rate exhibited short-run unidirectional causality on real income and import volume, from the results of a Vector Error Correction Model (VECM). The evidence has confirmed a bidirectional causality between the real effective exchange rate and volatility of exchange rate.

Bahmani-Oskooee and Aftab (2017) have also found the asymmetric effects of exchange rate volatility on trade flows. The study utilized monthly data from 117 Malaysian industries out of which 54 have exported to and 63 have imported from the USA. The study found that most industries are responsive to the volatility of real exchange rates.

Chi and Cheng (2016) have attempted to examine the short- and long-term impacts of real income, bilateral exchange rate, and volatility of exchange rate on maritime export volume of Australia to its major trading partners. Generalized Autoregressive Conditional Heteroscedasticity (GARCH) and mean adjusted relative change measures were included as two measures of real exchange rate volatility for comparison purposes. The study found that real income is a paramount factor of maritime export volume. Further, the study found that exchange rate volatility is also a paramount factor that affects maritime export volume.

Mundaca (2011) has presented a model to examine the effect of exchange rate volatility on international trade in terms of exchange rate uncertainty and optimal participation in international trade. According to this model, exchange rate fluctuations increase uncertainty in international trade and also have a negative deterrent effect.

4. Methodology and Findings

4.1. Model Specification

In much of the literature and empirical studies[v] , income, price, and exchange rate volatility variables are used as the main determinants of the import demand function. In this study following (Ekanayake et al.,2021; Kim, 2017; Bahmani-Oskooee *et al*., 2020;; Chi, 2020; Bahmani-Oskooee and Hegerty, 2007; Choudhry and Hassan, 2015), The main variables affecting the import demand (unloaded port cargo) as follow, the seasonal industrial production index as a proxy for real income variable in Iran, the world commodity price index, which reflects the supply and demand situation in the world commodity market[i] , and the real effective exchange of the Rial as the price variable, which is a proxy for the relative price of imports and the exchange rate volatility variable to develop adeterminant function of seaborne import volume in Eq. (1).

$$ULP_t = \alpha_0 + \beta_0 IPI_t + \beta_1 REER_t + WCP_t + \beta_2 ERVOL_t + \varepsilon_t \quad (1)$$

ULPt is the natural logarithm of IRAN's seaborne unloaded volume

IPIt is the natural log of IRAN's seasonally adjusted industrial production indicators, a surrogate variable of IRAN's real income,

REERt is the natural logarithm of real effective exchange rate of the RIAL,

WCPt is the natural log of world commodity prices,

ERVOLt is the average monthly value of the daily conditional heteroscedasticity for exchange rate volatility USD/RIAL, which was deduced by the EGARCH model.

Except for exchange rate volatility, all variables were treated with natural logs. The analysis period was from 1380:01- 1403:01 and seaborne trade volume data were obtained from the Port and maritime organization of Ministry of Roads and Urban Development, seasonal adjusted industrial production index were obtained from the Central Bank of IRAN and exchange rate data were obtained from financial and economic data website of the Ministry of Economic Affairs and Finance. Real effective exchange-rate data and world commodity prices were taken from the International Monetary Fund (IMF) website.

4.2. Conventional (ADF, PP) unit-root tests

Prior to the detailed analysis, integral degrees of variables that are included in the model were assessed. In order to apply the ARDL model, there should be no I(2) variable.

Table 1, shows the results of a conventional unit root tests[x]. The ADF, PP unit root tests have a null hypothesis in favor of non-stationarity.These tests indicated that the level variables as non-stationary and the difference variables as stationary.Therefore, all variables are I (1).

Table 1: Conventional unit root tests

	ADF		PP	
	Level	1st Difference	Level	1st Difference
ULP	-2.7175(1)	-10.819***	-2.446	-12.245***
IPI	-1.8930(4)	-2.9132***	-1.948	-10.233***
REER	-0.5181(0)	-7.7174***	-0.8650	-7.7374***
WCP	-2.2397(1)	-2.9754***	-2.0067	-4.5494***
ER	3.3838(1)	-9.9194***	2.5008	-9.3461***

Source: Author's computation

Notes: *** denotes rejection of the null hypothesis of unit roots at 1% significance level, respectively.
Figures in parenthesis are minimum lags determined by SIC (Schwardz criterion).
The critical values are based on Mackinnon (1996)'s one sided p-values.

4.3. Measures of exchange rate volatility

Volatility is defined as instability, fickleness, or uncertainty and is considered a measure of risk. Empirical evidence suggests that increased exchange rate volatility has an adverse effect on international trade flows[x] . Various measures of exchange rate volatility have been proposed in the literature[x] (CHI, 2020). This study introduces a conditional heteroscedasticity model to measure the USD/RIAL exchange rate volatility. Nelson (1991) indexed the GARCH[x] model by Bollerslev (1986) to propose an EGARCH model. This model eased the limiting conditions of the GARCH model, which required the condition of parameter non-negativity be satisfied, by taking the log of the model [x] (Souri, Ali. 1391). The[i] AR(k)-EGARCH (p, q) model's mean equation and variance equation are exhibited in Eq. (2) and Eq. (3), respectively.

$$R_t = \theta_0 + \sum_{n=1}^{k} \theta_n R_{t-n} + \varepsilon_t \qquad (2)$$

$$\log(h_t^2) = \omega + \sum_{i=1}^{p} \alpha_i \log(h_{t-1}^2) + \sum_{j=1}^{q} \beta_j \frac{|\varepsilon_{t-j}|}{\sqrt{h_{t-j}}} + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sqrt{h_{t-k}}} \qquad (3)$$

Where, Rt is the percentage change in the exchange rate, θ is the parameter of the autoregressive term, and ε_t is the error term.The variance equation of the EGARCH model makes it possible to test asymmetric variability. The coefficient of γ is smaller than 0 and in the case that it is statistically significant, triggers a leverage effect where the volatility of a negative shock has a larger effect than that of a positive shock. The persistency of volatility is measured by the size of α. Many studies propose results where the coefficient of α is close to unit, and [v] therefore the persistence degree of volatility is quite high.

First, the heteroscedasticity test is used to determine whether the conditional heteroscedasticity autoregressive model is valid. To end this, this paper estimated the exchange rate through the use of ordinary least squares (OLS) and conduct both Ljung-Box Q and LM, tests on the squared time series of the residuals.

Table 2: Heteroscedasticity test

Residual Diagnostic Test	ARCH Test for Heteroscedasticity	F-statistic	54483/92	0.0000
		Obs*R-squared	274/58	0.0000
	LM Test for Serial Correlation (lag 2)	F-statistic	28310.40	0.0000
		Obs*R-squared	275.66	0.0000
	J-B Test for Normality of Errors	skewness	0.773	0.0000
		kurtosis	2.244	0.0000
		Jarque-Bera	34.084	0.0000

Source: Author's computation

This paper found the squared term of the residuals of the exchange rate variations to have autocorrelation, which made it reasonable for us to adopt the EGARCH modele (Kim, 2016)

Table 3: Estimation of AR (1)-EGARCH (1, 1) model

Mean Equation				
Variables	Coefficient	Std. Error	*t*-Statistics	Prob.
Constant	16/85	5/1097	3/297	0/0008
AR(1)	0/99***	0/02261	5354/426	0.0000
Variance Equation				
ω	-0/77872***	0/07834	-9/94032	0.0000
α	0/9655***	0/0088	109/234	0.0000
β	0/6624***	0/08836	7/4974	0.0000
γ	0/1727***	0/05210	3/3149	0/0009
Diagnostic test[x] [v]				
LL -561/92*		ARCH 0/0268 (0/876) *		
J-B 30/0077 (0/000)*		Joint (χ^2) 0/0270 (0/869) *		
Q^2_{36} 18/745 (0/992) *		Q_{36} 53/682 (0/023) *		

Source: Author's computation

Notes: *** and * denote statistical significance and the rejection of null hypothesis at the 1% significance level respectively. Figures in parenthesis indicate the significance levels. *LL*, *ARCH*, *LM*, *Q*(*Q*2) and *JSB* refer to the log likelihood, the autoregressive conditional Heteroskedasticity test, the Breusch-Godfery serial correlation test, the Ljung-Box autocorrelation test and the joint sign bias test fo sign bias, negative sign bias, and positive sign bias. The *ARCH*, *LM*, and *JSB* tests are chi-square statistics.

The results show the existence of autocorrelation, heteroscedasticity and serial correlation. Generally, if the squared time series of the residuals in the mean equation has autocorrelation, volatility clustering phenomenon is highly likely to exist, and therefore the adoption of conditional heteroscedasticity models is appropriate. Consequently, this study estimates the AR (1)-EGARCH (1, 1) model as expressed in Eq. (2) and Eq. (3). In Table 3, which shows the results of estimating the EGARCH model, the coefficient of γ is larger than 0 and is statistically significant, and negative and positive shocks have the same size effect on volatility. Furthermore, the coefficient of α is close to unit and therefore the persistence degree of volatility is quite high.

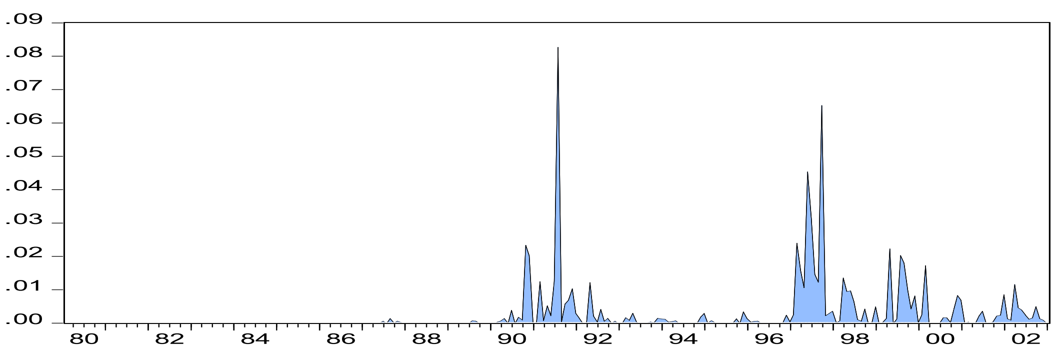

Fig. 1. Conditional variance

Source: Author's computation

Fig. 1, illustrates the movement of conditional variance, which shows high volatility during the global financial crisis.

4.4. Ng-Perron unit-root tests

Generally, the majority of conventional unit root tests have some problems. First, many have a low testing power when the root of the autoregressive polynomial is close to unit[x] . Second, when the moving average polynomial of a first order differencing time series analysis has a large negative autoregressive root, a serious large-size distortion can occur Ng and Perron (2001) (hereafter N-P) proposed a method that overcame these problems. The N-P unit root test consists of modified tests called M_{MAIC}^{GLS} (*MZa, MZt, MSB and MPT*), with generalized least squares *(GLS)* de-trending of the data using the modified Akaike information criteria *(MAIC)* (Elliot et al., 1996).

Table 4: N-P unit root tests

		MZ_a	MZ_t	MSB	MPT
ULP	Level	-9.8773	-2.2191	0.2246***	9.2403***
	1[st]Difference	-44.0116***	-4.6761***	0.106	2.148
IPI	Level	-19.3653***	-3.1107***	0.1606	2.2686
	1[st]Difference	-0.7533	-0.6014	0.7983***	31.5046***

REER	Level	-10.0641	-1.9153	0.1903***	10.4867***
	1st Difference	-21.819***	-3.2572***	0.1492	1.2823
WCP	Level	-11.1472	-2.2622	0.2029***	2.5446***
	1st Difference	45.5730***	11.8901***	0.2609	53.2294
ERVOL	Level	-40.0707***	-4/476***	0.1117***	0.6114***
	1st Difference	-42.0079***	-4.5830***	0.1091***	0.5832***

Source: Author's computation

Notes:. *** denotes rejection of the null hypothesis of unit roots at 1% significance level, respectively. The critical values referred to Ng and Perron (2001).

Table 4, show the results of N-P unit root tests. The MZa and MZt unit root tests have a null hypothesis in favor of non-stationarity, whereas MSB and MPT have a null hypothesis in favor of stationarity. These tests indicated that the level variables as non-stationary and the difference variables as stationary excluding the variable of industrial production indicators (IPI) and exchange rate volatility (ERVOL). Therefore, all variables are I (1), excluding the (IPI) , (ERVOL) which is I(0).

4.5. ARDL approach

4.5.1. ARDL bounds testing to cointegrtion

This study uses the relatively new ARDL technique to perform the cointegration test proposed by Pesaran et al. (2001)[x] . This technique is widely used for empirical modelling due to its desirable properties compared with the standard Johansen cointegration test that was developed by Johansen and Juselius (1990). First, the ARDL technique is more suitable for small sample sizes. Second, this technique is able to combine stationarity and non-stationarity variables to make analyses. Third, this technique can deal with endogenous issues of variables in the regression equation by providing unbiased long-term estimates. Fourth, this technique can form analyses by isolating or combining short-term and long-term effects The ARDL model used in this paper's analysis is expressed in Eq. (4).

From ARDL Eq. (4), the existence of a cointegration relationship among the variables are assessed by carrying out an *F* test from constraint conditions the coefficient of the lagged level variables to zero. Pesaran *et al*. (2001) provides the critical value bounds of the *F* test. If the *F* statistic exceeds the upper critical bounds, the null hypothesis is rejected and a cointegration relationship exists. [i]

$$\Delta \mathrm{ULP}_t = a_0 + \sum_{j=1}^{p} \beta_i \Delta \mathrm{ULP}_{t-j} + \sum_{j=0}^{p} \gamma_i \Delta \mathrm{IPI}_{t-j} + \sum_{j=0}^{p} \delta_i \Delta \mathrm{REER}_{t-j} + \sum_{j=0}^{p} \varphi_i \Delta \mathrm{WCP}_{t-j} + \sum_{j=0}^{p} \theta_i \Delta ERVOL_{t-j} + \lambda_1 \mathrm{ULP}_{t-1} + \lambda_2 \mathrm{IPI}_{t-1} + \lambda_3 \mathrm{WCP}_{t-1} + \lambda_4 \mathrm{ERVOL}_{t-1} + \varepsilon_t \quad (4)$$

Where Δ is the first-difference operator, α, β, γ, δ, φ, θ, λ are parameters to be estimated, p is the lag length and ε_t is a random error term (Eknayake et al., 2021)

4.5.2. The long-run ARDL model and error correction model

If the basis for a long-term equilibrium relationship (cointegration) among the variables exists, Eq. (5) is estimated using ARDL model, as the order of the lags is determined by the Akaike information criterion (AIC):

$$\mathrm{ULP_t} = \phi + \sum_{j=1}^{p} \beta_i \mathrm{ULP_{t-j}} + \sum_{j=0}^{p} \gamma_i \mathrm{IPI_{t-j}} + \sum_{j=0}^{p} \delta_i \mathrm{REER_{t-j}} + \sum_{j=0}^{p} \varphi_i \mathrm{WCP_{t-j}} + \sum_{j=0}^{p} \theta_i ERVOL_{t-j} + Z_t$$

Furthermore, the ARDL model that specify the short-term dynamics is expressed by constructing an error correction model (*ECM*) of Eq. (6).

$$\Delta\mathrm{ULP_t} = \mathrm{a_0} + \sum_{j=1}^{p} \beta_i \Delta\mathrm{ULP_{t-j}} + \sum_{j=0}^{p} \gamma_i \Delta\mathrm{IPI_{t-j}} + \sum_{j=0}^{p} \delta_i \Delta\mathrm{REER_{t-j}} + \sum_{j=0}^{p} \varphi_i \Delta\mathrm{WCP_{t-j}} + \sum_{j=0}^{p} \theta_i \Delta ERVOL_{t-j} + \lambda_1 \mathrm{e_{t-1}} + \mathrm{U_{t-1}} \qquad (6)$$

The results of ARDL in the cointegration test in Table (6), were able to confirm a strong cointegration ,to check the order of integration for each variable, the study proceed to generate the F-statistics as shown in Table 4, below

The null hypothesis shows a non-existence of a long-run relationship, while the alternative hypothesis shows the existence of a cointegrating relationship. It must be noted, that F-statistic is 4.772 and is greater than all the upper bounds at 1%, 2.5%, 5% and 10% significance levels. The paper therefore rejected the null hypothesis and accept the alternative hypothesis. So, we decided that there exists a long run relationship between the independent variables and the dependent variable (Kim, 2017).

Table 5. Result of F-Bounds test

Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic:n=100	
F-statistic	4.772888	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Note. k is the number of regressors.

Source: Author's computation

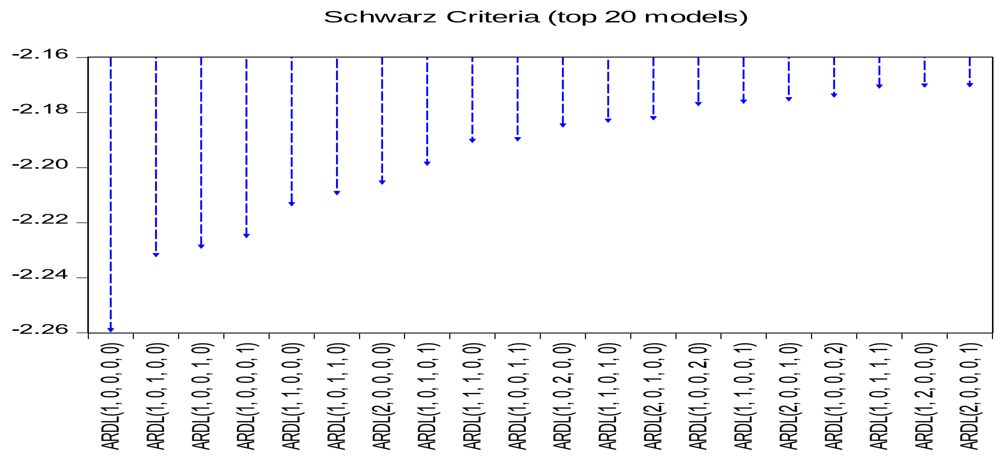

Fig. 1. SIC top model

Now, that we confirmed the existence of cointegration between the variables, we proceeded with the estimation of the appropriate ARDL model for the all variable.

The optimal ARDL (1, 0, 0, 0) specification has been chosen based on the Schwarz Bayesian Criterion and as presented in Table 6, below.

Table 6. Autoregressive Distributed Lag Estimates. ARDL (1, 0,0, 0, 0) selected

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNULP(-1)	0.693228	0.067401	10.28518	0.0000
LNREER	-0.018923	0.017408	-1.087033	0.2802
ERVOL1	-0.110518	0.042672	-2.589946	0.0114
LNWCP	0.125806	0.035799	3.514262	0.0007
LNIPI	0.014368	0.024150	0.594959	0.5535
C	4.503963	1.036509	4.345319	0.0000

R-squared	0.827359	Akaike info criterion	-2.477424
Adjusted R-squared	0.816702	Schwarz criterion	-2.307361
S.E. of regression	0.067821	Hannan-Quinn criter.	-2.408945
F-statistic	77.63609	Durbin-Watson stat	2.181030
Prob(F-statistic)	0.000000		

Note. P-values and any subsequent tests do not account for model.
Source: Author's computation using Eviews 10.

Table 7 displays the long-run parameters of the ARDL model. The estimates shows a strong causal smaller than the 5% level effects (statistical significance) directed from ERVOL and WCP towards seaborne Import, When REER and IP are not-significant.

Table 7. Estimated long run coefficients using the ARDL approach.

ARDL Long Run Form and Bounds Test

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.503963	1.036509	4.345319	0.0000
LNULP(-1)*	-0.306772	0.067401	-4.551478	0.0000
LNREER**	-0.018923	0.017408	-1.087033	0.2802
ERVOL1**	-0.110518	0.042672	-2.589946	0.0114
LNWCP**	0.125806	0.035799	3.514262	0.0007
LNIPI**	0.014368	0.024150	0.594959	0.5535

Source: Author’s computation

EC = LNULP - (-0.0617*LNREER -0.3603*ERVOL1 + 0.4101*LNWCP + 0.0468*LNIPI + 14.6818)

The results of estimating the long-term equilibrium equation through cointegration relationships indicated that a 1% increase in real income led to a 0.014 % increase in import volume, and increases in the real effective exchange led to a 0.018% decrease in import volume. However, the coefficient of the real effective exchange rate was unable to secure statistical significance. On the other hand, an increase of 1% in world commodity prices, which secured statistical significance, led to a increase of 0.12% in import volume. Moreover, an increase of one unit in exchange rate volatility, which was statistically significant, led to a decrease of 0.11% in import volume.

Following the estimation of F-Bounds Test, we advance our analysis by estimating Error Correction Model (ECM), In order to reach a balance in the long term. The results of ECM are presented in Table (8) below. As shown ECT are statistically significant with negative signs. With reference to the Granger Representation Theorem (Engle & Granger, 1987; Granger, 1983)[x] . v

The *ECM* coefficient, which shows the short-term adjustment speed for long-term equilibrium, was found to be statistically significant at the 1% significance level. The coefficient of the error correction term has a negative sign and, at (-0.30), is moderate. This means that when import volume goes above or below the equilibrium level, the speed is adjusted to 30% each month. It takes about 3 months for a complete convergence toward the long-term equilibrium level[x] .

Table 8. Short-run dynamic error correction representation for ARDL Model (1, 0, 0, 0, 0)

ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.

CointEq(-1)*	-0.306772	0.055634	-5.514079	0.0000
R-squared	0.260487	Mean dependent var		0.002365
Adjusted R-squared	0.260487	S.D. dependent var		0.076539
S.E. of regression	0.065820	Akaike info criterion		-2.592366
Sum squared resid	0.372572	Schwarz criterion		-2.564023
Log likelihood	113.7679	Hannan-Quinn criter.		-2.580953
Durbin-Watson stat	2.181030			
* P-value incompatible with t-Bounds distribution.				
F-Bounds Test[xx]		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.772888	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Author's computation

Furthermore, the diagnostic tests rejected some problems in econometric side. The test for ARCH test rejects heteroskedasticity in the disturbance term at 5% level of significance (Table 8). In additional to, the LM test[x] result indicates that there exists no serial correlation in the residuals.

Finally, the results of goodness of fit and diagnostic tests for long-term equation found no heteroscedasticity, autocorrelation, serial correlation, or non-normality.

i

Table 9. Heteroskedasticity test: ARCH

F-statistic	0.024533	Prob. F(1,83)	0.8759
Obs*R-squared	0.025117	Prob. Chi-Square(1)	0.8741

Source: Author's computation

The stability of the long-term coefficient is examined by carrying out CUSUM and CUSUMSQ tests based on sequential regression residuals proposed by Brown *et al.* (1975). According to Fig. 3, the depictions of CUSUM and CUSUMSQ are located within critical bounds with a 5% significance level. This signifies that the coefficients are stable with the passage of time (Yosri and Huang, 2019).

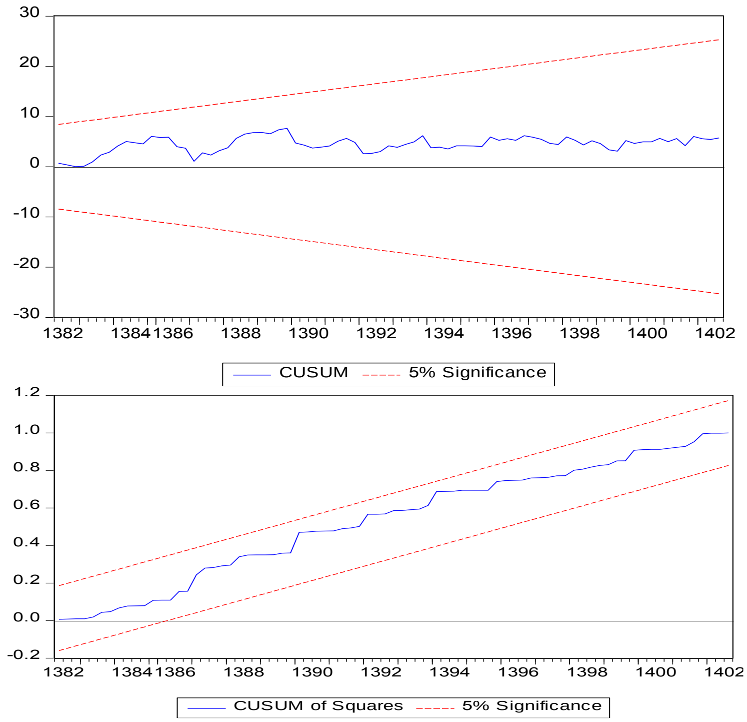

Fig. 3. CUSUM and CUSUMSQ tests for ARDL long-run equations
Source: Author's computation

4.6. VECM analysis[x]

The next step was to test the dynamic causality between each of the variables. The VECM model can capture short-term causality through the *F* statistic and long-term causality using ECT_{t-1}'s[x] *t* statistic. Table 8 indicate the results of dynamic causality estimated. The results of Table 8 show that USD/RIAL exchange rate volatility has short-term unidirectional causality with import volume and real income. Furthermore real income has a short-term unidirectional causality with the real effective exchange rate. Another short-term unidirectional relationship run from world commodity prices to exchange rate volatility. The undirectional causality between real effective exchange rate and exchange rate volatility was confirmed as well. A long-term causality, between exchange rate volatility and import volume as well as the real effective exchange rate and exchange rate volatility could be confirmed (Gujarati and Porter, 2009).

Table 10: VECM Granger causality analysis

	Dependent variables				
	Δ(LNULP)	Δ(LNIPI)	Δ (LNREER)	Δ (LNWCP)	Δ (ERVOL)
ECT_{t-1}	-0.127*** [-3.216] (0.001)	-0.094 [-1.27] (0.199)	0.14** [1.659] (0.094)	-0.006 [-0.13] (0.903)	-0.46*** [-4.681] (0.0000)
Δ (LNULP(-1))		-0.301 [-1.512] (0131)	0.322 [1.35] (0.23)	-0.165 [-1.34] (0.18)	0.136 [0.57] (0.56)
Δ (LNIPI(-1))	-0.06 [-1.259] (0.29)		-0.1394 [-0.63] (0.52)	0.057 [0.857] (0.39)	0.049 [0.28] (0.81)
Δ (LNREER(-1))	0.048 [0.954] (0.33)	0.011 [0.124] (0.901)		-0.001 [-0.024] (0. 98)	0.058 [0.461] (0.64)
Δ (LNWCP(-1))	0.0615 [0.66] (0.532)	-0.143 [-0.856] (0.392)	0.184 [0.923] (0.375)		-0.29** [-1.302] (0.054)
Δ (ERVOL (-1))	0.048 [0.95815] (0.327)	0.08 [0.87] (0.381)	-0.038 [-0.351] (0.722)	-0.018 [-0.33] (074)	

Source: Author's computation

Notes: *** and ** denote statistical significance at the 5% and 10% levels, Pr0b. in ( ) & t-statistics in [ ]

The error correction term of the import volume and USD/RIAL exchange rate volatility equation was found to be statistically significant as a negative sign at the 1% level. These analyses agree with the results of the cointegration test, which used ARDL, meaning that these variables are important for converting short-term disequilibrium to long-term equilibrium (Kim, 2017)

5. Conclusions and policy implications

Exchange rate volatility reflects uncertainty in international transactions of goods and financial assets. Exchange rate fluctuations/volatility which means continuous fluctuations in exchange rates can influence the competitiveness of IRAN s exports and imports, affect the cost of shipping, and impact the overall profitability of maritime trade-related businesses (Jovwo et al., 2023). The major purpose of this study is to analyze the exchange rate volatility and unloaded port cargo volume in IRAN.

The results of the ARDL analysis found, in long-term terms, that increases in real income has a statistically significant positive influence on the import volume, whereas world commodity prices has statistically significant positive impact on it. Furthermore, long-term coefficient of USD/RIAL indicates a statistically significant negative impact on import volume. In the case of the former, the analysis found a long-term causality as well. These results are significant in that if the government's port policy and infrastructure development plans for increasing import volume do not take into account domestic real income, world commodity prices, and foreign exchange market volatility, then these plans will not be successful. The government's port and logistics policy must be, first of all, based on the continuous stability of domestic real income, and there is a need to stabilize the import market through diversification. More importantly, import firms need to monitor foreign exchange market continuously, along with managing systematic internal and external exchange risk. Additionally, government must support the hedging of exchange risk through official financial institutions.

As a result, governments, businesses related to international and maritime trade, shipping companies, and even financial institutions should take preventive proceedings against exchange rate volatility to control the risks caused by fluctuations in exchange rate, because economic stability and reduse investment risks become opportunities for growth in international trade, which in turn improves production, investment in ports, and other transportation and trade support sectors in Iran.

Lastly, the limits of this study and future directions for research are presented. In order to draw conclusions that generalize the effects of exchange rate volatility on the import volume, each country and each import product needs to be analyzed, and it is necessary to take into account factors such as price rigidity, openness, and exchange rate policy. Moreover, in terms of introducing and analyzing a quantitative asymmetric ARDL model, there is a need to extend the study to export volume. If the negative effect of exchange rate volatility on import volume is related with high volatility and the positive effect is connected with low volatility, then the effect of exchange rate volatility on import volume is both non-monotone and non-linear. For this reason, there is a need to take into account non-linear models in future studies.

The subject about this study is that with the increase in world commodity prices, which secured statistical significance, maritime imports have increased striking, which indicates that sea-borne import play the significant role in our economy. It was recommended that the government should diversify the economy and encourage the domestic production of goods that are currently imported as this will revitalize the real sector and stabilize the exchange rate.

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