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The External Exchange Rate Volatility Influence on The Trade Flows: Evidence from Nonlinear ARDL Model

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Abstract

Purpose: Major trade partners of China, including Germany, Korea, the United Kingdom, the Netherlands, Malaysia, and Mexico, are examined in the research to see how currency exchange rate variations affect everything for Germany, Korea, the United Kingdom, the Netherlands, Malaysia, and Mexico. Our study also extends the existing literature by investigating the influence of external instability on Chinese exports to the US.

Study design/methodology/approach: To conduct this study's analysis, we apply the bounds test technique to the co-integration and error correction model to examine the asymmetric influence of third-country exchange rate volatility on trade flows of China in the short-run and long-run effect through measuring with two approaches, ARDL and NARDL on bilateral trade among Korea, Germany, Netherlands, United Kingdom, Malaysia, and Mexico.

Findings: The investigation found that third-country exchange rate (China/USD) volatility has a varying influence on China's exports to different countries, with short-term asymmetrical effects observed in Korea, Germany, the United Kingdom, and Malaysia. In the long run, only Korea and the United Kingdom show an asymmetric effect on China's exports. These findings highlight the need to consider the impact of significant fluctuations in third-country exchange rate volatility before making relevant policies or decisions.

Originality/value: As far as we know, this is the first paper in the literature that employs quantitative models, analyzes the empirical data, and provides various insights which are helpful in the decision-making process concerning export strategies, exchange rates, and international trade.

***Keywords*:** Third country exchange rate volatility (TCV), exports, China, Autoregressive Distributive Lag model, Nonlinear ARDL model

***JEL Classification*:** F31, F41, C32

1. Introduction

Since the abandonment of static exchange rates in the early 1970s, the exchange rate fluctuations' influence on foreign trade flows has been extensively researched at the industry, country, and, further lately, the entity level. The lack of hedging tools would negatively affect exports due to exchange rate fluctuations (Clark, 1973). However, subsequent studies such as Cushman (1986) and Viaene and De Vries (1992) relaxed Clark's assumptions by demonstrating that hedging risk could increase costs and lead to a decline in profits. The current theoretical literature suggests that there is a mixed association between exchange rate volatility and exports/imports (Chang & Rajput, 2018; Chang, 2020; Peng et al., 2022; Noman et al., 2022d; Bahmani-Oskooee & Aftab, 2017). Various empirical investigation has yielded combined outcomes concerning the connection between trade flows and exchange rate volatility, with some showing negative effects, others showing positive effects, and some finding no relationship. For example, Aftab et al. (2012), Saidu et al. (2013), Baek (2014), and Pino et al. (2016) concluded that exchange rate volatility hurts exports, while Uche et al. (2022a), Ali et al. (2022), and Chi and Chang (2016) found a positive impact. Other investigations also indicate a significant impact of exchange rate volatility on exports, such as Hashmi and Chang (2021), Chang et al. (2019a; 2019b), Sharma and Pal (2018), and Uche et al. (2022b).

The research examined how changes in the exchange rates between two nations and a third nation might impact commerce. The principal investigator, Cushman (1986), investigated the connection between the fluctuation of third-country exchange rates and the movement of commerce across nations and found a notable favorable influence. The strong influence of foreign exchange rate fluctuation on exports across many sectors has been strengthened by recent research. Furthermore, Bahmani-Oskooee & Aftab (2017) and Soleymani et al. (2017) concluded that third-country fluctuation significantly influences trade flows.

However, the research mentioned above has several flaws regarding examining the asymmetrical exchange rate volatility’s influence on trade flows. This research uses a time series evaluation using a nonlinear ARDL approach has drawbacks. In addition, neither the exchange rate volatility’s asymmetric influence nor the exchange rate volatility’s symmetric influence in other nations on China's exports was examined. The current study, therefore, aims to address these constraints by examining the influence of various types of exchange rate volatility, along with third-country exchange rate volatility, on the exports of China to its important trading counterparts, including the Netherlands, the United States, Germany, South Korea, the United Kingdom, Malaysia, and Mexico. The principle purpose of this investigation is to provide novel viewpoints and highlight how crucial it is for decision-makers to carefully monitor the impact of significant fluctuations in the volatility of exchange rates in third countries. Policymakers may use these conclusions to help them create effective policies and choices. Additionally, it is critical to consider the asymmetric effect of currency rate fluctuation in other countries on China's exports. Thus, applying similar rules throughout all countries may not be appropriate, necessitating a more sophisticated strategy (Xue et al., 2023a, 2023b; Dash et al., 2023).

This study adds two significant contributions to the repository of literature already available. Firstly, as distinguished by Syed et al. (2019), Cushman (1986), and Hashmi et al. (2021a, 2021b, 2022), many previous studies have overlooked the influence of the external market or third-country effect. This effect refers to the exchange rate volatility's influence between two countries on trade flows, which is further impacted by the volatility of exchange rates in other markets. For example, exports from China to Malaysia could be impacted by the mutual exchange rate volatility between the Chinese Yuan and the United States dollar and the exchange rate volatility between the US dollar and the Malaysian Ringgit. If the exchange rate fluctuations between the United States dollar and the Yuan upsurge, it could lead to declining exports from China to the US. Still, it may also lead to increased exports from China to Malaysia. This investigation aims to fill this gap by assessing the influence of third-country exchange rate volatility on China's exports (Xue et al., 2023c, 2023d).

Secondly, this investigation adds to the existing literature by assessing whether the asymmetric effect of exchange rate volatility changes from positive to negative variations in the exchange rate on trade flows. As Verheyen (2013), Derindag et al. (2022), and Chang et al. (2020c) state that, dealers may not respond to every single variation in the exchange rate. Instead, there may be a zone of inactivity where exporters do not modify if the exchange rate stays within that zone. However, they may alter their decisions if the exchange rate exceeds that zone, as the cost of reversing their decision may be more significant. Therefore, this investigation evaluates the asymmetric influence of third-country exchange rate volatility on exports.

There are several reasons why we chose to conduct our research on China. Firstly, studying a developed country like China is crucial as developed countries are typically more risk-tolerant. Hence, the exchange rate volatility's favorable influence on exports may be significant. Secondly, China is currently the global largest trading nation and is critical in international trade. Its economy has shifted from a centrally planned structure to a more market-oriented one, and it now ranks second in the world by nominal GDP. Thirdly, according to recent statistics from the International Trade Organization, China exported USD 2.294 trillion and imported USD 2.14 trillion worth of products worldwide in 2018. Fourthly, there are conflicting assessments of the exchange rates' role in China's economy.

On the one hand, policymakers may intentionally undervalue the exchange rate to exploit foreign demand and achieve the much-needed rapid growth rate. On the other hand, there are doubts about the efficiency of the exchange rate in reducing the trade surplus, especially in a developed economy like China, where prices can still be constrained by supply and demand decisions. Finally, given China's intense competition from developing countries to appreciate the Yuan, it is essential to discover the association between exchange rates and China's trade.

The remaining segments of the research are systematized as below. The paper's second section thoroughly reviews earlier investigations on the connection between exchange rate changes and volumes of trade while considering the influence of third-country variables and the exchange rate

volatility's asymmetrical character. The data and techniques used in this study are pronounced in Section 3. The study's findings and conclusions are demonstrated in Section 4, emphasizing the exchange rate volatility's influence in third countries on the Chinese export volume. Finally, Section 5 brings the investigation to a close by summarizing the key results and highlighting the policy implications of this research.

2. Literature Review

An approach for export markets was presented by Clark in 1973, emphasizing intense rivalry and the utilization of foreign currency transactions. He predicted that the lack of accessible hedging mechanisms would lead to exchange rate fluctuations detrimental to exports. Businesses were forced to base their choices as a consequence on their forecasts of currency volatility. Nevertheless, Clark's original hypotheses have come to be relaxed over time due to various circumstances. In particular, Derindag and et al. (2023) and Viaene and De Vries (1992) found that risk management by hedging might reduce risk exposure. Cushman (1986) noted that risk might be reduced by participating in import or export transactions with several nations with comparable exchange knowledge. Other aspects, such as the accessibility of reasonably priced substitute inputs, various marketplaces, and other hypotheses about shifts, have also been considered. Although these changes may lessen susceptibility to risk, they can increase costs and decrease earnings. Hedging methods may minimize volatility, but they can also result in greater trading costs and less accurate profit forecasts, according to Gohar et al. (2022a, 2023) and Obstfeld and Rogoff (1998). The possibility of a negative impact on trade ascending from exchange rate fluctuations may still outweigh any potential benefits.

Experimental research has produced conflicting results on the exchange rate volatility's influence on exports, with favorable, adverse, mixed, or undefined influences observed in various empirical studies (Tang, et al., 2016). For instance, Gohar et al. (2022b, 2023) and Saidu et al. (2013) employed GARCH, OLS, and Granger-Causality to assess the influence of volatile exchange rates on Nigeria's exports. They found an indication of an adverse influence on exports because of the exchange rate volatility. Serenis & Tsounis (2013) concluded that exchange rate volatility impacts export flows in both directions by considering the cases of Cyprus and Croatia. Studies on developing Asian countries tend to suggest adverse export effects resulting from unstable exchange rates, such as in the case of Korea-US trade ((Chang et al., 2022a, 2022b; Baek, 2014), East Asian nations (Maydybura et al., 2022; Pino et al., 2016), Pakistan's exports (Chang et al., 2020a, 2020b; Aftab et al., 2012; Chang et al., 2018), and China-Japan exports (Nishimura & Hirayama, 2013).

Empirical studies on emerging nations, such as those in Latin America (Arize et al., 2008), have frequently found a negative influence on exports from exchange rate volatility, with the impact being more substantial in the short term than the long term in the latter case. However, many

empirical suggestions also assist the opposite impact of unstable currencies on trade. Few investigations suggest a favorable impact of exchange rate volatility or mixed influence throughout multiple groups of products, as seen in the cases of the US and Germany (McKenzie-1999). For instance, Chi and Chang (2016) found that the exchange rate ambiguity's influence on trade for exports from Australia to major Asian nations was favorable. Mordecki and Miranda (2018) investigated the influence of exchange rate fluctuations on trade in Chile, Uruguay, and New Zealand, from 1990 to 2013. They found a negative impact on Uruguay but no evidence for New Zealand and Chile. Studies that use disaggregated data yield mixed findings.

Long-term exchange rate fluctuations have had little influence on most industries. However, some have been significantly impacted by the volatility in mutual trade between Brazil and the United States from 1971 to 2010. Sharma and Pal (2018) concluded that long-term nominal exchange rate fluctuations impact the exports of India to Germany, the United States, and China, while the short-run findings are mixed. Similarly, substantial influences of exchange rate volatility have been revealed for 13 categories of goods from Malaysia to the US, indicating a robust existence of short-run influences over long-term effects. However, there is a minimum readiness to trade when exchange rate fluctuation is high.

Finally, it is notable to consider the asymmetric exchange rate volatility's influence on trade flows. Sharma and Pal (2018) employed an asymmetric approach to exchange rate fluctuation. They found evidence that the influence of exchange rate volatility on Indian trade may positively and negatively impact volumes. Several investigations have used asymmetric influence to indicate asymmetric variations in trade volume influence due to variations in exchange rates (Bahmani-Oskooee & Aftab, 2017; Gohar et al., 2022c; Wang et al., 2022).

As discussed earlier, the link between exchange rate fluctuations and trade flows has been broadly investigated, and empirical indication suggests that the exchange rate volatility's influence on trade flows is complex and combined (Chiang, et al., 2010; Cui, et al., 2023; Lam, et al., 2010; Lv, et al., 2021). Nonetheless, there has been an upward trend in study attention to examining how imports and exports are impacted by exchange rate volatility in third-party nations. These researchers have examined various nations, sectors, and business data to find favorable benefits. The exchange rate volatility's influence in third countries on trade relationships between many industrialized nations was originally studied by Cushman (1986). His research showed that the United States exports to Canada were significantly positively influenced by exchange rate volatility. Parallel to this, Bahmani-Oskooee and Xu (2012) examined how commodities movements between China and the US were impacted by exchange rate fluctuations in third countries and found notable short-term impacts. Recent investigations have examined data on Japanese and American companies and found significant effects from third nations in various industries. Furthermore, research conducted by Soleymani et al. (2017) showed significant short- and long-term implications of fluctuation in third countries on trade flows in the ASEAN-4 nations. Parallel to this, Bahmani-Oskooee & Aftab (2017) found that third-country fluctuation substantially influenced product trade between Pakistan and the United States.

There are particular constraints to previous investigations on the connection between trade flows and exchange rate fluctuations, notably the failure to look at the asymmetric influences of local and foreign currency rate fluctuations on exports. Moreover, to uncover the asymmetrical exchange rate fluctuations' impact on trade flows, these researchers used a nonlinear ARDL model in time series assessment. This study aims to build on previous investigations by exploring the asymmetrical influence of third-country exchange rate fluctuations and third-country exchange rate fluctuations on the exports of China to its major trading nations. This research's results will offer a new understanding of the influences of significant variations in the fluctuation of exchange rates in third countries. Government representatives and policymakers should use these ideas while formulating sound judgments. It is important to understand that all governments cannot implement regulations uniformly since various nations may experience distinct impacts from the asymmetric exchange rate volatility's impact in third countries.

This investigation adds two significant new ideas to the body of knowledge. First, it concentrates on the third country's influence, a sometimes-overlooked part of the influence on the foreign market. This phenomenon has not been fully investigated in earlier investigations. According to Cushman's (1986) assumption, the fluctuation of exchange rates with a third nation may impact the fluctuation of exchange rates in transactions between the two nations. It means the alternate marketplace for exporting goods would affect the exchange rate volatility's influence on trade flows. For example, the volatility in the mutual exchange rate between the Chinese Yuan and the US dollar could affect exports from China to Malaysia. If the Chinese Yuan or US dollar exchange rate volatility rises, exports from China to the United States could decrease, while exports from China to Malaysia may increase. This research investigates the influence of third-country exchange rate volatility on the exports of China.

Secondly, this research paper adds to the prevailing literature by investigating whether the asymmetric impact in exchange rate fluctuations differs from positive to adverse variations in the third country exchange rate fluctuations on China's exports. Verheyen (2013) argued that merchants do not respond to every variation in the exchange rate. For instance, if a merchant changes the export number for all the minor fluctuations in the exchange rate, they would have to reverse their decision when the exchange rate returns to its previous level, resulting in additional costs. Therefore, there may be a zone of inactivity in which exporters do not adjust if the exchange rate stays within that zone. However, they can modify their strategy if the exchange rate surpasses that zone. Thus, this investigation aims to calculate how variations in foreign currency rates affect the exports of China's activity.

Given the limitations of the previous studies in failing to consider the effect of both favorable and adverse variations in the exchange rate volatility, as well as the role of the third country exchange rate volatility on the trade flows, this investigation intends to address these gaps in the literature by analyzing the exchange rate volatility's asymmetric influence, with a particular focus on the role of the third country impact. We examine several variables, such as the Industrial Production Index, Real Exchange Rate (REX), and the fluctuation of exchange rates in other nations, to better

understand the elements affecting this effect. We concentrate on the exports of China to six important trading nations, in particular: Malaysia, Mexico, South Korea, Germany, and the Netherlands. Our study's results show that the exports of China are significantly and unevenly impacted by foreign exchange rate fluctuation.

3. Data and Methodology

3.1 Data size and variables measurement

The sample size for the assessment in this paper includes China and its six main trading partners, including the US, South Korea, Germany, Netherlands, UK, Malaysia, and Mexico. The selection of these nations is based on the data obtainability and the level of trade between China and these countries. This study further extends the research by incorporating third-country exchange rate volatility, foreign income, and real exchange rate. Monthly data from January 1991 to March 2019 examines these variables' short- and long-term links. The Direction of Trade Statistics (DOTS) delivers data on China's exports. Concurrently, the Real Exchange Rate and Industrial Production Index (Income) are attained from the International Financial Statistics (IFS) database of the International Monetary Fund. FRED Economics drives the Third Country (United States) exchange rate data, and the third-country exchange rate fluctuation series for China with each trading nation is derived from the real exchange rate data of the United States using the GARCH approach.

3.2 Methodology

ARDL Model

To assess the asymmetric and symmetric exchange rate volatility's influence on trade flows by employing the ARDL approach, we have formulated an export model for each of China's top trading partner countries, denoted as country i, as a function of the receiver country's income, real exchange rate, bilateral exchange rate volatility, and third country exchange rate volatility. The foremost objective of this investigation is to examine the asymmetric impact of third-country exchange rate volatility on the trade flows of China with its top trading nations, with the United States (US) being chosen as the third country due to its status as China's largest trading partner. Consistent with Soleymani et al. (2017), we have specified the short- and long-term export demand approach in logarithmic form, expressed in a vector error-correction framework and estimated using the Pesaran et al. (2001) bounds testing or autoregressive distributed lag (ARDL) technique, as presented in equations 1 and 2.

$$\Delta LnX_{ijt} = \alpha_1 + \sum_{j=1}^{n1} \alpha_2 \Delta LnX_{ijt-j} + \sum_{j=0}^{n2} \alpha_3 \Delta LnIPI_{it-j} + \sum_{j=0}^{n3} \alpha_4 \Delta LnREX_{ijt-j} + \sum_{j=0}^{n4} \alpha_5 \Delta LnTCV_{USt-j} + \rho_1 LnX_{ijt-1} + \rho_2 LnIPI_{it-1} + \rho_3 LnREX_{ijt-1} + \rho_4 LnTCV_{USt-1} + e_t, \quad (1)$$

in equation 1, LnX_{ij} is the export of country j to the trading partner i of China, $LnIPI_i$ is the foreign trading partner income i, $LnREX_{ij}$ is the real exchange rate between the country j's currency and country i's currency, and $LnTCV_{US}$ represents the third country exchange rate volatility of country j's currency with Chinese Yuan and United States Dollar correspondingly. It has been expected that LnX_{ij} relies negatively on $LnREX_{ij}$ and positively on $LnIPI_i$. The real mutual exchange rate (REX) coefficient symbol is based on the price level estimated by Consumer Price Index (CPI). Though, for $LnTCV_{US}$, the coefficients could be negative or positive. The upsurge in exchange rate volatility could create ambiguity about future profits and prices and hurt trade flows.

Conversely, similar fluctuations could bring dealers to deal more to dodge income loss and profit in the forthcoming time. This same could be employed for third-country exchange rate volatility $LnTCV_{US}$. An upsurge in volatility could create ambiguity which, in return, could lead major traders to turn away trade from the US to other major trading partners of China. Alternatively, increasing third-country exchange rate volatility $LnTCV_{US}$ can allow dealers to capitalize on the scenario and turn away trade to the US from other major trading partners.

In equation 1, the short-run influence of all variables is expressed by the symbol of $\alpha_3 - \alpha_5$ normalized on α_2. In contrast, the sign of ρ2-ρ4 expresses the long-run influence of all variables stabilized on ρ_1.

The key benefit of the ARDL technique relative to the other models of the cointegration method is that either I(0) or I(1) may be the variables used in the approach. Another advantage of the bounds estimate technique is the opportunity to concurrently evaluate both the short- and long-term impact on the dependent variables by independent variables.

NARDL Model

This research discovers the asymmetric effect of the independent variables on the dependent variables both in the short- and long-term, founded on the nonlinear ARDL (NARDL) cointegration technique proposed by Shin et al. (2014). This method is focused on the favorable and adverse fractional sum of breakdowns of the preferred variables. The Nonlinear ARDL approach is very simple to apply, allowing mutual investigation of non-stationary and non-linearity and, most notably, detection of short-run and long-run asymmetries. This approach is the modified version of the ARDL approach introduced by Pesaran et al. (2001). The econometric equation of the NARDL model for export is designed as below:

$$\Delta LnX_{ijt} = \alpha_1 + \sum_{j=1}^{n1} \alpha_2 \Delta LnX_{ijt-j} + \sum_{j=0}^{n2} \alpha_3 \Delta LnIPI_{it-j} + \sum_{j=0}^{n3} \alpha_4 \Delta LnREX_{ijt-j} + \sum_{j=0}^{n4} \alpha_5 \Delta LnTCV^{+}_{USt-j} + \sum_{j=0}^{n5} \alpha_6 \Delta LnTCV^{-}_{USt-j} + \rho_1 LnX_{ijt-1} + \rho_2 LnIPI_{it-1} + \rho_3 LnREX_{ijt-1} + \rho_4 LnTCV^{+}_{USt-1} + \rho_5 LnTCV^{-}_{USt-1} + e_t, \quad (2)$$

TCV^{+} and TCV^{-} are the fractional sum of favorable and adverse shocks for Third Country Exchange Rate Volatility, a key research variable.

Employing the Autoregression distribution lag and Nonlinear ARDL approach requires the steps below. First, test the approach for error correction model (ECM), then approach to bound testing, which examines the symmetric and nonlinear long-run association to the null hypothesis of no long-run relationship. The null hypothesis is rejected based on the calculated F-statistics value. If the value of F-statistics is greater than that of the presented upper bound value of Pesaran et al. (2001), we reject the null hypothesis that no long-run relationship exists; however, if the value of F-statistics is less than that of the presented lower bound value it infers that null hypothesis is not rejected and have no long-run cointegration between the variables of interest, i.e. ($\boldsymbol{\rho_1 = \rho_2 = \rho_3 = \rho_4 = \rho_5 = 0}$) Finally, we assess if the influence of the exogenous variables is linear or nonlinear on the dependent variable in the long- and short-term results.

4. Results, discussions, and analysis

4.1 Descriptive Analysis

Descriptive statistics is essential for the research, which summarizes bulk data in different measures. In **Table. 1**, the data shows the mean, skewness, standard deviation, kurtosis, and Jarque-Bera test values, which represent the central tendency of distribution, dispersion between the values, and normal or abnormal distribution of each variable data, i.e., export, import, real exchange rate, income (IPI), and third country volatility of Korea, Germany, Netherlands, United Kingdom, Malaysia, Mexico, and United States (Third country).

4.2 Unit Root Test

The ARDL approach specifies that all the variables of either order zero I(0) or one I(1) should be integrated and that none of the variables of order two I(2) should be integrated. For this reason, ADF test is used to analyze the integration order of the variables. **Table 2** shows the findings of the Augmented Dickey-Fuller test at the level and first difference. The tables' findings signify that all variables are either integrated of order zero I(0) or one I(1), which is why further analysis is required. Since the data is in monthly frequency, a maximum of 4 lags were chosen for the first differentiated variables, then the ideal approach was designated by applying Schwarz Information Criterion (SIC). The Schwarz Information Criterion (SIC) provides an alternative to the AIC that assigns a higher penalty for additional coefficients and ignores the most insignificant variables.

Table 1: Descriptive statistics for log variables.

Variables	Mean	Standard Deviation	Skewness	Kurtosis	Jarque-Bera
Korea					
Export	21.40	1.32	-0.43	1.88	28.18***
Exch. Rate	4.81	0.18	-0.08	1.60	27.87***
income(IPI)	4.16	0.50	-0.43	1.81	30.79***
Germany					

Export	21.25	1.21	-0.37	1.69	31.80***
Exch. Rate	4.64	0.07	0.27	2.33	10.58***
income(IPI)	4.52	0.17	-0.16	1.91	18.23***
Netherlands					
Export	20.92	1.40	-0.47	1.86	30.53***
Exch. Rate	4.60	0.04	-0.08	2.34	6.468***
income(IPI)	4.42	0.15	-0.39	2.35	14.46***
United Kingdom					
Export	20.76	1.38	-0.50	2.07	26.27***
Exch. Rate	4.73	0.11	-0.10	1.45	34.30***
income(IPI)	4.63	0.07	-0.01	2.66	1.671***
Malaysia					
Export	20.20	1.55	-0.27	1.65	29.81***
Exch. Rate	4.62	0.12	0.63	2.47	26.48***
Income (IPI)	4.42	0.38	-0.90	2.80	45.97***
Mexico					
Export	19.46	2.09	-0.43	1.81	30.72***
Exch. Rate	4.61	0.14	-0.63	2.92	22.39***
Income(IPI)	4.55	0.13	-0.68	2.36	32.03***
United States (Third Country)					
Exch. rate volatility	0.04	0.06	1.41	4.33	137.4***

4.3 Bounds Test

Using the autoregressive distributive lag and nonlinear ARDL approach, we demonstrate the findings associated with the influence of third-country exchange rate volatility on China Exports. **Table 3** represents the bounds estimate for the exchange rate volatility of the United States (Third country) on China's exports to its major trading partners. The outcome specifies that the null hypothesis of no long-run association is rejected for Korea only in both approaches, estimated at a 1% significance level. In contrast, the null hypothesis for other countries, Germany, Netherlands, and Mexico, is accepted and has no long-run cointegration for both models estimated. Although for the United Kingdom, the null hypothesis is rejected in ARDL approach estimation at a 10% significance level and has a long-run connection. For Malaysia, the long-run cointegration is inconclusive. Hence, we compute the long- and short-term connection between third-country exchange rate volatility and China exports.

Table 2: Unit root tests at the level and first difference for log variables

Augmented Dickey-Fuller

Variables	at level	at first difference	at level	at first difference
	Korea		**Germany**	
Export	-1.72	-13.16***	-1.62	-16.75***
Exch. Rate	-1.76	-12.32***	-1.30	-13.93***
Income(IPI)	-1.95	-15.62***	-1.28	-17.15***
	Netherlands		**United Kingdom**	
Export	-1.63	-16.18***	-2.02	-19.70***
Exch. Rate	-2.69*	-13.78***	-1.34	-16.17***
Income(IPI)	-4.53***	-12.21***	-3.08*	-16.70***
	Malaysia		**Mexico**	
Export	-1.51	-13.26***	-1.62	-19.88***
Exch. Rate	-1.57	-15.61***	-2.55	-14.67***
Income(IPI)	-2.89*	-20.67***	-1.65	-12.57***
	United States(Third Country)			
Exch.Rate Volatility	-3.17*	-16.96***		

Note: A null hypothesis for statistics on the ADF test is that the series has a unit root. *, ** and *** suggest that the null hypothesis is rejected at 10%, 5% and 1% significance levels respectively.

Table 3: Bounds test for Third-country exchange rate volatility and China Exports

	Korea	Germany	Netherlands	UK	Malaysia	Mexico
	Panel A: ARDL Approach					
F-Statistic	6.50***	1.76	2.48	3.95*	3.27	2.71
	Panel B: NARDL model					
F-Statistics	i5i.52***	1.32	2.08	3.07	2.77	1.17
	Panel C: Bounds Critical Values					
	90%		95%		99%	

	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
ARDL model	2.72	3.77	3.23	4.35	4.29	5.61
NARDL model	2.45	3.52	2.86	4.01	3.74	5.06

Note: Panel A delivers the bounds test findings for the ARDL approach, Panel B for the nonlinear ARDL approach, and Panel C delivers the upper I(1) and lower I(0) bound critical values to 99%, 95%, and 90% correspondingly for all the estimated approaches. *, * * and * * * demonstrate rejection of Null hypothesisiat the level of 10%, 5% and 1% respectively. The null hypothesis for bounds tests is that no long-run relationships exist.

4.4 Long-run & Short-run Results (ARDL)

Table 4 shows, using complete sample details from January 1991 to March 2019, the short- and long-term symmetric impact of third-country exchange rate volatility on China's exports to its trading partners like Korea, Germany, Netherlands, UK, Malaysia, and Mexico. Panel A contains the tests in the short term. Panel B offers the diagnostic test statistics in the long term. In Panel C, the Ramsey Reset and LM test statistics show whether the approaches are defined appropriately and have no serial correlation issue. CUSUM and CUSUMQ estimate the model constancy, where S or U specifies whether the approach is stable or unstable. ECM (Error Correction Mechanism) displays the change speed to Long run equilibrium, and Adj.r^2 (adjusted r^2) indicates model goodness.

In the short run, outcomes recommend that third-country exchange rate volatility significantly favorably impacts China's Exports to Korea, Germany, the United Kingdom, and Malaysia only. However, the rest of the countries have an insignificant impact. Other independent variables like Industrial Production Index and real exchange rate have also had mostly favorable and negative significant results in different optimal lags for all countries.

In the long run, the outcomes represent third-country volatility significantly adversely and favorably impacts only China's exports to the United Kingdom and Malaysia. In contrast, the real exchange rate only positively impacts exports in Korea. While other countries have no long-run effect as Coefficients are insignificant and indicated by the bounds test also. The coefficient suggests that by 1% rise in volatility decreases the exports to the United Kingdom by (-55.41%). The Ramsey Reset test in Panel C demonstrates that the approach is quantified correctly only in Netherlands and Mexico. LM test shows no serial correlation issue in the data for Korea and Germany. In contrast, the graphical representation of the CUSUM and CUSUMQ test shows the approach is stable only for Korea and the United Kingdom, as shown in Figure: 1. Last Adjusted R^2 shows that the model is fit and good.

Table 4: Estimates from the ARDL model (Exports)

$$LnX_{ijt} = a_1 + a_2 LnIPI_{it-j} + a_3 LnREX_{ijt-j} + a_4 LnTCV_{USt-j} + e_t$$

	Korea	Germany	Netherlands	UK	Malaysia	Mexico
Panel A: Short-run coefficients						
Δlnexport(-1)	-0.62(-10.01***)	-0.67(-12.6***)	-0.59(-10.21***)	-0.49(-8.86***)	-0.48(-8.34***)	-0.51(-9.60***)
Δlnexport(-2)	-0.35(-5.94***)	-0.39(-6.94***)	-0.41(-6.96***)	-0.28(-5.11***)	-0.49(-8.54***)	-0.39(-7.51***)
Δlnexport(-3)	-0.08(-1.78*)	-0.09(-1.86*)	-0.19(-3.67***)		-0.27(-4.93***)	-0.11(-2.25**)
Δlnrex	-0.24(-0.82)	0.31(1.48)	3.14(2.54**)	0.33(2.29**)	-0.76(-1.29)	0.48(1.31)
Δlnrex(-1)	0.81(2.72***)		-5.58(-2.78***)		0.44(0.50)	0.68(1.82*)
Δlnrex(-2)			1.95(1.58)		-1.48(-1.69*)	
Δlnrex(-3)					1.59(2.74***)	
Δlnipi	1.63(11.95***)	0.26(2.23**)	0.14(1.00)	-0.05(-0.21)	1.68(6.30***)	3.21(7.94***)
Δlnipi(-1)	0.45(2.43**)	-0.30(-2.46**)	0.10(6.18)	0.14(0.70)	-0.09(-0.29)	0.76(1.74*)
Δlnipi(-2)	0.63(3.80***)	0.12(0.96)	0.36(2.54**)	0.58(2.9***)	0.55(1.9*)	2.59(6.00***)
Δlnipi(-3)		0.85(7.27***)		0.79(3.97***)	0.79(2.8***)	
Δlntcv	1.96(1.85*)	1.86(1.79*)	-0.15(-0.84)	1.46(1.15**)	0.98(2.72***)	-0.10(-0.43)
~~**Table no 4: Continued**~~						
Panel B: Long-run coefficients						
Lnrex	0.63(3.63***)	7.89(1.33)	-4.28(-0.30)	17.86(1.43)	2.02(1.52)	1.82(0.56)
Lnipi	2.55(40.45***)	7.83(3.46***)	16.43(2.52**)	-77.80(-2.01**)	4.84(11.54***)	15.16(5.57***)
Lntcv	-0.59(-1.02)	-0.74(-0.19)	6.82(0.67)	-55.41(-2.05**)	7.89(4.97***)	-2.98(-0.38)
Panel C: Diagnostics						
Reset	4.92***	3.11*	2.03	3.49**	5.30***	2.00
LM	1.43	1.90	2.39*	5.24***	5.15***	3.70**
CUSUM	S	U	U	U	U	U
CUSUMQ	U	U	U	S	U	U
ECM	-0.24***	-0.04*	0.02	-0.02**	-0.12***	-0.03
Adj.r^2	0.98	0.98	0.98	0.98	0.98	0.98

Notes: Values in parenthesis displays the t-statistics.
ECM stands for Error Correction Model.
*, * *, and * * * indicate the 10%, 5%, and 1% rejection of the null hypothesis, respectively.

4.5 Long-run & Short-run Results (NARDL)

Table 5 shows the asymmetric influence of third-country exchange rate volatility on China's exports to its foremost trading countries. In the short run, the findings show that third-country exchange rate volatility asymmetrically influences China's exports to Korea, Germany, the United Kingdom, and Malaysia. It means that the decline and upsurge in third-country exchange rate volatility are oppositely and substantially influence China's exports to these countries. Furthermore, third-country exchange rate volatility has a symmetric influence on China's exports in the short

run for the remaining countries. In the long-run form, only in the context of Korea and the United Kingdom have asymmetric effects; subsequently, an upsurge in third-country exchange rate volatility reduces China's exports, while a decrease in third-country exchange rate insignificantly affects.

Table 5: The nonlinear ARDL approach's (Exports) estimations

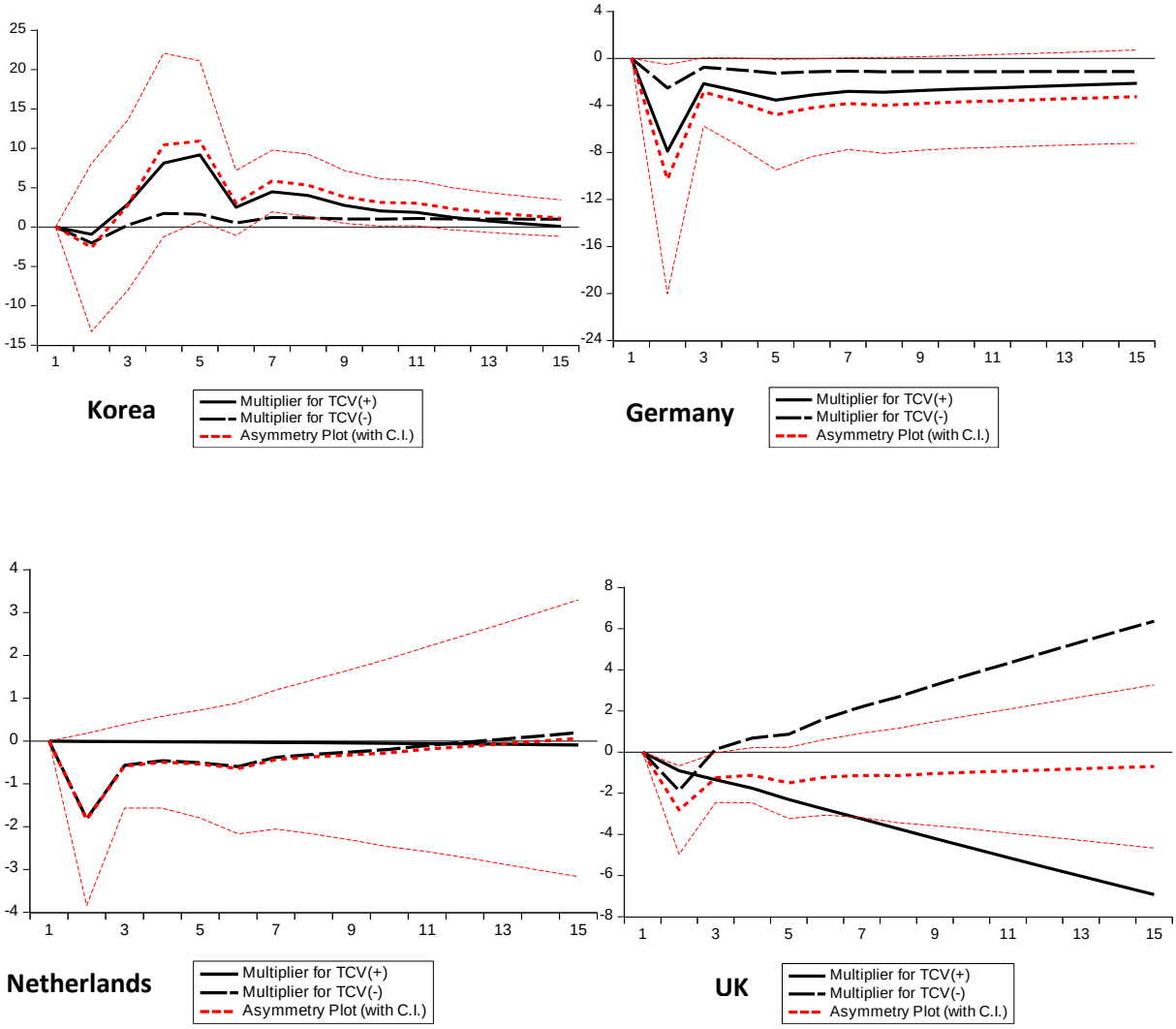
$$LnX_{ijt} = a_1 + a_2 LnIPI_{it-j} + a_3 LnREX_{ijt-j} + a_4^{+} LnTCV_{USt-j}^{+} + a_5^{-} LnTCV_{USt-j}^{-} + e_t$$

	Korea	Germany	Netherlands	UK	Malaysia	Mexico
Panel A: Short-run coefficients						
Δlnexport(-1)	-0.68(-10.45***)	-0.67(-12.65***)	-0.60(-10.37***)	-0.49(-8.81***)	-0.49(-8.27***)	-0.51(-9.53***)
Δlnexport(-2)	-0.44(-6.50***)	-0.39(-6.8***)	-0.39(-6.53***)	-0.28(-5.04***)	-0.48(-8.07***)	-0.39(-7.47***)
Δlnexport(-3)	-0.15(-2.67***)	-0.09(-1.9*)	-0.19(-3.54***)		-0.28(-5.10***)	-0.10(-2.21**)
Δlnrex	-0.19(-0.67)	0.39(1.80*)	3.00(2.42***)	0.34(2.22**)	-0.84(1.43)	0.53(1.41)
Δlnrex(-1)	0.79(2.72***)		-3.13(-2.54***)		0.29(0.34)	0.65(1.71*)
Δlnrex(-2)					-1.24(-1.42)	
Δlnrex(-3)					1.56(2.69***)	
Δlnipi	1.63(11.56***)	0.26(2.28**)	0.15(1.08)	-0.05(-0.22)	1.67(6.24***)	3.19(7.84***)
Δlnipi(-1)	0.29(1.55)	-0.31(-2.52***)	0.12(0.71)	0.14(0.70)	-0.09(-0.31)	0.78(1.77*)
Δlnipi(-2)	0.47(2.60***)	0.11(0.87)	0.36(2.59***)	0.57(2.87***)	0.54(1.90*)	2.60(6.02***)
Δlnipi(-3)	0.33(2.93*)	0.82(6.99***)		0.78(3.92***)	0.77(2.73***)	
Δlntcv_pos	-0.61(-0.10)	-8.02(-1.43)	-0.01(-0.03)	-0.90(-2.07**)	-12.17(-1.71*)	0.12(0.31)
Δlntcv_pos(-1)	-5.82(-0.51)					
Δlntcv_pos(-2)	0.47(0.04)					
Δlntcv_pos(-3)	8.85(1.44)					
Δlntcv_neg	1.99(1.80*)	2.51(2.28**)	1.85(1.46)	1.89(1.42)	2.35(1.66*)	-0.21(-0.76)
Δlntcv_neg(-1)	1.86(1.16)				-2.58(-1.83*)	
Δlntcv_neg(-2)	-0.17(-0.11)					
Δlntcv_neg(-3)	-1.79(-1.68*)					
~~**Table no: 5 Continued**~~						
Panel B: Long-run coefficients						
Lnrex	0.85(3.82***)	9.44(1.57)	-15.52(-0.41)	15.97(1.43)	2.31(1.71*)	3.56(0.80)
Lnipi	2.75(21.19***)	8.68(3.32***)	25.50(0.88)	-67.03(-1.59)	5.43(8.86***)	12.18(2.42***)
Lntcv_pos	-3.46(-2.75***)	2.74(0.64)	0.49(0.03)	-42.89(-1.18)	7.70(3.66***)	3.27(0.33)
Lntcv_neg	-0.93(-1.29)	0.83(0.20)	12.32(0.47)	-47.95(-1.72*)	10.16(4.58***)	-5.78(-0.63)
Panel C: Diagnostics						
Reset	3.22**	4.09***	4.53***	8.84***	5.12***	3.58**
LM	1.33	1.48	0.05	5.32***	4.77***	3.75**
CUSUM	U	U	U	U	U	U

CUSUMQ	U	U	U	S	U	U
ECM	-0.24***	-0.04**	0.01	-0.02*	-0.12***	-0.04
Adj. r^2	0.98	0.98	0.98	0.98	0.98	0.98

Notes: Values in parenthesis displays the t-statistics.
ECM stands for Error Correction Model. *, * *, and * * * indicate the 10%, 5%, and 1% rejection of the null hypothesis, respectively.

China's exports to Korea and vice versa for the United Kingdom. Ramsey Reset test shows the approach is not appropriately quantified only for all economies. LM test demonstrates no serial correlation issue in Korea, Germany, and Netherlands data. In contrast, the graphical representation of the CUSUMQ test shows that the model is stable only for the United Kingdom, as shown in Figure 3. Next, Adjusted R^2 also expressed that the model is fit and good for all countries. In addition, Figure 4. Dynamic Multiplier graphs also support the results mentioned in Table 5(a).



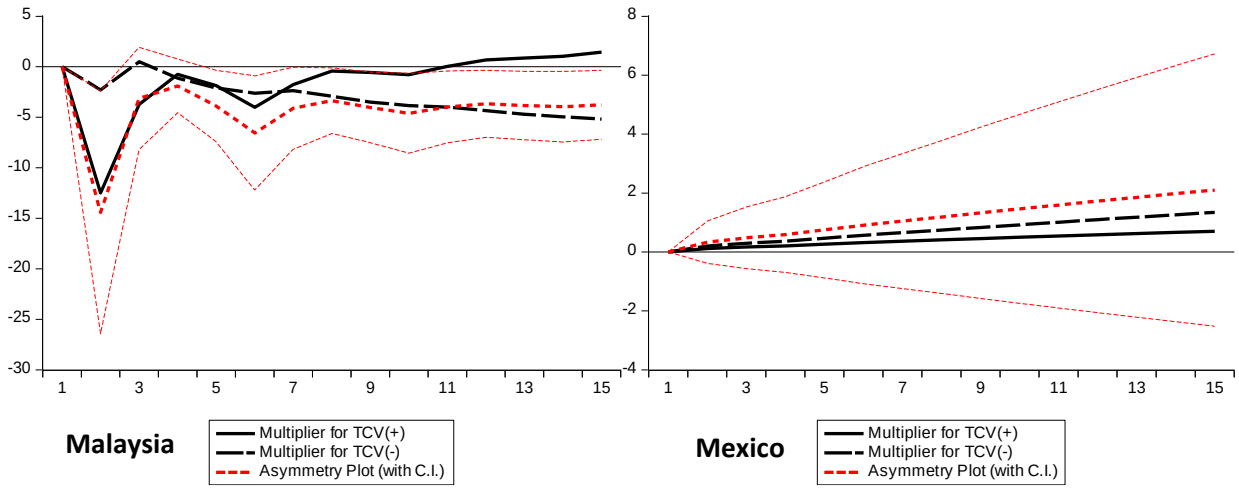


Figure 1. Dynamic Multiplier graphs NARDL Model (Exports)

5. Conclusion and policy recommendations.

In this research, we used monthly export data from January 1991 to March 2019 and applied the bounds test technique to the co-integration and error correction model (ECM). By following Soleymani et al. (2017), I examined the asymmetric influence of third-country exchange rate volatility on trade flows of China in the short run and long run effect through measuring with two approaches, ARDL and NARDL on bilateral trade among Korea, Germany, Netherlands, United Kingdom, Malaysia, and Mexico.

The findings of this study reveal that third-country exchange rate volatility asymmetrically influences China's exports to Korea, Germany, the United Kingdom, and Malaysia in the short-term influence and only in the context of Korea and the United Kingdom has an asymmetric influence in the long-run effect to the China exports. As a whole, the results of this study indicate that attention must be given to the influence of significant variations in the volatility of third-country exchange rates before making the appropriate policies or decisions. Government officials and other policymakers need to consider that the asymmetric influence of the volatility of the third country exchange rate is diverse from that of average variations in the volatility of the third country exchange rate on China exports. So, devising the same strategies for all governments may not be helpful. This research is related to decision sciences in several ways. It employs quantitative models, analyzes the empirical data, and provides various insights which are helpful in the decision-making process concerning export strategies, exchange rates, and international trade.

For those in charge of making decisions in the areas of international trade and exchange rate regulation, the research findings have significant policy ramifications. First, decision-makers need to understand how different countries' exports from China are impacted by exchange rate volatility in third-party countries. Effective trade policies must be developed with careful consideration of the unique traits and dynamics of each trading partner. Asymmetrical effects on China's exports

might result from short-term exchange rate movements, so it is crucial to track and analyze them. Consideration should be given to counteracting negative effects and fostering stability through targeted support and hedging tactics.

Long-term policymakers should also concentrate on comprehending the fundamental causes of the asymmetrical effects seen in Korea and the United Kingdom. It is crucial to increase trade competitiveness and resilience in these areas through long-term alliances, agreements, and diversification initiatives. Overall, while making judgments or developing trade policies, decision-makers must take into account the impact of considerable variations in third-country exchange rate volatility. Policymakers can successfully manage the difficulties presented by fluctuations in currency exchange rates by taking a holistic strategy that takes into account both internal and external influences.

References

Aftab, M., Hussain, Z., Ahmed, I., & Ahmed, S. (2012). Impact of exchange rate volatility on exports: a case study of Pakistan. *Journal of Basic and Applied Scientific Research*, 2(2), 1616-1622.

Ali, W., Gohar, R., Chang, B. H., & Wong, W. K. (2022). Revisiting the impacts of globalization, renewable energy consumption, and economic growth on environmental quality in South Asia. *Advances in Decision Sciences*, *26*(3), 78-98.

Arize, A. C., Osang, T., & Slottje, D. J. (2008). Exchange-rate volatility in Latin America and its impact on foreign trade. *International Review of Economics & Finance*, *17*(1), 33-44.

Bahmani-Oskooee, M., & Aftab, M. (2017). On the asymmetric effects of exchange rate volatility on trade flows: New evidence from US-Malaysia trade at the industry level. *Economic Modelling*, 63, 86-103.

Bahmani-Oskooee, M., & Xu, J. (2012). Impact of exchange rate volatility on commodity trade between US and China: is there a third country effect. *Journal of Economics and Finance*, 36, 555-586.

Baek, J. S. (2014). Exchange rate volatility and Korean exports to China. *Journal of the Korean Economy*, 15(1), 67-84.

Broll, U., & Eckwert, B. (1999). The costs of hedging risks arising from foreign currency debt. *Journal of International Money and Finance*, 18(2), 151-167.

Chang, B. H., Gohar, R., Derindag, O. F., & Uche, E. (2022a). COVID-19, lockdown measures and their impact on food and healthcare prices: empirical evidence using a dynamic ARDL model. *Journal of Economic Studies*, (ahead-of-print).

Chang, B. H., Derindag, O. F., Hacievliyagil, N., & Canakci, M. (2022b). Exchange rate response to economic policy uncertainty: evidence beyond asymmetry. *Humanities and Social Sciences Communications*, *9*(1), 1-14.

Chang, B. H., and Rajput, S. K. O. (2018). Do the changes in macroeconomic variables have a symmetric or asymmetric effect on stock prices? Evidence from Pakistan. *South Asian Journal of Business Studies*, *7*(3), 312-331.

Chang, B. H., Meo, M. S., Syed, Q. R., & Abro, Z. (2019a). Dynamic analysis of the relationship between stock prices and macroeconomic variables. *South Asian Journal of Business Studies*, *8*(3), 229-245.

Chang, B. H., Rajput, S. K. O., and Bhutto, N. A. (2020a). The asymmetric effect of extreme changes in the exchange rate volatility on the US imports: Evidence from multiple threshold nonlinear ARDL model. *Studies in economics and finance*

Chang, B. H., Sharif, A., Aman, A., Suki, N. M., Salman, A., and Khan, S. A. R. (2020b). The asymmetric effects of oil price on sectoral Islamic stocks: New evidence from quantile-on-quantile regression approach. *Resources Policy*, 65, 101571.

Chang, B. H., Rajput, S. K. O., Ahmed, P., & Hayat, Z. (2020c). Does Gold Act as a Hedge or a Safe Haven? Evidence from Pakistan. *The Pakistan Development Review*, 59(1), 69-80.

Chang, B. H. (2020). Oil prices and E7 stock prices: an asymmetric evidence using multiple threshold nonlinear ARDL model. *Environmental Science and Pollution Research*, 1-12.

Chang, B. H., Rajput, S. K. O., & Bhutto, N. A. (2019b). Impact of exchange rate volatility on the US exports: a new evidence from multiple threshold nonlinear ARDL model. *Journal of International Commerce, Economics and Policy*, *10*(02), 1950009.

Chang, B. H., Rajput, S. K. O., and Ghumro, N. H. (2018). Asymmetric impact of exchange rate changes on the trade balance: Does global financial crisis matter? *Annals of Financial Economics*, 1850015.

Chiang, T. C., Qiao, Z., & Wong, W. K. (2010). New evidence on the relation between return volatility and trading volume. *Journal of Forecasting*, *29*(5), 502-515.

Cui, M., Wong, W. K., Wisetsri, W., Mabrouk, F., Muda, I., Li, Z., & Hassan, M. (2023). Do oil, gold and metallic price volatilities prove gold as a safe haven during COVID-19 pandemic? Novel evidence from COVID-19 data. *Resources policy*, *80*, 103133.

Cushman, D. O. (1986). Has exchange risk depressed international trade? The impact of third-country exchange risk. *Journal of international Money and Finance*, 5(3), 361-379.

Clark, P. B. (1973). Uncertainty, exchange risk, and the level of international trade. *Economic Inquiry*, 11(3), 302-313.

Chi, J., & Chang, C. (2016). Exchange rate volatility and Taiwan's exports to China: A dynamic relationship. *China Economic Review*, 38, 73-85.

Dash, S., Parida, P., Sahu, G., & Khalaf, O. I. (2023). Artificial Intelligence Models for Blockchain-Based Intelligent Networks Systems: Concepts, Methodologies, Tools, and Applications. I*n Handbook of Research on Quantum Computing for Smart Environments* (pp. 343-363). IGI Global.

Derindag, O. F., Chang, B. H., Gohar, R., & Salman, A. (2022). Exchange Rate Effect on the Household Consumption in BRICST Countries: Evidence from MATNARDL Model. *Journal of International Commerce, Economics and Policy*, 2250010.

Derindag, O. F., Chang, B. H., Gohar, R., Wong, W. K., & Bhutto, N. A. (2023). Food prices response to global and national factors: Evidence beyond asymmetry. *Cogent Economics & Finance*, *11*(1), 2187128.

Gohar, R., Bagadeem, S., Chang, B. H., & Zong, M. (2022a). Do The Income And Price Changes Affect Consumption In The Emerging 7 Countries? Empirical Evidence Using Quantile ARDL Model. *Annals of Financial Economics*, 17(04), 2250024.

Gohar, R., Bhatty, K., Osman, M., Wong, W. K., & Chang, B. H. (2022b). Oil prices and sectorial stock indices of Pakistan: Empirical evidence using bootstrap ARDL model. *Advances in Decision Sciences*, 26(4), 1-27.

Gohar, R., Salman, A., Uche, E., Derindag, O. F., & Chang, B. H. (2023). Does US infectious disease equity market volatility index predict G7 stock returns? Evidence beyond symmetry. *Annals of Financial Economics*, *18*(02), 2250028.

Gohar, R., Chang, B. H., Derindag, O. F., & Abro, Z. (2022c) Nexus between Consumption, Income, and Price Changes: Asymmetric Evidence from NARDL Model. *ETIKONOMI*, *21*(2), 213-228.

Gohar, R., Osman, M., Uche, E., Auxilia, P. M., & Chang, B. H. (2022d). The economic policy uncertainty extreme dynamics and its effect on the exchange rate. *Global Economy Journal*, *22*(03), 2350006.

Hashmi, S. M., & Chang, B. H. (2021) Asymmetric effect of macroeconomic variables on the emerging stock indices: A quantile ARDL approach. *International Journal of Finance & Economics.* https://doi.org/10.1002/ijfe.2461.

Hashmi, S. M., Chang, B. H., & Shahbaz, M. (2021b). Asymmetric effect of exchange rate volatility on India's cross-border trade: Evidence from global financial crisis and multiple threshold nonlinear autoregressive distributed lag model. *Australian Economic Papers*, *60*(1), 64-97.

Hashmi, S.M., Chang, B.H. and Rong, L. (2021b). Asymmetric effect of COVID-19 pandemic on E7 stock indices: Evidence from quantile-on-quantile regression approach. *Research in International Business and Finance*, *58*, p.101485.

Hashmi, S. M., Chang, B. H., Huang, L., & Uche, E. (2022). Revisiting the relationship between oil prices, exchange rate, and stock prices: An application of quantile ARDL model. *Resources Policy*, *75*, 102543.

Mordecki, G., & Miranda, R. (2019). Real exchange rate volatility and exports: A study for four selected commodity exporting countries. *Panoeconomicus*, 66(4), 411-437.

Maydybura, A., Gohar, R., Salman, A., Wong, W. K., & Chang, B. H. (2022). The Asymmetric Effect of the Extreme Changes in the Economic Policy Uncertainty on the Exchange Rates: Evidence from Emerging Seven Countries. *Annals of Financial Economics*, 2250031.

Noman, M., Maydybura, A., Channa, K. A., Wong, W. K., & Chang, B. H. (2023). Impact of cashless bank payments on economic growth: Evidence from G7 countries. *Advances in Decision Sciences*, *27*(1), 1-22.

Nishimura, Y., & Hirayama, K. (2013). Exchange rate volatility and trade flows: Evidence from China and Japan. *China Economic Review*, 27, 162-173.

Obstfeld, M., & Rogoff, K. (1998). Risk and exchange rates. NBER Working Paper, (6694).

am, K., Liu, T., & Wong, W. K. (2010). A pseudo-Bayesian model in financial decision making with implications to market volatility, under-and overreaction. *European Journal of Operational Research*, *203*(1), 166-175.

Lv, Z. H., Chu, A. M. Y., Wong, W. K., & Chiang, T. C. (2021). The maximum-return-and-minimum-volatility effect: Evidence from including both Health Care and Treasure-Bill in the portfolio. *Risk Management*, *23*(1), 97-122.

Peng, B., Chang, B. H., Yang, L., & Zhu, C. (2022). Exchange rate and energy demand in G7 countries: Fresh insights from Quantile ARDL model. *Energy Strategy Reviews*, *44*, 100986.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326.

Pino, G., Felice, G., & Guida, P. (2016). Exchange rate volatility and exports: new empirical evidence from selected European countries. International *Journal of Economic Sciences*, 5(1), 1-14.

Tang, J., Sriboonchitta, S., Ramos, V., & Wong, W. K. (2016). Modelling dependence between tourism demand and exchange rate using the copula-based GARCH model. *Current Issues in Tourism*, *19*(9), 876-894.

Soleymani, A., Chua, S. Y., & Hamat, A. F. C. (2017). Exchange rate volatility and ASEAN-4's trade flows: is there a third country effect?. *International Economics and Economic Policy, 14*, 91-117.

Saidu, M. A., Abdulsalam, R., & Lawal, A. I. (2013). Impact of exchange rate volatility on Nigeria's export. *IOSR Journal of Humanities and Social Science*, 11(6), 39-45.

Serenis, D., & Tsounis, N. (2013). The impact of exchange rate volatility on trade flows: New evidence from selected EU countries. *International Journal of Economics and Financial Issues*, 3(1), 214-225.

Sharma, C., & Pal, D. (2018). Exchange rate volatility and India's cross-border trade: A pooled mean group and nonlinear cointegrationcointegration approach. *Economic Modelling*, 74, 230-246.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegrationcointegration and dynamic multipliers in a nonlinear ARDL framework. *Festschrift in honor of Peter Schmidt: Econometric methods and applications*, 281-314.

Syed, Q. R., Malik, W. S., & Chang, B. H. (2019). Volatility Spillover Effect of Federal Reserve'S Balance Sheet On The Financial And Goods Markets Of Indo-Pak Region. *Annals of Financial Economics*, *14*(03), 1950015.

Uche, E., Chang, B. H., & Effiom, L. (2022a) Household consumption and exchange rate extreme dynamics: Multiple asymmetric threshold nonlinear autoregressive distributed lag model perspective. *International Journal of Finance & Economics*.

Uche, E., Chang, B. H., & Gohar, R. (2022b). Consumption optimization in G7 countries: Evidence of heterogeneous asymmetry in income and price differentials. *Journal of International Commerce, Economics and Policy*, 13(1), 2250002.

Umaru, A., Sa'idu, B. M., & Musa, S. (2013). An empirical analysis of exchange rate volatility on export trade in a developing economy. *Journal of emerging trends in economics and management sciences*, 4(1), 42-53.

Verheyen, F. (2013). Exchange rate pass-through, nonlinear adjustment and inflation: empirical evidence from a highly inflationary country. *Applied Economics*, 45(29), 4121-4132.

Viaene, J. M., & De Vries, C. G. (1992). International trade and exchange rate volatility. *European Economic Review*, 36(6), 1311-1321.

Wang, X., Chang, B. H., Uche, E., & Zhao, Q. (2022). The asymmetric effect of income and price changes on the consumption expenditures: evidence from G7 countries using nonlinear bounds testing approach. *Portuguese Economic Journal*, 1-19.

Xue, X., Poonia, M., Abdulsahib, G. M., Bajaj, R. K., Khalaf, O. I., Dhumras, H., & Shukla, V. (2023a). On Cohesive Fuzzy Sets, Operations and Properties with Applications in Electromagnetic Signals and Solar Activities. *Symmetry*, *15*(3), 595.

Xue, X., Marappan, R., Raju, S. K., Raghavan, R., Rajan, R., Khalaf, O. I., & Abdulsahib, G. M. (2023b). Modelling and Analysis of Hybrid Transformation for Lossless Big Medical Image Compression. *Bioengineering*, *10*(3), 333.

Xue, X., Chinnaperumal, S., Abdulsahib, G. M., Manyam, R. R., Marappan, R., Raju, S. K., & Khalaf, O. I. (2023c). Design and Analysis of a Deep Learning Ensemble Framework Model for the Detection of COVID-19 and Pneumonia Using Large-Scale CT Scan and X-ray Image Datasets. *Bioengineering*, *10*(3), 363.

Xue, X., Shanmugam, R., Palanisamy, S., Khalaf, O. I., Selvaraj, D., & Abdulsahib, G. M. (2023). A hybrid cross layer with harris-hawk-optimization-based efficient routing for wireless sensor networks. *Symmetry*, *15*(2), 438.