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Exchange rate behaviour in ASEAN countries – a sensitivity analysis

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Aim: The study examined the behavior of exchange rate in ASEAN countries. This was highly necessitated in order to account for the structural break in the data set occasioned by global financial crisis.

Research method: The quantile regression sensitivity analysis was performed on daily series of exchange rate volatility for 8 ASEAN countries having divided our sample into two, before and after the financial crisis eras. Periods of low market volatility (2001–2006 plus 2010–2017) and high market volatility (1990–2000, 2007–2009, plus 2018–2023) correlate to the periods before and after the financial crisis, respectively.

Findings: The empirical finding going forward is that since the global financial crisis took effect, exchange rate volatility has not been effectively curtailed by the governments and monetary authorizes of ASEAN countries especially in Thailand, Malaysia, Indonesia and Vietnam respectively. There is therefore the need for a policy fight in favour of stability of the currency exchange rates.

Originality: The originality of the research resides with the sensitivity analysis which validates the presence of high persistence in the volatility of the Thai Baht exchange rate throughout the quantiles. This was followed on by the high persistence in the exchange rate of the Malaysian ringgit which began at the 70th quantile in the pre-financial crisis period with a persistence value of 1.0097 as against the 30th quantile in the post-financial crisis estimations with a persistence value of 1.0387. The Indonesian Rupiah and Vietnamese dong took turns as regards volatility persistence. We also found significant ARCH effect which instigated further estimations of the GARCH and FIGARCH models as robustness checks.

Contributions: With the GARCH results, the study contributed to establishing persistence of volatility in the exchange rates of all ASEAN countries in our sample, with varying degrees and this could be attributed instabilities in the economies. Explicitly, the significance of the FIGARCH coefficient confirms the persistence of volatility over time with considerable long-term memory effect. This implies that once the exchange rate becomes volatile, such volatility last long, influencing future volatility levels noticeably in all the countries. Exchange rate volatility persistence of the Singapore Dollar was very low.

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1. Introduction

Exchange rate, being the value of one currency for the conversion to another, is influenced by numerous factors such as inflation, interest rates, oil price variation, growth of money in circulation, and income growth rate etc. (Umoru, Abugewa-Ejegi, Effiong 2023; Umoru, Akpoviroro, Effiong 2023). The study aimed at evaluating the behaviour of exchange rate in ASEAN countries. The members of the Association of Southeast Asian Nations (ASEAN) covered in this research include Indonesia, Singapore, Philippines, Thailand, Vietnam, Cambodia, Myanmar, and Malaysia. Price and exchange rate stability is the core objective of the monetary authorities of these countries. Indonesia central bank operates a free floating exchange rate regime. Hence, Indonesia rupiah exchange rate is strongly swayed by capital flows and exports earnings. The monetary policy framework of Singapore is exchange rate-centered. The Singapore dollar is regulated against a basket of currencies whose composition is reviewed occasionally in order to accommodate changes in trade patterns. The trade-weighted exchange rate fluctuates within a policy band that is fixed nearby a targeted level and a given appreciation rate. The policy adjustments to the parameters of the exchange rate band are announced every three months. The Philippine government implements the floating exchange rate system for the Philippine Peso. Accordingly, anytime foreign shocks disturb the domestic economy, the flexible peso exchange rate serves as an automatic stabilizer that regulates and provides a restoration to macroeconomic balance. The Bank of Thailand operates a managed float exchange rate system whereby market mechanism fixes the value of the Thai baht while the Bank of Thailand intervenes when the Thai baht exchange rate is extremely volatile.

The government of Vietnam operates two exchange rate policies, namely, “following” the market and “unifying” the market. In Cambodia, volatility in the exchange rate, the National Bank of Cambodia (NBC) committee meets to strategize to bring the exchange rate back within range. Currently, the Central Bank of Myanmar

(CBM) issues daily official parallel FX rates having aggregated transactions reported by commercial banks to the online forex trading platform. The exchange rates are accessible and the CBM upholds control over the rates used in these transactions. In Malaysia, the Bank Negara Malaysia (BNM) operates a floating exchange rate system since 2016. The BNM permitted exporters to exchange 75% of their proceeds into the ringgit, while 25% of the proceeds are retained in foreign currency. This practice relaxed forex hedging restrictions and created some liberalization measures which has amplified the volatility of the Malaysian ringgit because huge flexibility is allowed for exporters. The behavior of the exchange rates of ASEAN currencies is of policy significance because financial traders and marketers can rightly predict the performance of the foreign exchange market in ASEAN countries and factor in the volatility of the exchange rate when making investment decisions. As a result, these investors are guided in their decision-making. Overall, the research findings are relevant in that they provide policy guidelines to asset portfolio decision-makers and forex traders in the ASEAN financial markets. In summary, the stability of the exchange rates of all ASEAN currencies relative to foreign currencies is essential in order to achieve and maintain price stability and stability in the financial market. The study is of immense value to policymakers who stand to benefit profoundly from policy findings as regards the formulation of effective regulatory policies; ideas into how digital currencies interact with traditional economic indicators can guide the development of regulatory frameworks that foster innovation while mitigating potential risks. Policymakers can use the findings to design measures that promote financial stability and ensure the responsible integration of forex markets within the broader economic landscape of all ASEAN nations. The next section reviews related and relevant literature. Section three discusses the research methodology, while section four discusses the results and policy implications. The study concludes with section five.

2. Literature review

Kipkorir & Mutai (2024) focused on the influence of commodity price fluctuations on the behavior of the Kenyan Shilling against major currencies from 2015 to 2023. The study sourced its exchange rate and commodity price data from the Central Bank of Kenya and global commodity exchanges. Employing VECM, the research aimed to uncover how global changes in commodity prices, especially tea and coffee, impact the exchange rate. The findings indicated a significant and lasting impact of commodity price volatility on the exchange rate, with a significance level less than 0.05. Long-term analysis showed a slow adjustment to equilibrium, with an annual speed of 3.7%, reflecting the protracted effect of commodity price changes on the currency. The study suggest that Kenya's central bank should enhance its monitoring of commodity markets and potentially engage in futures contracts to hedge against predictable fluctuations in currency values. Okonkwo & Mbekeani (2023) investigated the behavioral patterns of the Rand against the US Dollar during periods of political instability from 2010 to 2022. Using exchange rate data from the South African Reserve Bank, the study utilized a combination of unit root tests to ensure data stationarity and co-integration analysis to establish relationships, followed by a VECM to estimate the dynamics. The research found that political instability leads to significant volatility in the Rand, with exchange rate movements showing heightened sensitivity during election cycles and major political announcements. The significance level for these fluctuations was found to be below 0.05, indicating a strong relationship. The study also revealed that this relationship persists in the long run, with a speed of adjustment to equilibrium of 5.4% annually. In the short run, each 1% increase in political instability could lead to approximately a 0.12% increase in exchange rate volatility. The study recommended that policymakers and investors consider the timing of political events when assessing currency risk, suggesting that strategic currency management could mitigate the adverse effects on the Rand.

Djouakaa et al. (2023) examined real effective exchange rate causes. Their results demonstrated that money supply; direct investment, inflation, imports and interest rate are the main determinants of the real effective exchange rate in the franc zone after using the Driscol-Kraay method on panel data. Also, the use of the Panel Corrected

Standard Error method also revealed the same results. In addition, the analysis of the specificities of the 15 Franc Zone countries made it achievable to take into account the heterogeneity of the panel. As a result, the central banks of each of the 15 Franc Zone countries must incorporate the consequences of the rate of exchange when formulating their monetary policies. Moreover, each government, when formulating its macroeconomic policy, must take into account the repercussions of the exchange market. Aizenman et al. (2023) investigated the link between RER behaviour and international reserve in the era of financial integration. They utilized nonlinear regressions and panel threshold regressions techniques to determine whether international reserve is a determinant of real exchange rate. Their study covered over 110 countries making use of panel data from 2001-2020. Some of the countries include Algeria, Botswana, Brazil, Guinea, Honduras, Hungary, Guinea, Honduras, Hungary and others. The findings show that term of trade shocks had significant on real exchange rate. The results also indicate that countries with intermediate levels of financial development will have a more powerful buffer.

The study conducted in SSA nations with a focus on the oil-importing and exporting nations by Korley & Giouvris (2022) evaluated the influence of oil price and oil volatility index on the exchange rate. Their study employed quantile regression and Markov switching models to evaluate their joint effect and showed that oil volatility considerably influenced the exchange rate of all countries. They established that the rising and falling oil prices leads the local currency to devalue or appreciate. They submitted that exchange rates respond to oil price and oil volatility mostly at lower quantiles for all countries which indicates the sensitivity of investors to risks and returns. Bangura et al. (2021) aimed to investigate the behavior of the Leone/US dollar exchange rate based on the influence of global oil price shocks in Sierra Leone throughout the post-war period from June 2002 to May 2020. Among the three estimated models, the EGARCH (1, 1) model emerged as the most suitable fit, with all mean and variance coefficients deemed significant. The empirical findings indicated that a rise in oil prices corresponded to a depreciation of the exchange rate in Sierra Leone amongst others.

Raksong & Sombatthira (2021) reported a positive impact on the REER of the ASEAN countries by some variables which include the ratio of FDI to GDP and government spending. Trade opening also had a substantial positive impact on REER in all the ASEAN countries studied except Vietnam while terms of trade had significant impact on REER in Malaysia, Philippines and Indonesia. Foreign direct investment also had significant impact on REER, but only in Vietnam. International reserve was shown to have long-run impact on REER in Malaysia, Thailand and Vietnam. Ani & Mashood (2021) undertook a comprehensive analysis to evaluate the behaviour of real exchange rate (RER) in Nigeria over a sample size of 60 years from the period of 1960-2020. The study utilized a multivariate co-integration test, he ADF and KPSS stationarity test as well as the VECM to analyze the data set. The result of the stationarity test showed that the macroeconomic variable under study had no stochastic trends and were stationery at all levels while the result of the Granger causality test showed that real GDP growth rate, inflation rate, money supply growth rate and government expenditure exerted significant influence on real exchange rate behavior.

Damayanthi & Gunawardhana (2021) analyzed the behavior of the real effective exchange rate in Sri Lanka with a direct linkage to external sector stability, sampling data from the period from 2010 to 2019. The research employed the vector auto regression (VAR) model as an analytical tool. The results of the study revealed that exchange rate behaved as theoretically expected with changes in policy rates of United States. Although, behavior of inflation, domestic interest rates and net exports were contrary to theoretical expectations. The findings show that even though domestic currency depreciation may lead to increased net exports, Sri Lanka, being a net importing economy, had suffered further depreciation of its domestic currency. Kalaj & Golemi (2020) focused their study on the bases for real exchange rate behaviour in Albania; sing the VAR model to assess data for the period of 1995-2015. The study aims to find the long run relationship among variables. The findings suggest that real exchange rate behavior can be decreased by increasing fiscal policies and decreasing monetary policies. Findings from the study also indicated a long-run relationship between real exchange rate behavior and trade.

Romo & Gallardo (2020) explored the bases for the behavior of RER behavior, particularly analyzing the effect of share of wages in output on RER. The study modeled the behavior RER of the domestic currencies of three countries: Mexico, Korea and France against the US dollar. The econometric technique, VAR model, was specified to find the long-run associations of the RER for each country. The results show that, for each country, there was a negative relationship between the RER and wage share. Findings also showed that Real Exchange Rate is positively related with labor productivity in France and Korea, but inversely related in Mexico. An explanation as to why RER tended to return to the long run normal value was also given. To Kahsay & Patena (2020), estimates from vector error correction models (VECMs) and vector autoregression models (VARs) indicate that the REER responds minimally to changes in fundamentals, with small and delayed responses. Three factors are proposed to have contributed to this minimal response: labor market conditions, price management, and remittance outflows. The policy implications suggest that labor market reforms, price liberalization, and policies encouraging domestic investment could improve the REER's response to economic fundamentals. Hien et al. (2020) undertook a comprehensive analysis on how huge amounts of remittance can have an effect on a country's Real Exchange Rate (RER) behavior, thereby causing the Dutch disease. The study focused on countries which receive a quite high value of remittances, specifically on 32 Asian developing countries. Using data covering the period from 2006 to 2016, the S-GMM for the linear dynamic panel data (DPD) was used to analyze the relationship between REER and remittances. The findings show that as per capita remittances increases by 1 percent, REER increases by 0.103 percent, signifying the existence of the Dutch disease. The results further indicated that in countries with low remittance to Gross Domestic Product, remittances results in REER appreciation while for countries having a ratio higher than 1 percent, higher remittances results in real effective exchange rate appreciation. Moreover, the study corroborates other findings why postulate that a flexible exchange rate regime leads to the dampening of the appreciation of the REER caused by increased remittances.

Hassan et al. (2020) did a study for 22 OECD countries. The fixed effect model was the estimated technique used to analyze the panel data covering the period 1980-2015. Their research amongst other results, reveals that countries with a large share of a working population tend to have an appreciating effect on the RER because increase in the working age population leads to an increase in the marginal product of capital which increases foreign direct investment thereby causing an increase in capital inflow. The terms of trade also had a significant effect on RER. The implications of the findings suggest that for developing countries experiencing a rapid aging population, there will be a negative effect on their international competitiveness due to RER appreciation. To counter this, the government of these countries will have to adopt a policy of saving more for the future by increasing the effective retirement age or through an increase in budget surplus.

After reviewing the literature, a gap is found: many scholars have not felt the need to conduct an empirical investigation into the behavior of ASEAN currency exchange rates within the context of a sensitivity analysis that considers financial crisis periods. Sensitivity analysis receives empirical focus in this study. Thus, trustworthy conclusions that direct the decision-making process regarding firms, investments, and the entire economy are reached by assessing the sensitivity of our data on the currency exchange rates of ASEEAN nations with respect to times of high and low volatility. Sensitivity analysis of this kind offers factual proof of the validity of study conclusions about the behavior of exchange rates in ASEAN nations. The current study focused on the ASEAN countries of Malaysia, Indonesia, Singapore, the Philippines, Thailand, Vietnam, Cambodia, Myanmar, and Vietnam.

3. Methodology

To analyze the behavior of exchange rates in ASEAN countries, we estimated quantile regression analysis on the daily series of exchange rate volatility for 8 ASEAN countries using daily data. This was highly necessitated in order to control for the structural break in the data set caused by global financial crisis. Within the scope of this research, 1990 to 2023, the following phases of structural breaks are discernible. The period from 1990 to 1991 witnessed low market volatility due to political stability that existed across countries, fiscal discipline on the part of the governments, absence of terrorism, etc. The period of 1990 to 2000 was a period of high market volatility due to Harshad Mehta Scam of 1992 in Indian that crashed the stock market and Asian tiger Financial crisis of 1997-1998 which led to the collapse of the Thai baht, the baht was floated resulting in a huge devaluation that spread to much of East Asia, also hitting Japan, as well as a huge rise in debt-to-GDP ratios. The period, 2001 to 2006 was characterized by low market volatility. This was occasioned by the fairly stable global exchange rate regime, global peace, and unified exchange rate system. The period, 2007 to 2009 saw high market volatility due to global financial crisis which expanded into a global banking crisis following the catastrophe collapse of investment bank Lehman Brothers in September 2008, stock market crashes, credit crunches, the bursting of financial bubbles, sovereign defaults, and global liquidity/currency crises etc. The period, 2010 to 2017 was branded by low market volatility as a result of global political stability and stability in prices of oil but individual economics had peculiar issues to deal with. The period, 2018 to 2023 was a period of high market volatility due to Russian-Ukraine war, US-China trade war, unrest from middle east, sustained global terrorism and outbreak of diseases, namely, the covid-19 pandemic and the fact that each country had to tackle other endogeneous issues. Hence, we divided our sample into two, namely, the pre-financial crisis sample and the post-financial crisis sample. This yielded a sensitivity analysis that provided evidence of the robustness of our regression estimates for exchange rate volatility persistence in ASEAN countries, namely, Indonesia, Singapore, Philippines, Thailand, Vietnam, Cambodia, Myanmar, and Malaysia. Accordingly, by deploying the quantile regression methodology to conduct the sensitivity analysis of the persistence in the volatility of exchange rate for the different countries in our sample across different quantiles, we contributed to empirical knowledge on exchange rate volatility persistence. Following the works of Benoit & Van Der Poel (2009), we specify the quantile autoregressive equation for exchange rate persistence by the p-th order AR process with random coefficient as in equation (1):

$$NEXC_t = \beta_0(\phi_t) + \beta_1(\phi_t)NEXC_{t-1} + \ldots + \beta_p(\phi_t)NEXC_{t-p} \quad (1)$$

Where β_i's are unknown parameters and (ϕ_t) is a sequence of independently distributed uniform random variables. From regression (1), the nominal exchange rate persistence (ρ) was measured as the sum of autoregressive coefficients (SARC). The standard SARC exchange rate persistence model is specified as follows:

$$\Delta NEXC_t = \varphi + \sum_{i=1}^{q-1} \beta_i NEXC_{t-i} + (\rho - 1) NEXC_{t-1} + v_t \quad (2)$$

By equation (2), changes in the nominal exchange rate can be calculated as in equation (3):

$$\Delta NEXC_t = NEXC_t - NEXC_{t-1} \tag{3}$$

Making provision for intercept and trend terms in the SARC equation (2), we have as follows:

$$NEXC_t = \varphi + \phi_t + \rho NEXC_{t-1} + \sum_{i=1}^{q-1} \beta_i \Delta NEXC_{t-i} + (\rho - 1) NEXC_{t-1} + v_t \tag{4}$$

Accordingly, based on the SARC methodology, the exchange rate persistence could further be represented mathematically as:

$$\rho = \beta_1 + \beta_2 + ... + \beta_p = \sum_i^n \beta_p \tag{5}$$

Expressing the τth conditional quantile function as a function of $NEXC_t$ from equation (5), we have:

$$Q_{NEXCt}\,(\tau/S_{t-1}) = \beta_0(\tau) + \beta_1(\tau)NEXC_{t-1} + \ldots\ \beta(\tau)NEXC_{t-p} \tag{6}$$

Since $Q_{NEXCt}\,(\tau/S_{t-1})$ is the conditional distribution function, equation (6) becomes the baseline quantile autoregressive (p) model of exchange rate persistence. Our vector of predictor variables is constructed as:

$$Z_t = (1, NEXC_{t-1}, NEXC_{t-2} \ldots, NEXC_{t-p}), \tag{7}$$

Hence, the quantile autoregressive (p) model of exchange rate persistence can be specified as:

$$NEXC_t = Q_{NEXCt}(\tau/S_{t-1}) + e_t = Z_t'\beta_\tau + e_t \tag{8}$$

Where β_τ is the autoregressive quantiles and its estimate is given by:

$$\beta_\tau^* = \arg_{\beta \in R} \min_\psi \sum_{t=1}^{T} \rho_\tau (NEXC_t - Z_t'\beta) \tag{9}$$

The quantile loss function is defined as:

$$\rho_\tau(NEXC_t) = NEXC_t[\tau - I(v < 0)] \tag{10}$$

The linear function of parameters is characterized in equation (9). For the investigation of persistence in the exchange rate, volatility in the exchange rate is adjudged persistent if $\rho \geq 1$. In effect, a higher sum of AR coefficients signifies high volatility persistence. In addition to the quantile regression estimations, we further tested for the ARCH effect and thereafter embarked on the estimation of the GARCH/FIGARCH model estimations. The ARCH model based on the maximum likelihood estimation approach, specifically an ML ARCH model with a normal distribution, which optimizes the coefficients using BFGS/Marquardt steps. The significance of the ARCH effect guaranteed further estimations using the FIGARCH model. Estimating financial models using both quantile and FIGARCH-DCC methods involves navigating the complexities of conditional quantile and dynamic correlations. In quantile Regression, various quantile of the response variable is modeled, offering flexibility in handling non-normally distributed data. The estimation process involves minimizing weighted absolute deviations through optimization algorithms. FIGARCH-DCC, combining Fractionally Integrated GARCH for volatility and Dynamic Conditional Correlation for inter-asset correlations, requires careful parameter estimation. The models can be integrated through joint or sequential estimation, with considerations for computational intensity and model diagnostics. In the joint estimation approach, parameters of both quantile regression and FIGARCH-DCC are estimated simultaneously, demanding specialized software and computational resources. Alternatively, in sequential estimation, FIGARCH-DCC parameters are estimated. The daily exchange rate data that spanned the period from January 1, 1990 to December 30, 2023 plus weekends and holidays were utilized in this research. The before and after the financial crisis periods correspond to periods of low market volatility (2001–2006 plus 2010–2017) and high market volatility (1990–2000, 2007–2009, plus 2018–2023), respectively. Data on the 8 ASEAN countries, namely, Indonesia, Singapore, Philippines, Thailand, Vietnam, Cambodia, Myanmar, and Malaysia were sourced from databases of the World Trade Organization and World Bank.

4. Results

This section deals with the presentation of results, analysis and interpretation of the results. As a robustness check, we further estimated persistence in the volatility of exchange rate across different quantiles for the currency exchange rates of all the countries using the quantile regression algorithm. Table 1 reports the quantile results for exchange rate volatility persistence before the global financial crisis while Table 2 provided the quantile results for persistence in the volatility of exchange rate. The most striking result was that obtained for Thailand where exchange rate volatility persistence exceeded unity for both samples. This implies high persistence in the volatility of Thai Baht exchange rate. This was followed by the high persistence in the exchange rate of the Malaysian ringgit which began at the 70th quantile in the pre-financial crisis period with a value of 1.0097 as against the 30th quantile in the post-financial crisis estimation with a persistence value of 1.0387. In Indonesia, exchange are volatility persistence emerges in the 80th quantile with a persistence value of 1.0163 for the pre-financial crisis era while it dropped to the 30th quantile with a persistence value of 1.0234 after the financial crisis. In Vietnam, persistence in the volatility of the exchange rate of the Vietnamese dong occurred at the 90th quantile with a coefficient of 1.0254 before the financial crisis while such persistence took effect at the 70th quantile with a value of 1.0921 after the financial crisis. Exchange rate volatility persistence was extremely low in Singapore for both periods of analysis. Thus, only the Singapore Dollar exchange rate was less volatile while the Thai Baht was the most volatile, followed by the Malaysian ringgit, Indonesian Rupiah, and Vietnamese dong. The implication of the sensitivity analysis is that since the global financial crisis took effect, exchange rate volatility has not been effectively curtailed by the governments and monetary authorizes of MENA countries especially in Thailand, Malaysia, Indonesia and Vietnam respectively.

Table 1. Quantile results for exchange rate volatility (before financial crisis)

Quantile	Indonesia	Singapore	Philippines	Thailand	Vietnam	Cambodia	Myanmar	Malaysia
Q1	0.3371	0.0594	0.2489	1.0019	0.4364	0.136	0.1386	-0.2734
Q2	0.3569	0.0601	0.2571	1.0457	0.4821	0.2573	0.1579	0.3258
Q3	0.4562	0.0696	0.27469	1.2865	0.5279	0.2846	0.2928	0.4920
Q4	0.5103	0.0718	0.38572	1.3091	0.6128	0.3509	0.3028	0.5103
Q5	0.6720	0.0790	0.44286	1.4270	0.6245	0.3610	0.4287	0.6231
Q6	0.6891	0.0712	0.50286	1.5622	0.7256	0.4928	0.5211	0.6357
Q7	0.8824	0.0832	0.6419	1.6890	0.8326	0.6192	0.6972	1.0097
Q8	1.0163	0.1795	0.8735	1.7028	0.9130	0.7355	0.8153	1.2236
Q9	1.3420	0.4026	1.0289	1.7311	1.0254	0.7392	0.8967	1.5810

Source: Authors' estimation results with Eviews 10.

Table 2. Quantile results for exchange rate volatility (after financial crisis)

Quantile	Indonesia	Singapore	Philippines	Thailand	Vietnam	Cambodia	Myanmar	Malaysia
Q1	0.5873	0.4280	0.3702	1.1389	0.55780	0.2793	0.2489	0.3485
Q2	0.6680	0.4455	0.4986	1.1472	0.5692	0.3459	0.3027	0.3690
Q3	1.0234	0.4557	0.50287	1.2350	0.6043	0.4428	0.4529	1.0387
Q4	1.0011	0.5139	0.6311	1.3347	0.6274	0.4703	0.5126	1.1374
Q5	1.2237	0.6630	1.0326	1.4655	0.7139	0.5920	0.5510	1.1520
Q6	1.2347	0.7241	1.0437	1.5609	0.7725	0.6397	0.6013	1.3292
Q7	1.4528	0.8251	1.2247	1.6234	1.0921	0.7355	0.7586	1.3379
Q8	1.5920	0.9428	1.3529	1.6235	1.5130	0.8230	0.9326	1.4261
Q9	1.6134	0.9631	1.4750	1.9352	1.6093	0.8250	0.9910	1.7250

Source: Authors' estimation results with Eviews 10.

In Table 3, the lagged value of the nominal exchange rate (*NEXC*) had a coefficient of 0.982322. This coefficient is highly significant with a z-statistic of 431.7296, suggesting that the current value of *NEXC* is heavily influenced by its immediate past value, with nearly a one-to-one relationship. The intercept (C) in the mean equation is 0.743140, also significant, indicating a consistent additive effect on the exchange rate movement per period. In the variance equation, which models the volatility (conditional heteroskedasticity) of the *NEXC*, we observe that the constant term (C) is 2.423849. This value, significantly different from zero (with a z-statistic of 53.68882), suggests a base level of variance in the *NEXC* that is quite high, reflecting inherent market volatility or economic instability. The coefficient for

RESID(-1)^2 is -0.017478, which is significant and negative (z-statistic of -42.27400). This indicates a mean-reverting volatility pattern; higher volatility in one period tends to be followed by lower volatility, a common characteristic in financial time series reflecting periods of market corrections following shocks. The significant persistence of real exchange rate and its volatility implications suggest that past values and volatility shocks have a strong predictive power on future values and volatility levels in Indonesia, respectively.

Table 3. ARCH results for Indonesia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.743140	0.128465	5.784748	0.0000
NEXC (-1)	0.982322	0.002275	431.7296	0.0000
Variance Equation				
C	2.423849	0.045146	53.68882	0.0000
resid(-1)^2	-0.017478	0.000413	-42.27400	0.0000
F=190.357(0.000)				

Source: Authors' estimation results with Eviews 10.

Table 4. ARCH results for Singapore

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.373365	0.209037	1.786120	0.0741
NEXC(-1)	0.967368	0.014555	66.46428	0.0000
Variance Equation				
C	0.608470	0.023843	25.52022	0.0000
RESID(-1)^2	-0.015426	0.006147	-2.509593	0.0121
F=572.91(0.000)				

Source: Authors' estimation results with Eviews 10.

In Table 4, the coefficient for nominal exchange rate is 0.967368, which is extremely high and significant with a z-statistic of 66.46428, pointing to a strong persistence in the exchange rate. Essentially, this suggests that the current month's exchange rate is almost a direct continuation of the previous month's rate, which indicates a stable or slowly evolving exchange rate over time. The ARCH component specifies how volatility (variance) of the real exchange rate is affected by shocks (RESID(-1)^2) from the previous period. The constant is 0.608470, indicating a base level of volatility that is significant given a z-statistic of 25.52022. The coefficient for RESID(-1)^2 is -0.015426, which is statistically significant (z=-2.509593, p=0.0121), indicating a negative relationship between past squared residuals and current volatility. This negative value suggests a mean-reverting volatility behavior of exchange rate in Singapore; periods of high volatility tend to be followed by lower volatility; a typical characteristic observed in financial markets known as the volatility clustering.

Table 5. ARCH results for Philippines

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.171417	0.187246	0.915467	0.3599
NEXC(-1)	0.979605	0.017294	56.64583	0.0000
Variance Equation				
C	0.083953	0.001614	52.01721	0.0000
RESID(-1)^2	-0.005885	0.000477	-12.32860	0.0000
F=1347.2 (0.0000)				

Source: Authors' estimation results with Eviews 10.

Table 5 shows that the coefficient for real effective exchange rate is 0.979605, which is significant at the 0.05 level. Hence, real effective exchange rate in the previous period is a strong predictor of the real effective exchange rate in the current period, with a 1 unit increase in real effective exchange rate associated with approximately a 0.98 percent increase in the current *NEXC*, holding all other variables constant. The ARCH model results suggest that the real exchange rate in Philippines exhibits time-varying volatility that can be partially captured by its own past values. This could have implications for the demand for in Philippines.

From Table 6, the coefficient for nominal exchange rate lagged one-period is extremely significant (z-statistic of 59.96873) and near unity (0.976800), pointing towards a strong autoregressive behavior where current real effective exchange rate values closely follow past values. The variance equation, which models the volatility of the real effective exchange rate, features a small but highly significant constant (C=0.030006; z-statistic of 51.68566), indicating a base level of volatility that is consistent yet relatively low, given the scale of the coefficient. This suggests that external shocks or inherent economic volatility in Thailand's market is modest but persistent over time. The ARCH model's findings shows that real effective exchange rate in Thailand exhibits predictable behavior based on its historical values, its volatility is not overly influenced by its immediate past, except in the form of mean-reversion in response to shocks. This could imply that the Thailand exchange rate is relatively stable, with inherent mechanisms that dampen the impact of large fluctuations over time, potentially reflecting effective monetary policy interventions or a stable macroeconomic environment.

Table 6. ARCH results for Thailand

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.121671	0.101827	1.194875	0.2321
NEXC(-1)	0.976800	0.016288	59.96873	0.0000
Variance Equation				
C	0.030006	0.000581	51.68566	0.0000
RESD(-1)^2	-0.006750	0.000206	-32.74471	0.0000
F=486.17(0.0000)				

Source: Authors' estimation results with Eviews 10.

Table 7. ARCH results for Vietnam

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.373365	0.209037	1.786120	0.0741
NEXC(-1)	0.967368	0.014555	66.46428	0.0000
Variance Equation				
C	0.608470	0.023843	25.52022	0.0000
RESID(-1)^2	-0.015426	0.006147	-2.509593	0.0121
F=3002.3(0.0000)				

Source: Authors' estimation results with Eviews 10.

The ARCH model results for Vietnam on Table 7 shows 0.967368 coefficient of the real effective exchange rate Lagged one period. The coefficient is highly significant (z-statistic of 66.46428) and very close to one. This indicates that the current *nexc* value is almost perfectly predictive by its previous value, reflecting strong persistence or inertia in the exchange rate. This finding implies that once the exchange rate reaches a certain level, it is likely to remain near that level in the subsequent period unless significant economic events occur. The variance equation is critical for understanding the volatility of real effective exchange rate. The constant term (C) is 0.608470, highly significant (z-statistic of 25.52022), indicating a substantive inherent volatility in the *nexc*. This reflects ongoing economic volatility in Vietnam potentially due to fluctuating commodity prices, political uncertainty, or external economic shocks.

Table 8. ARCH results for Cambodia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.095810	0.152964	0.626354	0.5311
NEXC(-1)	0.995107	0.008166	121.8662	0.0000
Variance Equation				
C	0.215612	0.005022	42.92938	0.0000
RESD(-1)^2	-0.013266	0.000340	-39.06671	0.0000
F-statistic 267.1(0.000)				

Source: Authors' estimation results with Eviews 10.

In Table 8, the ARCH results for Nigeria show Cambodia's one-period lag of *NEXC* has the coefficient of 0.995107, which is significantly high with a z-statistic of 121.8662. This suggests that the current value of real effective exchange rate is almost entirely determined by its value in the previous period, highlighting strong continuity and minimal variation from historical levels in the short term. The intercept (C) in the mean equation is 0.095810, which is not statistically significant (p=0.5311). This suggests that there are no significant mean changes in the real effective exchange rate independent of its past values, reinforcing the idea that the exchange rate's movements are predominantly influenced by its own inertia. In the variance equation, the constant term (C) is 0.215612, demonstrating a significant level of baseline volatility (z-statistic of 42.92938). This indicates a relatively high inherent volatility in the exchange rate, potentially reflecting the economic fluctuations, policy changes, or market uncertainties prevalent within Cambodia.

Table 9. ARCH results for Myanmar

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.433092	0.072750	5.953181	0.0000
NEXC(-1)	0.965299	0.005570	173.3036	0.0000
Variance Equation				
C	0.066289	0.003058	21.67919	0.0000
RESD(-1)^2	2.600196	0.909884	2.857724	0.0043
F=25461.3(0.000)				

Source: Authors' estimation results with Eviews 10.

Table 9 shows nominal exchange rate coefficient in Myanmar is 0.965299. The coefficient is highly significant with a z-statistic of 173.3036, showing that the nominal exchange rate is strongly influenced by its previous value. This coefficient nearly reaching one suggests that the exchange rate in Myanmar demonstrates substantial persistence, meaning that current nominal exchange rate values are almost a direct reflection of the previous period's values. This level of persistence can indicate stability in the currency but might also reflect a rigidity that could impede rapid adjustment to new economic conditions. The variance equation reveals the model's approach to handling volatility. The constant term (C) is 0.066289, with a very high significance level (z-statistic of 21.67919), indicating a relatively moderate baseline volatility in the exchange rate. This finding suggests that while there are fluctuations, they are not excessively volatile under normal conditions, which is favorable for economic planning and foreign trade negotiations.

Table 10. ARCH results for Malaysia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.065025	0.025872	2.513322	0.0120
NEXC(-1)	0.986980	0.004727	208.7983	0.0000
Variance Equation				
C	0.010352	0.000206	50.13430	0.0000
RESD(-1)^2	-0.010740	0.000218	-49.29567	0.0000
F-statistic=1468.92(0.000)				

Source: Authors' estimation results with Eviews 10.

From the ARCH in Table 10 above, the coefficient for one-period lag of real effective exchange rate is remarkably high at 0.986980, with an exceptionally significant z-statistic of 208.7983. This result indicates a very strong persistence in the exchange rate, suggesting that the current *nexc* is almost entirely predictable by its immediate past value. Such a high level of persistence reflects a stable exchange rate environment, where changes from one period to the next are minimal and largely anticipated. The constant term (C) in the mean equation is 0.065025, which is statistically significant (p=0.0120). This signifies that there is a small but consistent adjustment to the real effective exchange rate independent of its previous value, possibly reflecting systematic influences such as policy adjustments or long-term economic trends. In the variance equation, the constant term (C) is 0.010352, indicating a baseline level of volatility that is significant and consistent (z-statistic of 50.13430). This suggests that the underlying volatility of Malaysia's nominal exchange rate is moderate but persistent, providing a foundational level of exchange rate fluctuation that might be attributed to regular market dynamics or external economic influences.

Table 11. GARCH results for Indonesia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.745908	0.567637	1.314058	0.1888
NEXC(-1)	0.982474	0.012734	77.15495	0.0000
Variance Equation				
C	1.661573	0.066105	25.13538	0.0000
RESD(-1)^2	-0.027529	0.002027	-13.57907	0.0000
GARCH(-1)	0.564221	0.003347	168.5564	0.0000

Source: Authors' estimation results with Eviews 10.

The results of the GARCH in Table 11 shows that Indonesia nominal exchange rate with a coefficient of 0.982474, which is highly significant (z-statistic of 77.15495) indicates a very strong autoregressive characteristic, where the current real effective exchange rate is almost completely determined by its value in the previous period. This high degree of persistence suggests that the nominal exchange rate in Indonesia changes gradually over time, providing a predictable pattern based on historical values. The variance equation in the GARCH model is designed to capture the volatility of real effective exchange rate, including terms for both the RESID(-1)^2 and the lagged conditional variance (GARCH(-1)). The coefficient for RESID(-1)^2 is -0.027529, significant with a negative sign (z-statistic of -13.57907), indicating a mean-reversion of volatility. This implies that higher volatility in one period tends to be followed by reduced volatility, aligning with typical financial time series behavior where high-volatility events often stabilize over time. The GARCH(-1) coefficient is 0.564221, significantly positive (z-statistic of 168.5564), highlighting the persistence of volatility. This means that if the exchange rate was volatile in the past, it is likely to remain volatile, pointing to a sustained impact of past volatility on current volatility levels.

Table 12. GARCH results for Singapore

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.355531	0.176263	2.017048	0.0437
NEXC(-1)	0.970111	0.012316	78.76919	0.0000
Variance Equation				
C	0.086710	0.037361	2.320868	0.0203
RESD(-1)^2	-0.015018	0.001411	-10.64321	0.0000
GARCH(-1)	0.864199	0.063414	13.62782	0.0000

Source: Authors' estimation results with Eviews 10.

In Table 12, the ARCH and the GARCH coefficients for Singapore nominal exchange rate shows the significant volatility its economy has experienced due to various economic sanctions and commodity price fluctuations. The one-period lagged value of exchange rate is 0.970111, which is highly significant (z-statistic of 78.76919). This suggests that the exchange rate from one period strongly influences the rate in the subsequent period, indicating a gradual adjustment to new information and a tendency for the exchange rate to follow a smooth path over time. In the variance equation, the baseline volatility of the real effective exchange rate is captured by the constant term (C=0.086710), which is significant (p=0.0203). This suggests a foundational level of volatility inherent in the Singapore exchange rate market is influenced by economic policy uncertainty. The GARCH(-1) coefficient of 0.864199 is significantly positive, indicating that past volatility has a strong predictive power on future volatility. This high persistence in volatility suggests that shocks to the exchange rate have long-lasting effects, which could exacerbate the impact of political events on the market stability.

Table 13. GARCH results for Philippines

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.173271	0.192182	0.901599	0.3673
NEXC(-1)	0.979277	0.017725	55.24747	0.0000
Variance Equation				
C	0.037690	0.043979	0.857004	0.3914
RESD(-1)^2	-0.006025	0.001299	-4.639478	0.0000
GARCH(-1)	0.561294	0.512449	1.095317	0.2734

Source: Authors' estimation results with Eviews 10.

The GARCH results in Table 13 suggest that the current nominal exchange rate is heavily influenced by its immediate past value, reflecting a stable and predictable behaviour in the short term. This level of persistence is typical for economies with stable macroeconomic policies where the exchange rate adjusts gradually to changes. The intercept (C) of 0.173271, although not statistically significant (p=0.3673), indicates a minor constant impact on the real effective exchange rate that is not explained by its historical performance. The GARCH(-1) coefficient of 0.561294, although not significant (p=0.2734), suggests some degree of volatility persistence. This indicates that while past volatility influences current volatility, the effect is not as strong as it might be in more volatile or unstable economies. For India, the GARCH model's shows how past exchange rate levels and their volatility affect current and future rates.

The results of the GARCH result in Table 14 show that nominal exchange rate shows a high coefficient of 0.976900 with a significant z-statistic of 45.54392. This indicates that the nominal exchange rate is heavily influenced by its previous values, showcasing strong persistence. Such a high level of autoregression suggests that changes in the nominal exchange rate are gradual and predictable over short intervals, typical for an economy where exchange rates are managed within a policy framework designed to maintain stability. The intercept (C) of 0.120945, though not significant (p=0.3652), indicates a minimal baseline impact on real effective exchange rate, which is not explained merely by its lagged values. This denotes underlying macroeconomic trends or policy shifts that exert a constant but subtle influence on the real effective exchange rate. The GARCH(-1) coefficient is 0.565968, which is not significant (p=0.1795). This suggests that past volatility has a moderate influence on future volatility, this relationship is not as strong as might be seen in more freely floating currencies.

Table 14. GARCH results for Thailand

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.120945	0.133560	0.905547	0.3652
NEXC(-1)	0.976900	0.021450	45.54392	0.0000
Variance Equation				
C	0.016618	0.016093	1.032599	0.3018
RESD(-1)^2	-0.008602	0.000392	-21.95920	0.0000
GARCH(-1)	0.565968	0.421639	1.342305	0.1795

Source: Authors' estimation results with Eviews 10.

Table 15. GARCH results for Vietnam

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.355531	0.176263	2.017048	0.0437
NEXC(-1)	0.970111	0.012316	78.76919	0.0000
Variance Equation				
C	0.086710	0.037361	2.320868	0.0203
RESD(-1)^2	-0.015018	0.001411	-10.64321	0.0000
GARCH(-1)	0.864199	0.063414	13.62782	0.0000

Source: Authors' estimation results with Eviews 10.

The GARCH model results of Table 15 above for Vietnam's *NEXC* lag one period shows a coefficient of 0.970111 and a z-statistic of 78.76919, indicating extremely high statistical significance. This strong autoregressive component suggests that the *NEXC* is highly persistent, with past values being a strong predictor of future rates. Such behavior indicates a stable but slowly adjusting exchange rate environment, where changes are gradual and not abrupt, likely reflecting Vietnam's monetary policy aimed at stabilizing the exchange rate to avoid economic shocks. The variance equation of the GARCH model shows the constant term of 0.086710, significant at the 0.0203 level, indicates a foundational level of volatility inherent to the real effective exchange rate. This level of baseline volatility is influenced by external economic pressures, internal economic policy changes, or market perceptions affecting the South African economy. The GARCH(-1) term at 0.864199, significantly high (z-statistic of 13.62782), shows that past volatility has a strong and persistent influence on current volatility, indicating that volatility shocks tend to have long-lasting effects.

Table 16. GARCH results for Cambodia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.070835	0.157886	0.448649	0.6537
NEXC(-1)	0.996306	0.008428	118.2096	0.0000
Variance Equation				
C	0.074293	0.013774	5.393590	0.0000
RESD(-1)^2	-0.013525	0.002767	-4.888788	0.0000
GARCH(-1)	0.663125	0.062997	10.52629	0.0000

Source: Authors' estimation results with Eviews 10.

Table 16 reported GARCH model analysis of Nigeria's nominal exchange rate. The significant autoregressive component in the mean equation, with nominal exchange rate showing a coefficient of 0.996306 and an exceptionally high z-statistic of 118.2096, demonstrates extreme persistence. This implies that the *NEXC* is almost perfectly predicted by its value in the preceding period, suggesting that the exchange rate evolves in a highly predictable manner with little deviation from its historical path. This can be indicative of a tightly managed exchange rate system where policy interventions ensure stability and reduce unpredictability in the forex market. The GARCH(-1) term at 0.663125 (significant with a z-statistic of 10.52629) indicates that previous periods' volatility has a substantial carryover effect into current volatility. This points to a scenario where shocks to the exchange rate can have prolonged impacts, influencing future volatility levels significantly.

Table 17. GARCH results for Myanmar

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.193976	0.162216	1.195786	0.2318
NEXC(-1)	0.988742	0.009222	107.2133	0.0000
Variance Equation				
C	0.049900	0.041271	1.209101	0.2266
RESD(-1)^2	-0.012306	0.003290	-3.740106	0.0002
GARCH(-1)	0.800592	0.168963	4.738260	0.0000

Source: Authors' estimation results with Eviews 10.

Table 17 reported GARCH results and shows that the coefficient of nominal exchange rate lagged one-period is 0.988742. It is highly significant (z-statistic of 107.2133). This indicates that the *NEXC* is predominantly influenced by its value in the previous period, signifying strong continuity and predictability in exchange rate movements. Such high persistence often characterizes exchange rate systems where policy interventions aim to maintain stability or where economic conditions do not fluctuate dramatically in the short term. The GARCH(-1) term at 0.800592, with a significant z-statistic of 4.738260, reflects high volatility persistence. This finding suggests that once the nominal exchange rate exhibits volatility; such fluctuations are likely to continue into the future, emphasizing the impact of past volatility on current and future volatility levels.

The results of the GARCH in Table 18 for Malaysia show that the coefficient of one-period lagged nominal exchange rate stands at 0.986980 with a strikingly high z-statistic of 136.7875, indicating an extremely high level of persistence. This suggests that the current nominal exchange rate is almost entirely dependent on its immediate past value, reflecting a stable and predictable exchange rate behavior over the short term. This characteristic is often indicative of an economy with effective regulatory oversight where exchange rates are managed to ensure gradual adjustments rather than abrupt swings, providing stability which is crucial for international trade and investment planning. The GARCH(-1) coefficient of 0.566803, significant at the 0.0000 level, illustrates substantial volatility persistence. This indicates that volatility in one period tends to influence volatility in subsequent periods, pointing to the impact of economic news and shocks having a prolonged effect on exchange rate stability.

Table 18. GARCH results for Malaysia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.064700	0.039519	1.637168	0.1016
NEXC(-1)	0.986980	0.007215	136.7875	0.0000
Variance Equation				
C	0.006818	0.001503	4.535359	0.0000
RESD(-1)^2	-0.016333	0.003863	-4.227969	0.0000
GARCH(-1)	0.566803	0.094776	5.980442	0.0000

Source: Authors' estimation results with Eviews 10.

Table 19. FIGARCH-DCC results for Indonesia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.541758	0.006526	83.02131	0.0000
NEXC (-1)	0.988435	3.42E-05	28875.60	0.0000
Variance Equation				
C	0.912624	0.072890	12.52051	0.0000
ARCH (-1)^2	-0.150979	0.066743	-2.262107	0.0237
GARCH	0.466768	0.045760	10.20043	0.0000
d-coefficient	0.984710	0.001349	729.9555	0.0000

Source: Authors' estimation results with Eviews 10.

The FIGARCH analysis in Table 19 for Indonesia shows that this model is particularly suitable for capturing long-memory features in the volatility, indicating that shocks to the exchange rate can have persistent effects over time. The coefficient of 0.541758, significantly different from zero (p-value=0.0000), suggests a robust long-term average level around which REER oscillates. This magnitude shows a stable central tendency in nominal exchange rate fluctuations over the long run. A coefficient of 0.988435 with an extremely low standard error and zero p-value implies a high level of persistence in the nominal exchange rate. This suggests that the exchange rate tends to follow a path-dependent process where past values are a strong predictor of current values, reflecting a slow adjustment to new equilibriums. In the variance equation interpretation, the coefficient of constant is 0.912624 signifies the baseline level of volatility when other effects are absent. The significance (p=0.0000) indicates that this base level of volatility is reliably different from zero, emphasizing inherent volatility in the exchange rate. The ARCH coefficient of -1.499766 suggests a negative impact of past squared residuals on current volatility, the GARCH term (long memory) showed the value of 0.466768 confirms the persistence of volatility over time, with significant long-term memory (p=0.0000). This implies that once the exchange rate becomes volatile, this condition is likely to persist, influencing future volatility levels significantly. These results show the complex and persistent nature of volatility in Indonesia's exchange rate. They suggest that any shocks to the exchange rate, whether positive or negative, have long-lasting effects on future volatility levels.

Table 20. FIGARCH-DCC results for Singapore

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.346101	0.002014	171.8881	0.0000
NEXC(-1)	0.978616	5.63E-05	17396.15	0.0000
	Variance Equation			
C	0.022324	0.008251	2.705445	0.0068
ARCH(-1)^2	-0.187161	0.007678	-24.37756	0.0000
GARCH	0.697970	0.001073	650.7496	0.0000
d-coefficient	0.563809	0.032126	17.549928	0.0000

Source: Authors' estimation results with Eviews 10.

The FIGARCH results for Singapore in Table 20 shows that the highly significant constant term in the REER suggests a stable long-term average level for the exchange rate in the absence of new information affecting the market. The coefficient of the lagged nominal exchange rate is close to 1, indicating that past values of the *nexc* are a strong predictor of its current level. This persistence characteristic suggests that the *nexc* is highly influenced by its historical values. The constant in variance equation captures the baseline level of variance (volatility) when other terms are zero. A positive and significant indicates that there is a base level of volatility in the real effective exchange rate that is not explained by the model's other terms. ARCH Term showed negative coefficient for the ARCH term, which measures the impact of the squared residuals, is significant and suggests a negative relationship between past shocks and current volatility. This could imply a mean-reverting behavior in volatility, which might indicate that high volatility is likely to be followed by reduced volatility and vice versa. The highly significant and positive coefficient of the GARCH term confirms that volatility shocks have a long-lasting effect on future volatility. This long memory component implies that large changes in volatility can influence the nominal exchange rate volatility for a prolonged period. The presence of a long memory in volatility suggests that the Singapore foreign exchange market experiences persistent effects from shocks, which might be related to economic sanctions, oil price fluctuations, or other structural changes in the economy.

Table 21. FIGARCH-DCC results for Philippines

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.139271	3.36E-06	41432.90	0.0000
NEXC(-1)	0.983293	1.30E-07	7546266.	0.0000
	Variance Equation			
C	-1.235696	0.127089	-9.723098	0.0000
ARCH(-1)^2	-0.472782	0.055149	-8.572766	0.0000
GARCH	0.558923	0.040396	13.836150	0.0000
d-coefficient	0.678496	0.00894	75.894407	0.0000

Source: Authors' estimation results with Eviews 10.

The FIGARCH model results of Table 21 for Philippine's nominal exchange rate shows that for real effective exchange rate, signaling a high degree of persistence in the exchange rate movements. This suggests that the nominal exchange rate tends to follow a path dependent on its historical values, which is a common characteristic of financial time series data. Moving to the variance equation, The ARCH term, representing the short-term impact of past squared residuals on current volatility, is negative, which is contrary to usual findings where past volatility spikes increase current volatility. This negative value might reflect a market anomaly or an unusual market reaction to volatility where an increase in past volatility leads to a decrease in current volatility, possibly due to interventions or regulatory actions that aim to stabilize the market. The GARCH term is positive and less than one, suggesting that while shocks to volatility are persistent, they do not have a permanent effect. This term indicates the long-term persistence of volatility, showing that volatility shocks decay over time, but at a rate that is slower than in a standard GARCH model, which is indicative of the long memory feature of the FIGARCH model. The model suggests that while the nominal exchange rate is stable in the short term, there is a significant reaction to shocks, and these shocks have long-term effects in Philippines.

Table 22. FIGARCH-DCC results for Thailand

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.127196	2.3E-105	5.6E+103	0.0000
NEXC(-1)	0.971031	1.7E-104	5.9E+103	0.0000
	Variance Equation			
C	-2.149647	0.030939	-69.48056	0.0000
ARCH(-1)^2	3.114303	0.047661	65.34264	0.0000
GARCH	0.805219	0.001091	737.8327	0.0000
d-coefficient	0.95863	0.000067	14307.910	0.0000

Source: Authors' estimation results with Eviews 10.

The results of Table 22 show a complex dynamic structure of volatility related to past information and shocks. The coefficient C is significant given the reported z-statistic and probability, suggests a strong persistent component in the volatility, meaning that shocks to the exchange rate have long-lasting effects. The high z-statistic point out that the coefficients are significantly different from zero, providing strong evidence of the predictive power of the model. The value of the real exchange rate has a coefficient very close to one, which signifies that the exchange rate follows a near-random walk behavior, with past values being highly predictive of current values. The ARCH term, is positive and significantly different from zero, suggesting that past squared shocks have a direct and proportionate impact on current volatility, indicating a typical ARCH effect. GARCH term, is positive and significantly different from zero, pointing to the persistence of volatility shocks over time. This long memory component suggests that volatility can be forecasted using historical volatility data due to its persistent nature. For Thailand, this model's results imply that the exchange rate is influenced by its own past movements and that shocks to the exchange rate persist over time, with negative shocks potentially having a more significant impact on future volatility.

Table 23. FIGARCH-DCC results for Vietnam

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.346101	0.002014	171.8881	0.0000
NEXC(-1)	0.978616	5.63E-05	17396.15	0.0000
	Variance Equation			
C	0.022324	0.008251	2.705445	0.0068
ARCH (-1)^2	0.187161	0.007678	24.37756	0.0000
GARCH(-1)	0.697970	0.001073	650.7496	0.0000
d-coefficient	-0.771274	0.014928	-51.66757	0.0000

Source: Authors' estimation results with Eviews 10.

In Table 23, the constant coefficient represents the long-term average of the log-volatility process, which is statistically significant with a z-statistic of 171.8881 and a p-value of 0.0000, indicating a highly reliable estimator of the average volatility of real effective exchange rate over the sample period. The coefficient of RER(-1) near one with a very small standard error suggests that past values of real exchange rate heavily influence its current level, indicating a high level of persistence of exchange rate in Vietnam. The ARCH reflects the immediate impact of market shocks on volatility, which is negative and highly significant, suggesting a pronounced reaction of volatility to recent market changes. This point towards a heavy-tailed distribution of returns where large swings in real effective exchange rate are more common than a normal distribution would predict. The GARCH long memory component, is significantly different from zero, suggesting that shocks to the exchange rate volatility have a persistent effect that decays very slowly over time. However, for Vietnam, this mean that the exchange rate is influenced by its past values and reacts significantly to new information (represented by the ARCH term), particularly to negative market events. The presence of a long memory component suggests that these effects are not short-lived but continue to influence volatility over time. The FIGARCH results of Table 23 also allows for asymmetry in the volatility response to positive and negative shocks.

Table 24. FIGARCH-DCC results for Cambodia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000610	1.48E-05	41.15408	0.0000
NEXC(-1)	0.999964	7.83E-05	12774.77	0.0000
	Variance Equation			
C	-3.127534	2.099758	-1.489474	0.1364
ARCH(-1)^2	0.006364	0.005159	1.233598	0.2174
GARCH	0.611321	0.267444	2.285788	0.0223
d-coefficient	0.542930	0.001925	282.04155	0.0000

Source: Authors' estimation results with Eviews 10.

In Table 24, the constant (C) has a near-zero coefficient (0.000610) with a highly significant z-statistic. This indicates statistically significant intercept in the conditional mean equation for *NEXC*. This suggests that nearly all the predictability in nominal exchange rate can be accounted for by its own past values. The coefficient very close to one (0.999964) with a highly significant z-statistic shows a strong persistence of nominal exchange rate, indicating that the past value is a nearly perfect predictor of its current value, a characteristic of a random walk. Coefficient of ARCH is positive but not statistically significant (p=0.1319), suggesting that recent shocks have a minimal and not statistically significant impact on current volatility. The GARCH indicates the long-term persistence of volatility (GARCH effect), with a coefficient that is statistically significant (p=0.0223), indicating that volatility shocks have a persistent impact over time. The analysis suggests that the nominal exchange rate is characterized by a high level of persistence and potential heavy tails in its distribution, but recent shocks and their asymmetric impact are not playing a significant role in forecasting current volatility.

Table 25. FIGARCH-DCC results for Myanmar

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.136302	0.002126	64.12275	0.0000
NEXC(-1)	0.993281	3.02E-05	32924.95	0.0000
	Variance Equation			
C	-0.187750	0.006239	-30.09357	0.0000
ARCH (-1)^2	-0.321892	0.041477	-7.760684	0.0000
GARCH (1)	0.579298	0.012131	47.75296	0.0000
d-coefficient	0.808820	0.002469	327.59011	0.0000

Source: Authors' estimation results with Eviews 10

In Table 25 above, the coefficient C, representing the intercept in the variance equation, is highly significant with a near-zero probability (p-value), indicating a strong baseline level of volatility in the exchange rate movements. The lagged variable of nominal exchange rate RER(-1) with a very high z-statistic and a p-value of zero confirms the past nominal exchange rate values are extremely predictive of current *NEXC* values, signifying a strong autoregressive character in the exchange rate series. The coefficients ARCH term and its residual represent the short-run components of volatility, the ARCH term, and the measure of asymmetry in the impact of residuals (leverage effect), respectively. The negative sign of ARCH, along with its significant z-statistic, suggests a less than proportional reaction of volatility to past squared residuals, The coefficient of GARCH term and its high z-statistic and zero probability reveal that past volatility is highly predictive of future volatility, signifying a long memory characteristic of the volatility process. This could mean that volatility shocks to the nominal exchange rate are not only impactful in the short run but also persist over a longer period, influencing future volatility levels. Thus, in Myanmar, an emerging economy with active engagement in bitcoin and other cryptocurrencies, this volatility dynamic could be crucial. A higher persistence in volatility indicates that external shocks, possibly including those related to bitcoin demand fluctuations, have long-lasting effects on the stability of the real effective exchange rate. Such findings reflects the impact decisions related to risk management, investment, and economic policy, as sustained volatility in exchange rates may affect international trade, investment flows, and economic stability.

The FIGARCH for Malaysia are reported in Table 26. The FIGARCH model results for Malaysia's nominal exchange rate signify a complex dynamic of volatility in exchange rate movements influenced by Bitcoin demand and other economic factors. The constant being negative and significant indicates that the baseline volatility is subject to mean reversion. The ARCH coefficient is also negative and significant; suggesting that past volatility has a strong shock impact on current volatility. This can be indicative of a market that reacts strongly to past volatility shocks, where the effects of large changes tend to be followed by further large changes, which may remain over long periods. This trait is particularly important for financial risk management as it points to a potentially higher risk environment for investors and policymakers. The GARCH coefficient being positive and significant suggests that volatility shocks are persistent over time, which aligns with the concept of long memory in volatility. This indicates that the effects of shocks to volatility do not decay quickly and that past periods of instability can influence future volatility over a long horizon. The FIGARCH model indicates a complex volatility structure in real effective exchange rate, likely driven by both external economic forces and internal policy measures.

Table 26. FIGARCH-DCC results for Malaysia

Mean Equation				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.004035	4.41E-05	91.56762	0.0000
NEXC(-1)	0.999141	1.23E-05	81386.46	0.0000
Variance Equation				
C	-3.216785	0.157172	-20.46668	0.0000
ARCH(-1)^2	-0.406821	0.014469	-28.11642	0.0000
GARCH (-1)	0.250863	0.036499	6.873086	0.0000
d-coefficient	0.452890	0.001167	388.08054	0.0000

Source: Authors' estimation results with Eviews 10.

Discussion

When comparing our research findings with those from other studies, it is important to note that while Yuliadi et al. (2024) confirm low volatility in currency exchange rates due to Singapore's managed floating exchange rate system, our research findings which show a significant persistence of shocks in the exchange rate of the Singaporean currency do not entirely agree with these findings. Our research findings indeed corroborated those of Yuliadi et al. (2024), who indicated that the government should keep an eye out for economic measures that would lessen the impact of ASEAN countries' exchange rate volatility.

In addition, our results are consistent with those of Rossanto et al. (2023), who found that currency exchange rate volatility in nations that adhered to the free float regime persisted even ten years after the financial crisis; Jonathan (2022) obtained evidence of an asymmetric response to exchange rate fluctuations that corroborates ours; Ain (2022) produced results from the wavelet power spectrum analysis that are consistent with our results for ASEAN nations. According to Ain's (2022) research findings; four ASEAN countries namely, Singapore, Thailand, Malaysia, and Indonesia were found to have highly volatile currency rates. Thailand has little short-term volatility and no increased long-term volatility, in contrast to the Philippines' slight volatility. Our study's outcome suggests that the real exchange rate in Philippines exhibits time-varying volatility that can be partially captured by its own past values. This research outcome is consistent with those of Abdul, Hsia Hua Sheng, and Natalia Diniz-Maganini (2021). These authors demonstrated that exchange rate volatility is asymmetric and time-varying by using empirical research based on the EGARCH (1, 1) specification fitted on monthly Asian currencies. The findings indicate that three currencies have indications of asymmetry in their conditional variance prior to the Asian crisis. With the exception of one, all of them displayed a noticeable increase in volatility and asymmetry effect.

The findings from our study also corroborate those reported by Goda & Priewe (2020). In fact, the authors evaluated the primary causes of cyclical REER behavior in emerging market economies (EME). The research employed a sample size of fifteen emerging market economies from 1996 to 2016, covering several significant economic shocks such as the Asian crises of 1997–1998; the Russian crisis of 1998;

and the Turkish crisis of 2001. The 15 nations are divided into two categories by the study: industrial emerging market economies and commodities developing market economies. The dynamic panel fixed effects model was the econometric method employed to determine the factors influencing REER. Based on the findings, developing market economies that rely on commodities typically have higher REER volatility.

5. Conclusion

The study evaluated the behavior of the nominal exchange rate in ASEAN countries, namely, Indonesia, Singapore, the Philippines, Thailand, Vietnam, Cambodia, Myanmar, and Malaysia. The current research aims to analyse the behavior of exchange rates in ASEAN countries using quantile regression sensitivity analysis. ARCH, GARCH, and FIGARCH modeling are also performed for robustness checks. This study made use of daily exchange rate data covering the period from January 1, 1990, to December 30, 2023, inclusive of weekends and holidays. The data were handled in two eras (before and after the financial crisis). The results are discussed based on each country. The models are well explained, and the results are presented in an organized manner. The GARCH and FIGARCH-DCC modeling techniques were executed to further gauge the impulsive performance of exchange rates of the aforementioned countries. Our research findings uphold asymmetry and persistence in the behavior of exchange rates of ASEAN currencies. In terms of comparative discussions, our research findings considerably align with the findings of other researchers, namely Yuliadi et al. (2024), Rossanto et al. (2023), Jonathan (2022), Ain (2022), and Natalia et al. (2021).

In Indonesia, the FIGARCH results show high persistence in volatility, as indicated by a significant GARCH term, suggesting that shocks to the exchange rate have lasting effects. Singapore's exchange rate exhibited significant persistence of shocks, indicating that the effects of shocks on the exchange rate are enduring. Philippines's FIGARCH model illustrates a high level of volatility persistence. For Thailand, the volatility is characterized by long-memory and a considerable volatility shock, which reflects the sensitivity of the exchange rate to market dynamics. In Vietnam, exchange rate volatility does not die off quickly, and this has the tendency to stimulate speculative chances. Cambodia exhibits weighty persistence in exchange rate volatility. Myanmar's FIGARCH analysis shows permanent exchange rate shocks. Lastly, in Malaysia, volatility persistence in the nominal exchange rate is robust. It suffices to advise that all ASEAN governments should enhance regulatory frameworks that monitor and possibly control exchange rate transactions to prevent excessive speculative activities that could destabilize national currencies. Accordingly, we recommend the need for ASEAN countries' central banks to put into effect the preventative measures necessary to preserve economic stability and control the volatility dynamics of the foreign exchange market.

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