

Exchange Rate Volatility and Corporate Financial Risk Exposure

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Abstract:

This study investigates whether exchange rate volatility affects the stock returns and financial risk exposure of multinational firms. Using daily data for Apple, Toyota, Shell, Unilever and HSBC from 2018 to 2024, it combines ARIMAX, GARCH-X, VAR and Granger causality models. Stock prices and major bilateral exchange rates are converted into logarithmic returns, while conditional currency volatility is estimated with GARCH models. The results show heterogeneous effects. Exchange rate movements predict returns for Toyota and Unilever, whereas exchange rate volatility significantly raises conditional return volatility for Apple and Toyota in the baseline specification. Robustness tests using EGARCH, GJR-GARCH, sub-period samples and a trade-weighted dollar index show that these relationships are sensitive to model choice, market regime and currency measure. The findings therefore support a firm-specific rather than universal currency-risk effect. The study contributes by separating mean-return and volatility channels and by linking financial time-series evidence to corporate hedging, accounting disclosure and risk-management decisions.

Keywords: Exchange Volatility; Corporate Financial Risk Exposure; ARIMA; GARCH; VAR.

1. Introduction

1.1 Research Background

Exchange rate volatility poses a material risk to multinational firms, as their revenues, costs, assets and earnings are often denominated in diverse currencies. It generates transaction exposure from contractual cash flows, translation exposure upon consolidation of foreign operations, and economic exposure via shifts in competitiveness, profit margins and firm value. Foreign exchange risk thus impacts both cor-

porate cash flows and reported financial positions [1, 2, 3].

Currency risk grew more prominent after COVID-19 supply-chain disruptions and subsequent monetary tightening lifted uncertainty, interest-rate differentials and foreign-currency funding costs. Amid historically high foreign-exchange turnover and firm-level evidence connecting dollar volatility to lower investment and productivity, the 2018–2024 period captures both normal and stressed market conditions [4, 5].

Exchange rate exposure varies with firms' foreign

market participation and operating structures. Domestic currency depreciation can benefit exporters via higher translated revenue but raise import costs, while diversified firms may offset cross-currency losses. A single market-wide exchange rate measure may thus misrepresent individual multinationals' actual exposure [6].

In addition, currency volatility can shape corporate decisions. It may delay irreversible investment by raising uncertainty over project cash flows and intensify balance-sheet pressure for firms with foreign-currency liabilities. These mechanisms imply exchange-rate risk functions via financing constraints and firm-specific financial structures. Its effect may thus be reflected in firm risk even with muted average return responses [7-10].

For equity investors, currency risk affects both mean returns and volatility. Exchange-rate movements shift margins, cash flows and valuations, with impacts contingent on the balance of foreign revenues, costs and liabilities. Currency volatility may raise uncertainty and equity risk without generating consistent return effects [11-13]. Given return characteristics including volatility clustering, fat tails and time-varying variance, ARCH and GARCH models are suitable to examine this risk channel.

Exchange-rate exposure also shapes accounting information. Translation adjustments, hedging gains or losses and foreign-currency monetary items may shift earnings or other comprehensive income, while greater exposure correlates with larger analyst forecast errors and forecast dispersion [14, 15]. Clear disclosures regarding currency positions, hedges and sensitivities are therefore vital for interpreting reported financial results.

1.2 Research Questions and Contribution

Although existing literature documents exchange rate exposure, most studies focus on macro-level exchange rate effects, leaving firm-level time-series evidence for multinationals underexplored. This research gap is critical, as multinationals including Apple, Toyota, Shell, Unilever and HSBC differ substantially in business models, currency exposure and hedging capacity.

Against this backdrop, this study addresses the core research question: Does exchange rate volatility significantly affect the stock returns and financial risk exposure of multinational firms? To answer this question, this paper first examines the impact of major exchange rate fluctuations on multinationals' daily stock returns, then investigates whether exchange rate volatility elevates firms' conditional stock return volatility and further explores whether global diversification generates heterogeneous sensitivity to exchange rate shocks. Daily stock prices are converted into logarithmic returns and tested for stationarity. This study employs ARIMAX models to estimate mean return effects, GARCH-X models to examine the volatility channel, and VAR and Granger causality tests to

provide dynamic supplementary evidence. As robustness checks, this analysis adopts asymmetric GARCH models, sub-period analysis and trade-weighted exchange rate indicators.

This study contributes to the literature by differentiating exchange rate-driven return and volatility effects and linking financial time-series results to corporate risk management and accounting disclosure practices.

2. Literature Review and Hypotheses

2.1 Exchange Rate Exposure and Firm Value

Exchange rate exposure defines the sensitivity of firm value to exchange rate movements, encompassing transaction exposure from foreign-currency cash flows, translation exposure from the consolidation of overseas operations, and economic exposure driven by changes in corporate competitiveness, cash flows and firm value.

Prior literature documents heterogeneous exchange rate exposure across firms. Recent firm-level evidence indicates that exposure varies with corporate international trade activities and foreign market layouts. Existing studies further suggest that exchange rate exposure is difficult to quantify, as it is determined by both bilateral exchange rate fluctuations and firm-specific attributes, including cash flow structures, competitive positions, hedging behaviors and diversification strategies. Such factors differ markedly across cross-industry multinationals such as Apple, Toyota, Shell, Unilever and HSBC, validating the superiority of firm-level analysis over aggregate market indicators.

2.2 Exchange Rate Volatility and Stock Return Risk

Exchange rate movements affect stock performance through return and volatility channels. The return channel operates via shifts in corporate cash flows, profit margins and equity valuations. Domestic currency appreciation lowers the translated value of foreign revenues, whereas depreciation boosts export income. However, currency depreciation can also raise import input costs and the local-currency value of foreign debt, leading to heterogeneous return effects across firms.

The volatility channel constitutes the core of this study. Exchange rate volatility elevates uncertainty regarding future earnings, financing costs and cash flows. Even without stable mean return responses, currency fluctuations can heighten firms' conditional stock return volatility. This distinction is critical, as exchange rate risk primarily transmits through volatility risk rather than mean return changes. Given the inherent volatility clustering, fat tails and time-varying variance of financial returns, ARCH and

GARCH-type models are standard tools for capturing dynamic conditional variance. Stock market literature further validates the applicability of GARCH-based frameworks for analyzing exchange rate and equity risk linkages.

2.3 Corporate Hedging and Risk Management

Exchange rate volatility effects are contingent on corporate hedging strategies and firm characteristics. Multinational firms mitigate foreign exchange exposure via forwards, options, swaps, natural hedging and foreign-currency borrowing. Prior studies confirm that derivative usage, foreign-currency debt and comprehensive hedging policies reduce exchange rate exposure, thereby shaping firm risk and value. Natural hedging refers to the matching of foreign-currency revenues with foreign-currency costs or liabilities. These practices lower the sensitivity of earnings and cash flows to currency fluctuations [16–19]. Hedging capacity is uneven across firms. Larger firms may have stronger treasury functions and wider derivative-market access. Firms with high leverage, weak liquidity or concentrated foreign revenues may be more exposed to exchange rate shocks. Hedging effectiveness depends on firm size, leverage, liquidity and the degree of internationalization. Exchange rate volatility can also affect investment decisions, especially in open economies and among firms without currency-derivative hedging [20, 21].

Exchange rate exposure further carries significant accounting implications. Currency movements affect reported earnings through foreign currency translation, hedging gains and losses, and revaluation of foreign-currency assets and liabilities. Prior evidence indicates that greater foreign exchange exposure correlates with larger analyst forecast errors and higher forecast dispersion, reducing earnings predictability and financial information quality. Accordingly, currency risk represents a critical disclosure and risk-communication concern for multinational firms [22].

2.4 Hypotheses Development

Exchange rate changes may influence multinational firms through cash flows, profit margins, foreign-currency liabilities and reported earnings. Firms operating across currency regions should show return sensitivity to exchange rate movements [23–25].

H1: Exchange rate changes have a significant impact on the stock returns of multinational firms.

Exchange rate volatility may alter firm risk even with an inconsistent influence on average returns. Elevated currency volatility raises uncertainty over future earnings, cash flows and financing costs, which should be captured in conditional stock return volatility.

H2: Exchange rate volatility increases the conditional vol-

atility of multinational firms' stock returns.

Lastly, exchange rate exposure is heterogeneous across multinationals owing to disparities in revenue geography, cost structures, industrial attributes and hedging capacity. Firms adopting distinct international business models may therefore respond asymmetrically to identical exchange rate shocks.

H3: Firms with different international business models show different levels of exchange rate sensitivity.

3. Data and Variable Construction

Exchange rates and stock prices react rapidly to new information; daily financial data are thus appropriate for capturing short-term return dynamics and volatility clustering in financial time-series analysis.

3.1 Sample Selection and Data Sources

3.1.1 Sample Period

The sample spans January 2018 to December 2024, covering the pre-pandemic era, the COVID-19 shock, and the subsequent monetary tightening cycle. Specifically, 2018–2019 serves as a stable baseline period, 2020–2021 reflects abrupt supply chain and market disruptions, and 2022–2024 features sustained inflation, cross-border interest-rate divergence and a strong U.S. dollar. These regimes incorporate stable and turbulent conditions with economically significant foreign-exchange turnover and dollar volatility. The full sample period also provides sufficient daily observations to support robust volatility estimation and sub-period empirical tests.

3.1.2 Sample Firms

The sample comprises five multinational corporations across distinct industries. This focused sample is adopted to compare heterogeneous exchange rate responses among firms with varied international business structures, rather than conducting a broad industry-wide analysis.

As listed in Table 1, the sample firms include Apple, Toyota, Shell, Unilever and HSBC. Apple is selected for its substantial overseas revenue and global supply chain. As an export-oriented manufacturer, Toyota's market competitiveness is highly sensitive to exchange rate fluctuations. Operating globally within dollar-dominated international energy markets, Shell bears significant currency exposure. Unilever's extensive cross-border consumer goods operations expose the firm to widespread currency translation effects. As a representative financial institution, HSBC faces exchange rate risk arising from its cross-border banking businesses and multi-currency operations.

Table 1. Sample Firms and Reasons for Selection

Firm	Industry	Reasons for Selection
Apple	Technology	High overseas revenue and global supply chain exposure
Toyota	Automotive	Export-oriented business sensitive to yen movements
Shell	Energy	Global operations and dollar-denominated commodity exposure
Unilever	Consumer Goods	Significant international sales and currency translation exposure
HSBC	Banking	Cross-border financial activities and multi-currency balance sheet

3.1.3 Data Sources

Table 2 summarises the data sources and variable definitions. Daily stock prices are retrieved from Yahoo Finance using adjusted closing prices, which incorporate dividends and stock splits. Corresponding exchange rate data (GBP/USD, EUR/USD, USD/JPY and AUD/USD) are also

sourced from Yahoo Finance. Market control variables include the S&P 500, FTSE 100 and Nikkei 225 indices to capture broad equity market fluctuations. The VIX index is adopted as a proxy for global market uncertainty and investor risk sentiment. All variables are sampled at a daily frequency, making them suitable for ARIMA, GARCH and VAR-based empirical analysis.

Table 2. Data Sources and Variables

Data Type	Variable	Source
Stock Prices	Daily adjusted closing prices	Yahoo Finance
Exchange Rates	GBP/USD, EUR/USD, JPY/USD, AUD/USD	Yahoo Finance / FRED
Market Indices	S&P 500, FTSE 100, Nikkei 225	Yahoo Finance
Market Uncertainty	VIX Index	Yahoo Finance / FRED

3.2 Variable Construction

3.2.1 Dependent Variable: Firm Stock Returns

The dependent variable is the daily stock return of firm i , denoted as $R_{i,t}$, which is calculated using logarithmic returns:

$$R_{i,t} = \ln \left(\frac{P_{i,t}}{P_{i,t-1}} \right) \quad (1)$$

where $P_{i,t}$ denotes adjusted closing stock price of firm i on day t . Logarithmic returns are widely adopted in financial research due to their superior aggregate properties and more favourable statistical characteristics compared with raw price levels.

3.2.2 Exchange Rate Returns

The main explanatory variable is the exchange rate return, denoted as FX_t :

$$FX_t = \ln \left(\frac{E_t}{E_{t-1}} \right) \quad (2)$$

where E_t represents the exchange rate on day t . Currency pairs are matched to firms according to their business exposure. For example, JPY/USD is particularly relevant for

Toyota, while GBP/USD and EUR/USD are more relevant for Shell, Unilever and HSBC.

3.2.3 Exchange Rate Volatility

The key risk variable is exchanging rate volatility, denoted as σ_t . Instead of simple rolling standard deviation, this study adopts a GARCH model to estimate volatility. This approach captures time-varying volatility and volatility clustering, which are common features of exchange rate series [26, 27]. The estimated conditional variance is used as the primary measure of currency-market uncertainty.

3.2.4 Control Variables

Several control variables are included to isolate the effect of exchange rate movements. As Table 3 shows, Market return controls for overall stock market performance, while the VIX index captures global risk sentiment and uncertainty. Firm size and leverage are included where available because larger firms may have greater hedging capacity, whereas highly leveraged firms may be more vulnerable to external shocks. A measure of internationalisation, such as foreign revenue share, may also be included to examine whether firms with greater global exposure are more sensitive to exchange rate fluctuations.

Table 3. Variable Definitions

Variable Type	Symbol	Definition	Measurement
Dependent Variable		Firm stock return	Log return of adjusted stock price
Explanatory Variable		Exchange rate return	Log return of exchange rate
Risk Variable		Exchange rate volatility	Conditional variance from GARCH
Control Variable		Market return	Log return of market index
Control Variable	VIX	Market uncertainty	Daily VIX level or change

4. Empirical Methodology

This chapter outlines the empirical framework examining the impacts of exchange rate volatility on multinational firms' stock returns and financial risk exposure. The methodology follows four structured stages. First, raw financial data are converted into return series and tested for stationarity. Second, ARMA/ARIMA models are estimated to capture stock return mean dynamics. Third, GARCH models are applied to analyse time-varying volatility and evaluate the exchange rate volatility effect on firm-level risk. Finally, VAR and Granger causality tests are utilized to explore the dynamic linkage between exchange rates and stock returns.

4.1 Data Processing and Stationarity Tests

4.1.1 Return Construction

Before estimation, stock prices and exchange rates are converted into logarithmic returns. The daily stock return of firm i is calculated as:

$$R_{i,t} = \ln(P_{i,t}) - \ln(P_{i,t-1}) \quad (3)$$

Exchange rate returns are calculated as:

$$FX_t = \ln(E_t) - \ln(E_{t-1}) \quad (4)$$

Where $P_{i,t}$ is the adjusted closing stock price and E_t is the exchange rate. Log returns are widely used because they are generally more stable than price levels and reduce the risk of spurious regression in financial time series analysis.

4.1.2 Descriptive Statistics and Stationarity

This study presents descriptive statistics for stock and exchange rate returns, including mean, standard deviation, minimum, maximum, skewness and kurtosis, while the Jarque-Bera test is applied to evaluate data normality. The Augmented Dickey-Fuller (ADF) and KPSS tests are jointly employed to verify series stationarity. The ADF test detects unit roots, whereas the KPSS test confirms stationarity; the combination enhances the reliability of time-series modelling suitability assessments. Consistent with financial theory, price-level series are non-stationary, while return series exhibit stationarity. Accordingly, all subsequent empirical analyses are performed based on re-

turn series.

4.2 ARIMA Mean Equation Modelling

4.2.1 Model Specification

To test H1, this study extends the ARIMA model into an ARIMAX mean equation by including exchange rate returns and control variables. ARIMA-type models are used to capture the mean dynamics of firm stock returns before volatility modelling. The model is specified as:

$$R_{i,t} = \alpha_i + \sum_{p=1}^P \phi_p R_{i,t-p} + \sum_{q=1}^Q \theta_q \varepsilon_{i,t-q} + \sum_{l=0}^L \beta_l FX_{k,t-l} + \gamma_1 R_{m,t} + \gamma_2 VIX_t + \varepsilon_{i,t} \quad (5)$$

Where $R_{i,t}$ is the daily stock return of firm i , $\varepsilon_{i,t}$ represents contemporaneous and lagged exchange rate returns, $R_{m,t}$ controls for overall market performance, and VIX_t captures global investor sentiment. The coefficients $\alpha_i, \phi_p, \theta_q, \beta_l, \gamma_1, \gamma_2$ are the key parameters for testing whether exchange rate changes significantly affect stock returns.

4.2.2 Model Selection

The AR and MA lag orders are selected using ACF, PACF, AIC and BIC. The lag length of exchange rate returns is also selected based on information criteria. This allows the model to capture both the stock return's own time-series dynamics and the delayed impact of exchange rate movements.

4.3 GARCH Volatility Modelling

4.3.1 Baseline GARCH(1,1) Model

After estimating the ARIMAX mean equation, a GARCH (1,1) model is used to capture volatility clustering in firm stock returns because large shocks in financial returns often tend to be followed by large shocks and small shocks by small shocks [28]:

$$h_{i,t} = \omega + \alpha \varepsilon_{i,t-1}^2 + \beta h_{i,t-1} \quad (6)$$

where $h_{i,t}$ is conditional variance, $\varepsilon_{i,t-1}^2$ captures recent shocks, and $h_{i,t-1}$ measures volatility persistence.

4.3.2 Exchange Rate Volatility-Augmented GARCH Model

To test H2, exchange rate volatility is added to the vari-

ance equation. This specification follows the GARCH-X logic, where an external risk variable is included in the conditional variance equation to test whether it increases firm-level volatility:

$$h_{i,t} = \omega + \alpha \varepsilon_{i,t-1}^2 + \beta h_{i,t-1} + \delta FXVOL_{k,t} \quad (7)$$

where $\varepsilon_{i,t}$ is the exchange rate volatility estimated from a separate GARCH model. A positive and significant δ indicates that exchange rate volatility increases firm-level stock return volatility.

4.4 VAR and Granger Causality Analysis

4.4.1 VAR Model Specification

VAR analysis is retained as a supplementary test of dynamic relationships. The VAR model includes firm returns, exchange rate returns, market returns and VIX, allowing the variables to interact dynamically without imposing a single dependent-variable structure:

$$Y_t = A_0 + A_1 Y_{t-1} + \dots + A_p Y_{t-p} + u_t \quad (8)$$

This model examines how these variables interact over time.

4.4.2 Granger Causality Tests

Granger causality tests examine whether lagged exchange-rate returns contain incremental predictive information for future stock returns. The ARIMAX model remains the main test of H1.

4.5 Model Diagnostics

Following the ARIMAX and GARCH estimations, diagnostic tests are conducted to verify model adequacy. The Ljung–Box test examines residual autocorrelation, while the ARCH–LM test detects remaining ARCH effects. These standard time-series diagnostics validate whether the chosen specifications adequately capture key data characteristics. Where residual dependence or heteroskedasticity persists, alternative lag structures and volatility specifications are adopted to improve model fit.

Overall, the integrated framework of ARIMA, GARCH and VAR–Granger tests enable comprehensive evaluation of firm-level exchange rate exposure. ARIMA models characterize return-generating processes, GARCH-based specifications quantify the volatility spillover from exchange rates to firm risk, and VAR–Granger analysis identifies dynamic causal interactions between currency and stock returns. This multi-method design directly addresses the study’s research objectives and hypotheses. The complete methodological procedure is illustrated in Fig. 1.

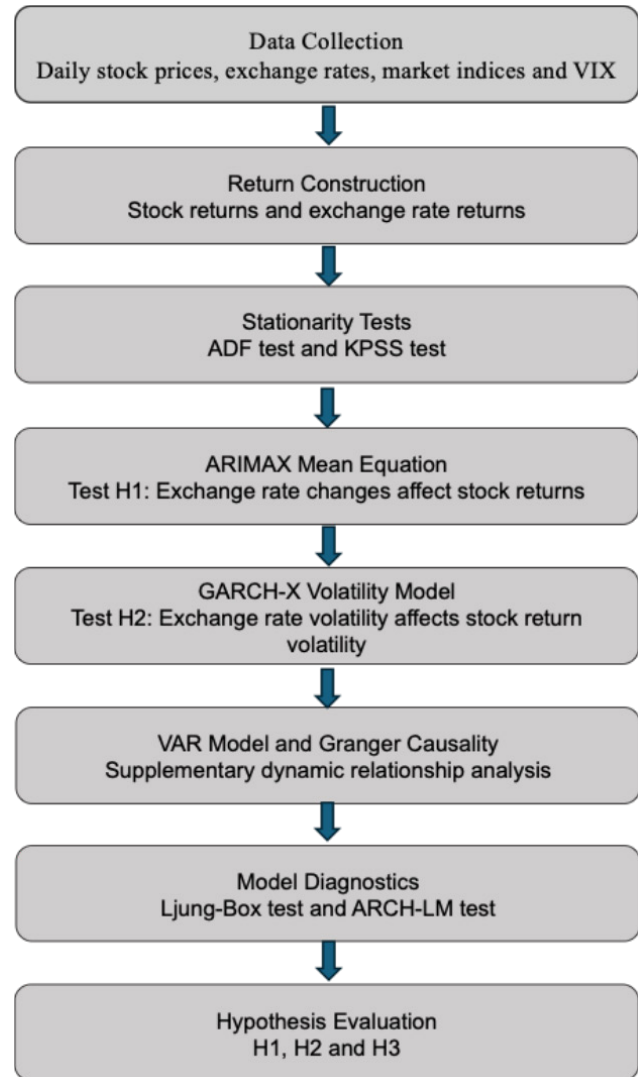


Fig. 1 Methodology Flow Chart

5. Empirical Results and Analysis

5.1 Descriptive Statistics and Stationarity

Descriptive statistics reveal that the average daily returns of sample firms and exchange rate series are close to zero, consistent with conventional financial return characteristics. However, return standard deviations vary substantially across firms, indicating heterogeneous market risk levels. As reported in Table 4, Apple and Shell exhibit relatively higher return volatility, whereas Toyota and Unilever demonstrate more stable return performance. The skewness, kurtosis and Jarque-Bera test results collectively reject the normality of all return series, confirming prominent fat-tailed distributions and extreme values. These empirical features validate the adoption of GARCH-type models, as conventional mean-based mod-

els fail to capture time-varying volatility dynamics.

Table 4. Descriptive Statistics

Firm	Mean	SD	Skewness	Kurtosis	JB Statistic	JB pvalue
Apple	0.001283	0.021246	-0.202083	7.813241	1382.34028	0
Toyota	0.000406	0.016369	0.055874	7.023508	959.915205	0
Shell	0.000144	0.022717	-0.691412	17.822121	13130.2433	0
Unilever	0.00019	0.015255	-0.855242	21.822716	21165.3079	0
HSBC	0.000239	0.018097	-0.368758	7.692133	1336.68222	0
GBPUSD	-5.00E-05	0.006381	-0.286642	7.73506	1347.90449	0
EURUSD	-9.90E-05	0.005088	-0.100216	4.92802	222.627949	0
USDJPY	0.000238	0.006106	-0.330641	6.662493	820.680652	0
AUDUSD	-0.000161	0.007038	-0.168987	4.785257	195.606053	0
SP500	0.000544	0.013873	-1.114204	15.790355	9987.11926	0
FTSE100	3.80E-05	0.011294	-1.041508	16.949073	11785.7499	0
Nikkei225	0.000372	0.014309	-1.546909	28.54054	39217.0351	0
VIX	0.000447	0.089819	1.709445	13.306924	6986.84807	0

The ADF and KPSS tests in Table 5 show that most price-level series are non-stationary, while the log return series are stationary. This result justifies the use of log returns rather than raw prices in the empirical models. By

transforming prices and exchange rates into returns, the analysis avoids spurious regression and provides a suitable basis for ARIMA, GARCH and VAR estimation.

Table 5. ADF and KPSS Stationarity Test Results

Firm	ADF Statistic	ADF p-value	KPSS Statistic	KPSS p-value
Apple	-10.310524	0.01	0.06902	0.1
Toyota	-11.966976	0.01	0.048298	0.1
Shell	-11.637306	0.01	0.119021	0.1
Unilever	-11.319742	0.01	0.04568	0.1
HSBC	-10.673588	0.01	0.446923	0.05693
GBPUSD	-12.221918	0.01	0.038968	0.1
EURUSD	-10.83007	0.01	0.054667	0.1
USDJPY	-10.318202	0.01	0.26077	0.1
AUDUSD	-11.486306	0.01	0.050977	0.1
SP500	-10.899473	0.01	0.057192	0.1
FTSE100	-11.464507	0.01	0.078784	0.1
Nikkei225	-11.42326	0.01	0.095581	0.1
VIX	-12.780291	0.01	0.036245	0.1

5.2 ARIMA Mean Equation and Volatility Clustering

The ARIMA results show that the selected mean equations vary across firms. Apple is fitted with ARIMA (0,0,1), Toyota with ARIMA (1,0,3), Shell with ARIMA (2,0,2),

Unilever with ARIMA (1,0,1), and HSBC with ARIMA (1,0,0). These differences suggest that the short-run return dynamics are firm-specific. However, the ARIMA models are not intended to prove strong stock return predictability. Instead, they are used to control for short-term autocorrelation before estimating the volatility models.

The Ljung-Box test results in Table 6 indicate that the ARIMA residuals do not contain serious remaining autocorrelation. This suggests that the mean equations are adequate. ARCH-LM statistics reject the null hypothesis

of homoskedasticity for all five firms, confirming the existence of volatility clustering. Therefore, GARCH-type models are necessary to examine firm-level conditional risk exposure.

Table 6. ARIMA Model Selection and ARCH-LM Test Results

Firm	ARIMA Order	Ljung Box p-value	ARCH LM p-value	Ljung Box Statistic	ARCH LM Statistic
Apple	0,0,1	0.786075	0	14.829577	237.821213
Toyota	1,0,3	0.415045	0	20.698845	125.784138
Shell	2,0,2	0.161087	0	26.144663	572.768009
Unilever	1,0,1	0.301586	0	22.743066	201.837034
HSBC	1,0,0	0.865618	0	13.267401	82.928416

5.3 Baseline GARCH Results

Baseline FX-augmented GARCH results yield the core empirical findings of this study. Exchange rate volatility exerts statistically significant effects on the stock volatility of Apple and Toyota. Specifically, Apple's conditional return volatility is significantly associated with EUR/USD fluctuations, whereas Toyota's volatility responds significantly to USD/JPY movements. This indicates that exchange rate volatility elevates firm-level financial risk exposure, particularly for multinationals with extensive overseas revenues, global supply chains, or export-dependent business models. Nevertheless, the small magnitude of the estimated FX volatility coefficients implies a limited economic effect for both firms. These results align with prior literature, confirming heterogeneous exchange rate exposure contingent on firm-specific trade structures, hedging capabilities, diversification strategies and business characteristics.

In comparison, the baseline GARCH model yields insignificant

FX volatility coefficients for Shell, Unilever and HSBC. This does not indicate an absence of currency exposure but suggests that their stock volatility is dominated by factors beyond single bilateral exchange rate movements. Shell's risk dynamics are largely driven by energy and commodity market fluctuations, while HSBC's volatility is more sensitive to interest rate movements, banking sector risks and broader financial conditions. Such cross-firm heterogeneity further supports the notion that currency exposure varies with firm internationalization, financial structures, hedging practices and industry attributes.

Overall, the baseline GARCH results in Table 7 provide partial validation for H2. As illustrated in Fig. 2, exchange rate volatility raises conditional stock volatility for selected multinationals rather than generating a universal effect. The findings fully support H3, as exchange rate sensitivity exhibits clear cross-firm and cross-industry heterogeneity. This confirms that exchange rate risk primarily operates through firm-specific volatility channels instead of uniform mean return effects.

Table 7. Baseline FX-Augmented GARCH Results

Firm	FXVol (Foreign exchange volatility) Used	Alpha 1 (ARCH effect)	Beta 1 (GARCH persistence effect)	FXVol Coefficient	FXVol p-value	Persistence (Sum of alpha and beta)
Apple	EURUSD FXVol	0.096286	0.872289	2.00E-06	< 0.001	0.968576
Toyota	USDJPY FXVol	0.052071	0.935636	1.00E-06	< 0.001	0.987707
Shell	GBPUSD FXVol	0.067056	0.927123	< 0.001	0.922444	0.994179
Unilever	GBPUSD FXVol	0.025051	0.958788	< 0.001	0.999914	0.983839
HSBC	GBPUSD FXVol	0.057516	0.936099	< 0.001	0.999855	0.993615

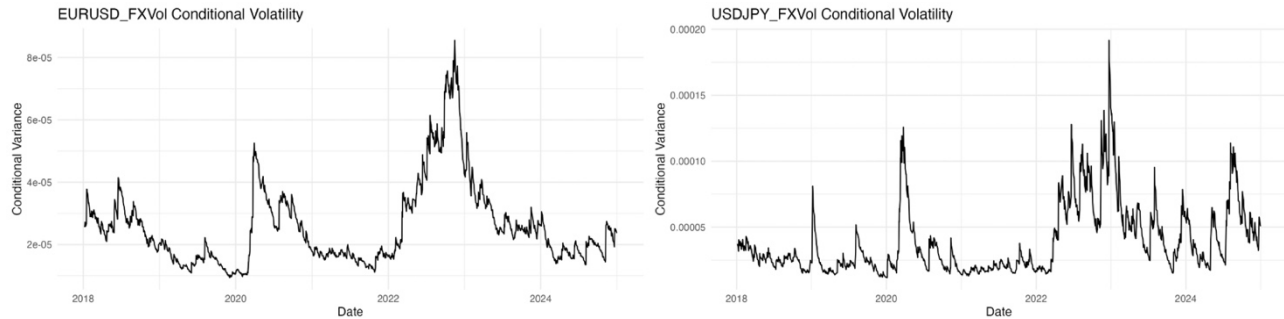


Fig. 2 Conditional Volatility of EUR/USD and USD/JPY

5.4 VAR and Granger Causality Results

The VAR and Granger causality tests in Table 8 examine whether exchange rate returns contain predictive information for firm stock returns. The results show significant Granger causality for Toyota and Unilever. Toyota's result is consistent with its export-oriented business model and sensitivity to yen movements. Unilever's result suggests that GBP/USD movements may contain useful information for a globally diversified consumer goods firm. Apple and HSBC show marginal evidence at the 10% level,

while Shell does not show a significant Granger causality result.

These findings provide partial support for H1. Exchange rate movements do not predict stock returns equally across all firms. Instead, the return effect is heterogeneous and depends on business model, industry exposure, revenue geography and market conditions. This interpretation is consistent with prior evidence that firms with export sensitivity or substantial international revenue exposure may respond more strongly to exchange rate movements.

Table 8. VAR and Granger Causality Test Results

Firm	FX Used	Market Control	Selected Lag AIC	Granger p-value
Apple	EURUSD	SP500	4	0.097654
Toyota	USDJPY	Nikkei225	4	0.010271
Shell	GBPUSD	FTSE100	5	0.170368
Unilever	GBPUSD	FTSE100	5	0.027553
HSBC	GBPUSD	FTSE100	5	0.058916

6. Robustness Tests

6.1 Alternative GARCH Specifications

To test whether the baseline results are sensitive to volatility model specification, the FX-augmented GARCH model is re-estimated using EGARCH and GJR-GARCH models. These alternative models are useful because they allow for asymmetric volatility responses, where negative and positive shocks may affect volatility differently [29, 30]. The results are mixed, as shown in Table 9. Under the EGARCH specification, the exchange rate volatility coefficient is not statistically significant for any of the five firms. This suggests that the baseline findings are not fully

robust across all volatility models.

However, the GJR-GARCH results show significant FX volatility effects for Apple, Toyota and Unilever, while Shell and HSBC remain insignificant. This indicates that exchange rate volatility can affect stock risk but becomes more relevant when asymmetric volatility responses are considered. However, the robustness evidence is mixed. The significance under GJR-GARCH but not EGARCH suggests that the estimated FX volatility effect is sensitive to model specification. The difference across models lies in volatility asymmetry: GJR-GARCH incorporates leverage effects, where adverse exchange shocks may drive larger stock volatility responses than positive currency movements.

Table 9. Alternative GARCH Robustness Results

Firm	EGARCH FXVol p-value	GJR-GARCH FXVol p-value	Robustness Interpretation
Apple	0.197884	0	Significant only under GJR-GARCH
Toyota	0.812804	0	Significant only under GJR-GARCH
Shell	0.581114	0.133223	Not Significant
Unilever	0.223335	0.003724	Significant only under GJR-GARCH
HSBC	0.34114	0.999996	Not Significant

6.2 Sub-period Robustness Test

The sample is further divided into three sub-periods: 2018–2019, 2020–2021 and 2022–2024 (Table 10). These periods represent the pre-pandemic phase, the COVID-19 shock period and the monetary tightening period, which are relevant because both foreign exchange turnover and dollar volatility have been central to recent global finan-

cial conditions. The sub-period results are more limited. Only Shell shows a statistically significant FX volatility coefficient during the 2018–2019 pre-pandemic period. Apple, Toyota, Unilever and HSBC are not significant across the three sub-periods, although Toyota shows marginal evidence during the COVID-19 period. The full-sample significance may be driven by pooled-period dynamics rather than stable effects across market regimes.

Table 10. Sub-period Robustness Test Results

Period	Firm	FXVol Used	FXVol p-value	Result
Pre_Pandemic_2018_2019	Apple	EURUSD_FXVol	0.56623	Not significant
Pre_Pandemic_2018_2019	Toyota	USDJPY_FXVol	0.064755	Marginal at 10%
Pre_Pandemic_2018_2019	Shell	GBPUSD_FXVol	0	Significant
Pre_Pandemic_2018_2019	Unilever	GBPUSD_FXVol	1	Not significant
Pre_Pandemic_2018_2019	HSBC	GBPUSD_FXVol	1	Not significant
COVID_2020_2021	Apple	EURUSD_FXVol	0.622267	Not significant
COVID_2020_2021	Toyota	USDJPY_FXVol	0.063779	Marginal at 10%
COVID_2020_2021	Shell	GBPUSD_FXVol	0.420645	Not significant
COVID_2020_2021	Unilever	GBPUSD_FXVol	0.128667	Not significant
COVID_2020_2021	HSBC	GBPUSD_FXVol	0.420687	Not significant
Tightening_2022_2024	Apple	EURUSD_FXVol	0.994426	Not significant
Tightening_2022_2024	Toyota	USDJPY_FXVol	1	Not significant
Tightening_2022_2024	Shell	GBPUSD_FXVol	0.999883	Not significant
Tightening_2022_2024	Unilever	GBPUSD_FXVol	0.997563	Not significant
Tightening_2022_2024	HSBC	GBPUSD_FXVol	0.516236	Not significant

6.3 Alternative Exchange Rate Measure Robustness

As shown in Table 11, none of the FX volatility coefficients is statistically significant when the trade-weighted

U.S. dollar index is used as the alternative exchange rate measure. The p-values are far above conventional significance levels for all five firms. This suggests that the baseline bilateral exchange rate results are not robust to the use of a broader dollar-based exchange rate measure. Al-

though the persistence values remain high for most firms, the alternative FXVol coefficients are extremely small and statistically insignificant. Therefore, general U.S. dollar

volatility does not appear to explain firm-level conditional volatility in this specification.

Table 11. Alternative Exchange Rate Measure Robustness Results

Firm	Alternative FXVol Used	FXVol Coefficient	FXVol p-value	Persistence	Result
Apple	DTWEXBGS_FXVol	1.70E-14	0.999998	0.995821	Not significant
Toyota	DTWEXBGS_FXVol	1.37E-14	1.000000	0.985602	Not significant
Shell	DTWEXBGS_FXVol	1.56E-13	0.999999	0.993529	Not significant
Unilever	DTWEXBGS_FXVol	2.76E-14	1.000000	0.991939	Not significant
HSBC	DTWEXBGS_FXVol	8.35E-07	0.629689	0.893400	Not significant

6.4 Overall Robustness Summary

Overall, the robustness tests indicate that the baseline findings are only partially robust. The results are sensitive to model specification, sub-period selection and exchange rate measurement. Therefore, the evidence supports a firm-specific and model-dependent FX risk effect rather than a universal relationship across all firms.

7. Conclusion

This study examines whether exchange rate volatility affects the stock returns and financial risk exposure of multinational firms. Using daily data from 2018 to 2024 and applying ARIMA, GARCH, VAR and Granger causality models, the results show that exchange rate risk has a heterogeneous impact across firms. The mean return effect is only partially supported, as exchange rate movements significantly predict stock returns for Toyota and Unilever, while the evidence for other firms is weaker. In contrast, the volatility channel provides stronger evidence. The FX-augmented GARCH results show that exchange rate volatility significantly increases conditional return volatility for Apple and Toyota, although the economic magnitude is modest. Robustness tests further suggest that the results are sensitive to model specification, sample period and exchange rate measure.

In conclusion, the findings indicate that exchange rate volatility does not create a universal effect on multinational firms, but its impact depends on business model, industry exposure and currency structure. For managers and investors, foreign exchange risk should be treated as an important firm-level risk factor, especially in periods of global uncertainty.

Future research can further expand the analysis in several directions. First, future studies may incorporate a larger sample of multinational firms from different industries and countries to improve the generalizability of the findings.

Second, additional macroeconomic variables, such as interest rates, inflation and geopolitical risk, could be included to capture broader sources of financial uncertainty. Third, future research may employ more advanced models, including machine-learning techniques and high-frequency data analysis, to explore the dynamic relationship between exchange rate volatility and corporate financial risk. Finally, corporate hedging strategies and foreign revenue structures could be explicitly incorporated to better explain firm-level heterogeneity in exchange rate exposure.

This study has several limitations. First, the sample consists of only five multinational firms, which may limit the representativeness of the results. Second, the analysis focuses primarily on bilateral exchange rates and does not fully account for other factors affecting stock returns, such as commodity prices and monetary policy shocks. Third, although the study employs several robustness tests, the empirical results remain sensitive to model specification, sample period and exchange rate measurement. Finally, due to data constraints, firm-specific hedging activities and detailed foreign revenue information are not directly included in the empirical models. These limitations provide opportunities for future research to further investigate the mechanisms through which exchange rate volatility affects corporate financial risk.

References

- [1] Lal, M., Kumar, S., Pandey, D. K., Rai, V. K., Lim, W. M., Exchange rate volatility and international trade, *Journal of Business Research*, 2023, 167: 114156. <https://doi.org/10.1016/j.jbusres.2023.114156>
- [2] He, Q., Wang, W., Yu, J., Exchange rate co-movements and corporate foreign exchange exposures: A study on RMB, *International Review of Financial Analysis*, 2023, 90: 102831. <https://doi.org/10.1016/j.irfa.2023.102831>

- [3] He, Q., Liang, B., Liu, J., RMB internationalization and exchange rate exposure of Chinese listed firms, *Journal of International Money and Finance*, 2024, 145: 103098. <https://doi.org/10.1016/j.jimonfin.2024.103098>
- [4] Hussain, M., Bashir, U., Rehman, R. U., Exchange rate and stock prices volatility connectedness and spillover during pandemic-induced crises: Evidence from BRICS countries, *Asia-Pacific Financial Markets*, 2024, 31(1): 183–203. <https://doi.org/10.1007/s10690-023-09411-0>
- [5] Wang, A. T., Liang, C.-C., Exchange rates, credit default swaps and market volatility of emerging markets: Panel CS-ARDL approach, *Borsa Istanbul Review*, 2024, 24(1): 176–186. <https://doi.org/10.1016/j.bir.2023.12.001>
- [6] Kwon, T. H., Bae, S. C., Liu, C., Diversification and firm risk: New evidence on exchange rate exposure, *Journal of International Financial Markets, Institutions and Money*, 2025, 101: 102158. <https://doi.org/10.1016/j.intfin.2025.102158>
- [7] He, Q., Liang, B., Zhang, C., Does policy uncertainty affect firms' exchange rate exposure? Evidence from China, *China Economic Review*, 2026, 95: 102599. <https://doi.org/10.1016/j.chieco.2025.102599>
- [8] Huang, W., Zhang, W., Exchange rate and corporate investment: Heterogeneous effects via the global value chain networks, *Journal of International Money and Finance*, 2024, 147: 103159. <https://doi.org/10.1016/j.jimonfin.2024.103159>
- [9] Du, Q., Hong, S., Wang, Y., Wang, Y., Exchange rate, foreign currency debt and firm-level investment, *Journal of International Money and Finance*, 2026, 161: 103475. <https://doi.org/10.1016/j.jimonfin.2025.103475>
- [10] Bergbrant, M. C., Francis, B. B., Hunter, D. M., How does currency risk impact firms? New evidence from bank loan contracts, *Journal of Corporate Finance*, 2024, 84:102542. <https://doi.org/10.1016/j.jcorpfin.2024.102542>
- [11] El-Diftar, D., The impact of exchange rates on stock market performance of the Emerging 7, *Journal of Capital Markets Studies*, 2023, 7(2): 125–139. <https://doi.org/10.1108/JCMS-03-2023-0005>
- [12] Bonga-Bonga, L., Mpoha, S., Assessing the extent of exchange rate risk pricing in equity markets: Emerging versus developed economies, *African Journal of Economic and Management Studies*, 2024, 16(1): 148–159. <https://doi.org/10.1108/AJEMS-11-2023-0436>
- [13] Umore, D., Igbinovia, B., Odegha, B., Exchange rate volatility, stock prices and returns in BRICS: The moderating effect of inflation with wavelength analysis, *Economic Forum*, 2025, 15(1): 38–57. <https://doi.org/10.62763/ef/1.2025.38>
- [14] Yusoff, I., Chen, C., Lai, K., Naiker, V., Wang, J., Foreign exchange exposure and analysts' earnings forecasts, *Journal of Banking & Finance*, 2023, 146: 106715. <https://doi.org/10.1016/j.jbankfin.2022.106715>
- [15] Wang, L., Zhang, G., Lou, X., Guo, F., Does corporate internationalization affect analysts' earnings forecast bias? Evidence from China, *Research in International Business and Finance*, 2024, 72(A): 102505. <https://doi.org/10.1016/j.ribaf.2024.102505>
- [16] Das, J. P., Kumar, S., The dynamic effect of corporate financial hedging on firm value: The case of Indian MNCs, *Borsa Istanbul Review*, 2023, 23(3): 696–708. <https://doi.org/10.1016/j.bir.2023.01.010>
- [17] Chowdhury, R., Doukas, J. A., Mandal, S., CEO risk preferences, hedging intensity, and firm value, *Journal of International Money and Finance*, 2023, 130: 102751. <https://doi.org/10.1016/j.jimonfin.2022.102751>
- [18] Ullah, S., Irfan, M., Kim, J. R., Ullah, F., Capital expenditures, corporate hedging and firm value, *The Quarterly Review of Economics and Finance*, 2023, 87: 360–366. <https://doi.org/10.1016/j.qref.2021.06.008>
- [19] Ji, P., Wei, L., Hedging with derivatives to increase firm value, *Finance Research Letters*, 2023, 55(B): 103981. <https://doi.org/10.1016/j.frl.2023.103981>
- [20] Han, X., Laing, E., Enterprise risk management and foreign currency derivatives usage, *International Review of Economics & Finance*, 2025, 103: 104518. <https://doi.org/10.1016/j.iref.2025.104518>
- [21] Kim, S. F., Currency carry trades, risk management, and firm value: Evidence from Korean banking industry, *Journal of International Financial Markets, Institutions and Money*, 2023, 88: 101850. <https://doi.org/10.1016/j.intfin.2023.101850>
- [22] Al Amosh, H., Exchange rate volatility and ESG performance: An international empirical analysis, *Journal of Corporate Accounting & Finance*, 2025, 36(3): 14–28. <https://doi.org/10.1002/jcaf.22774>
- [23] Mohanty, D., Mohapatra, A. K., Tripathy, S., Matta, R., Nexus between foreign exchange rate and stock market: Evidence from India, *Investment Management and Financial Innovations*, 2023, 20(3): 79–90. [https://doi.org/10.21511/imfi.20\(3\).2023.07](https://doi.org/10.21511/imfi.20(3).2023.07)
- [24] Naidoo, D., Moores-Pitt, P. B. D., Akande, J. O., The exchange rates volatilities impact on the stock and real estate markets in South Africa, *International Journal of Housing Markets and Analysis*, 2025, 18(3): 598–620. <https://doi.org/10.1108/IJHMA-10-2023-0142>
- [25] Durmaz, N., Yang, S., Wang, D., Sector-specific exchange rate movements in Hong Kong stock market, *Australian Economic Papers*, 2026, 65(1): 30–48. <https://doi.org/10.1111/1467-8454.70008>
- [26] Dinga, B., Jimbo, H. C., Cletus, K. K., Che, S. F., Modeling and predicting exchange rate volatility: Application of symmetric GARCH and asymmetric EGARCH and GJR-GARCH models, *Journal of the Cameroon Academy of Sciences*, 2023, 19(2): 155–178. <https://doi.org/10.4314/jcas.v19i2.6>
- [27] Ahmar, A. S., Al Idrus, S., Asmar, A., Analyzing Rupiah-

USD exchange rate dynamics: A study with ARCH and GARCH models, JOIV: International Journal on Informatics Visualization, 2024, 8(3-2): 1802–1809. <https://doi.org/10.62527/joiv.8.3-2.3251>

[28] Adegboyo, O. S., Sarwar, K., Modelling and forecasting of Nigeria stock market volatility, Future Business Journal, 2025, 11(1): Article 124, 1–13. <https://doi.org/10.1186/s43093-025-00536-4>

[29] Peter, M., Mirau, S., Sinkwembe, E., Kasumo, C., Guambe,

C., Symmetric and asymmetric GARCH estimations of the impact of macroeconomic uncertainties on stock market dynamics in Tanzania, Future Business Journal, 2025, 11(1), 203:1–19. <https://doi.org/10.1186/s43093-025-00632-5>

[30] Kim Karlsson, H., Li, Y., Investigation of Swedish Krona exchange rate volatility using APARCH-Support Vector Regression, Financial Innovation, 2026, 12(1), 73:1–32. <https://doi.org/10.1186/s40854-026-00910-3>