

Exchange Rate Volatility and Corporate Profitability in Emerging Markets: Evidence from Peruvian Listed Firms

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Ricardo Hardy Andrade Caldas*

Abstract

This study examines whether exchange-rate volatility is associated with the profitability of Peruvian listed firms from 2010 to 2023. Using panel-data econometric techniques, the analysis is based on an effective estimation sample of 195 firm-year observations from 15 non-financial firms listed on the Lima Stock Exchange. The results indicate that exchange-rate volatility is not statistically significantly associated with corporate profitability, whereas financial leverage is negatively associated with profitability, and sales growth is positively and significantly associated with it. These findings suggest that firm-specific financial characteristics are more closely related to corporate profitability than exchange-rate uncertainty in the Peruvian context.

Keywords: exchange rate volatility; corporate profitability; firm-level evidence; emerging markets; Peru.

JEL Classification: F31, G32, C23

* Faculty of Engineering, Economics, and Business, Universidad Científica del Sur (Lima, Peru). ORCID: <https://orcid.org/0000-0002-0528-1847>. E-mail: randradec@cientifica.edu.pe

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Volatilidad del tipo de cambio y rentabilidad corporativa en mercados emergentes: evidencia de empresas peruanas cotizadas

Resumen

Este estudio examina si la volatilidad del tipo de cambio se asocia con la rentabilidad de empresas peruanas cotizadas durante 2010-2023. Mediante técnicas econométricas de datos de panel, el análisis utiliza 195 observaciones empresa-año de 15 empresas no financieras listadas en la bolsa de valores de Lima. Los resultados indican que la volatilidad cambiaria no presenta una asociación estadísticamente significativa con la rentabilidad, mientras que el apalancamiento financiero se asocia negativamente y el crecimiento de las ventas positivamente y de forma estadísticamente significativa con el ROA. Estos resultados sugieren que, en la muestra analizada, las características financieras de las empresas están más estrechamente relacionadas con la rentabilidad que la incertidumbre cambiaria.

Palabras clave: volatilidad del tipo de cambio; rentabilidad corporativa; evidencia a nivel de empresa; mercados emergentes; Perú.

Clasificación JEL: F31, G32, C23

Volatilidade da taxa de câmbio e rentabilidade corporativa em mercados emergentes: evidências de empresas peruanas listadas

Resumo

Este estudo examina se a volatilidade da taxa de câmbio está associada à rentabilidade de empresas peruanas listadas no período de 2010 a 2023. Por meio de técnicas econométricas de dados em painel, a análise utiliza 195 observações empresa-ano de 15 empresas não financeiras listadas na Bolsa de Valores de Lima. Os resultados indicam que a volatilidade cambial não apresenta associação estatisticamente significativa com a rentabilidade, enquanto a alavancagem financeira apresenta associação negativa, e o crescimento das vendas apresenta associação positiva e estatisticamente significativa com o ROA. Esses resultados sugerem que, na amostra analisada, as características financeiras das empresas estão mais estreitamente relacionadas à rentabilidade do que a incerteza cambial.

Palavras-chave: volatilidade da taxa de câmbio; rentabilidade corporativa; evidências em nível de empresa; mercados emergentes; Peru.

Classificação JEL: F31, G32, C23

Introduction

Exchange-rate volatility is a key source of macro-financial uncertainty for firms operating in emerging economies. Currency movements can affect corporate performance through production costs, export competitiveness, foreign-currency liabilities, financing conditions, investment decisions, and operating cash flows. However, the empirical record shows no uniform effect. Firm characteristics and institutional conditions can shape how exchange-rate movements are transmitted to corporate outcomes, making the relationship particularly difficult to generalize across emerging markets (Dornbusch, 1976; Eklou, 2023; Taylor et al., 2021). This question is therefore relevant to international corporate finance, especially in economies where firms remain exposed to external financial conditions.

The empirical literature reports mixed findings on the relationship between exchange-rate volatility and corporate financial performance. Exchange-rate risk can affect profitability through financing costs, investment decisions, and cash-flow variability, but the magnitude of the effect varies across firms and markets. Evidence from international and emerging-market settings points to heterogeneous exposure rather than a uniform response, suggesting that firm-level financial characteristics can influence how currency shocks transmit to corporate outcomes (Bartram et al., 2010; Eklou, 2023; Geyer-Klingenberg et al., 2021). This provides a rationale for examining exchange-rate volatility together with leverage, size, sales growth, and liquidity.

One reason for the mixed findings is that firms are not equally exposed to exchange-rate risk. Differences in capital structure, foreign-currency debt, export orientation, size, liquidity, and risk-management practices can alter how currency movements affect profitability. Consequently, firm-level studies often report results that vary across countries and industries, limiting the scope for broad generalizations from one market to another (Taylor et al., 2021; Sikarwar, 2023). Evidence from emerging economies is therefore most informative when it explicitly considers institutional and financial market characteristics.

Peru offers a useful setting for examining this relationship. It is a small open economy with a flexible exchange-rate regime and an inflation-targeting framework, and its firms remain exposed to international commodity markets and external financial conditions. Listed companies also vary substantially in their use of foreign-currency financing and in their participation in international trade. Yet firm-level evidence from Peru remains limited, leaving

room to examine whether exchange-rate volatility is associated with corporate profitability after accounting for observable firm-specific financial characteristics.

Existing studies have examined exchange-rate effects on international trade, corporate investment, firm value, and financial exposure, but fewer have focused directly on corporate profitability while controlling for firm-level financial characteristics. This distinction matters in emerging economies because leverage, size, liquidity, and growth can influence how external shocks affect firms' financial results. The period following the COVID-19 disruption also provides a useful setting for examining this relationship amid shifting international financial conditions (Taylor et al., 2021; Manner et al., 2024).

Against this background, the study examines whether exchange-rate volatility is associated with corporate profitability after controlling for firm-specific financial characteristics. The analysis uses firm-level data on companies listed on the Lima Stock Exchange from 2010 to 2023 and estimates the relationship between return on assets (ROA), exchange-rate volatility, financial leverage, firm size, sales growth, and liquidity. The objective is to determine whether exchange-rate uncertainty remains associated with profitability after accounting for differences in firms' financial conditions.

The study makes three contributions. First, it provides firm-level evidence from Peru, a market underrepresented in the international literature on exchange-rate exposure and corporate profitability. Second, it evaluates exchange-rate volatility alongside several firm-specific financial characteristics within the same panel-data framework. Third, the 2010–2023 period covers different macroeconomic conditions, including the COVID-19 disruption and the subsequent recovery, allowing the relationship to be examined across a changing external environment.

The article is organized as follows. Section 2 reviews the theoretical foundations and empirical literature on exchange-rate volatility and corporate profitability. Section 3 presents the hypotheses, data, and variable construction. Section 4 outlines the econometric methodology and model selection procedures. Section 5 reports the empirical findings. Finally, section 6 concludes by summarizing the main findings, implications, limitations, and directions for future research.

Theoretical Framework and Literature Review

Exchange Rate Exposure and International Financial Theory

Exchange-rate volatility is central to international corporate finance because currency movements can transmit macroeconomic shocks to firms operating in open economies. The relevant channels include financing costs, international competitiveness, investment decisions, foreign-currency liabilities, and expected cash flows. Earlier work distinguished transaction, translation, and economic exposure, while subsequent research has shown that a firm's effective exposure also depends on its operating and financial characteristics (Adler & Dumas, 1984; Bartram et al., 2010; Geyer-Klingeborg et al., 2021). These distinctions are important when evaluating whether exchange-rate uncertainty is reflected in corporate profitability.

The macroeconomic foundations of exchange-rate dynamics have been extensively developed in international economics. Dornbusch's (1976) overshooting model showed that monetary shocks, together with sluggish price adjustments, generate pronounced short-run exchange-rate volatility. Subsequently, Obstfeld and Rogoff (1995) extended this perspective by integrating exchange-rate determination into a framework of intertemporal optimization, rational expectations, and international capital mobility. Together, these frameworks explain how macroeconomic disturbances are transmitted to firms through exchange-rate movements and provide the conceptual foundation for contemporary empirical analyses of exchange-rate uncertainty and corporate profitability in internationally integrated markets.

The corporate finance literature defines exchange-rate exposure as the sensitivity of a firm's value to unexpected exchange-rate movements. The seminal contribution of Adler and Dumas (1984) established that exchange-rate exposure extends beyond direct foreign-currency transactions, affecting expected cash flows, production costs, pricing decisions, and international competitiveness. Complementing this perspective, Shapiro (1974) distinguished economic exposure as the long-term effect of exchange-rate movements on firms' competitive position, while Hodder (1982) emphasized accounting exposure arising from the consolidation of foreign subsidiaries' financial statements. Collectively, these foundational contributions characterize exchange-rate exposure as a multidimensional phenomenon in which currency fluctuations affect firms' operational, financial, and strategic decisions, providing the theoretical basis for contemporary empirical research on exchange-rate uncertainty and corporate profitability.

Empirical studies show substantial variation in exchange-rate exposure across firms, industries, and countries. Export orientation, production structure, foreign-currency liabilities, and risk-management practices can all influence firms' sensitivity to currency movements. Firm-level evidence from emerging markets also links exposure to financial structure and access to financing, supporting models that combine macroeconomic and firm-specific variables (Eklou, 2023; Sikarwar, 2023; Sharma, 2024).

Corporate Strategies for Exchange Rate Risk Management

Exchange-rate risk management is a well-established component of corporate financial strategy for firms operating across currency markets. Currency derivatives can reduce short-term exposure, while operational measures such as geographic diversification, production flexibility, and matching foreign-currency revenues with liabilities can reduce longer-term exposure. However, the effectiveness of these strategies varies depending on firms' financial constraints, organizational characteristics, and institutional settings (Eklou, 2023; Stulz, 2022; Sharma, 2024).

Available evidence also suggests that hedging can affect firms' financial vulnerability as exchange-rate uncertainty rises. Financial hedging may reduce cash-flow variability, while operational responses can provide additional flexibility when firms face external shocks. At the same time, exchange-rate risk can influence investment decisions when effective risk-management mechanisms are limited (Geyer-Klingenberg et al., 2021; Taylor et al., 2021). These findings support treating risk-management capacity as a potential mechanism through which firm characteristics condition the effects of currency volatility.

Nevertheless, the effectiveness of exchange-rate risk management remains context-dependent. Some studies link financial hedging to lower cash-flow volatility and higher firm value, though the benefits can vary with financial structure, governance, operational flexibility, and internationalization (Geyer-Klingenberg et al., 2021; Stulz, 2022). The relevant question is therefore not simply whether firms hedge, but under what conditions those strategies mitigate the financial consequences of exchange-rate movements.

Evidence from emerging markets points in the same direction: the consequences of currency fluctuations depend on firm-specific conditions, including leverage, liquidity, size, export orientation, and access to external finance (Eklou, 2023; Sharma, 2024). These characteristics can either amplify or dampen the transmission of exchange-rate shocks to profitability. This

motivates the empirical specification used here, which evaluates exchange-rate volatility together with firm-level financial variables.

Evidence from Latin American markets also indicates heterogeneous effects. For example, Araujo et al. (2023) examine exchange-rate volatility and investment among Brazilian companies and report that the relationship varies by firm and sector. Manner et al. (2024) show that exchange-rate and commodity-price risks are significant sources of variation in Latin American stock markets. Together, these studies support the need to account for differences in firms' financial structure and international exposure when studying currency risk in the region.

Despite this body of research, firm-level evidence on exchange-rate volatility and corporate profitability remains limited in Latin American emerging economies. Much of the literature examines exchange-rate exposure, investment, financial markets, or macroeconomic adjustment in isolation. Fewer studies integrate a firm-level panel structure with exchange-rate volatility and internal financial variables into a single profitability model. The gap is especially pronounced in Peru, where evidence on the joint role of exchange-rate uncertainty and firm-specific financial conditions remains scarce (Manner et al., 2024; Taylor et al., 2021).

Exchange Rate Volatility and Corporate Performance

Exchange-rate volatility can affect corporate profitability through export revenues, import costs, foreign-currency liabilities, financing conditions, and investment decisions. The expected effect is therefore not necessarily uniform across firms. International finance theory links currency uncertainty to expected cash flows and investment decisions, while empirical studies indicate that the magnitude and direction of exposure depend on firms' international activities and financial characteristics (Manner et al., 2024; Taylor et al., 2021).

Financial leverage may shape this transmission because firms with substantial debt, particularly foreign-currency debt, can be more vulnerable to currency depreciation due to higher debt-servicing costs and tighter financing conditions. This issue is especially relevant in emerging economies, where access to long-term domestic financing may be limited. Evidence linking leverage to firms' exposure to exchange-rate risk supports including leverage as a control variable in the profitability model (Taylor et al., 2021; Sharma, 2024).

Firm size can affect both profitability and the capacity to absorb external shocks. Larger firms may have more diversified operations, broader access to capital markets, stronger bargaining power, and more developed risk-management capabilities. Greater internationalization, however, can also increase exposure to foreign-currency movements (Manner et al., 2024; 2021; Sharma, 2024).

Sales growth reflects firms' operational dynamism and is an important indicator of future corporate profitability. Firms with sustained sales growth typically generate stronger internal cash flows, which support investment, technological upgrading, and greater financial flexibility to respond to adverse macroeconomic conditions. In internationally integrated markets, expanding firms may also be better positioned to exploit opportunities arising from exchange-rate movements by strengthening their competitive position and increasing export activity. Nevertheless, rapid expansion may simultaneously increase financing requirements and firms' exposure to external financial risks, particularly in emerging economies with imperfect capital markets. Therefore, sales growth represents an important control variable for distinguishing the effects of firms' growth dynamics from those associated with exchange-rate volatility when explaining corporate profitability (Araujo et al., 2023; Taylor et al., 2021).

Liquidity is another important dimension of firms' financial resilience. Firms with stronger liquidity positions may better absorb temporary financing pressures and cash-flow fluctuations, whereas liquidity constraints can limit investment and increase reliance on external finance. The literature therefore treats liquidity as a firm-level characteristic that can affect how macroeconomic disturbances are transmitted to corporate performance (Geyer-Klingenberg et al., 2021; Taylor et al., 2021). In the present model, liquidity is included to separate this short-term financial capacity from the association between exchange-rate volatility and profitability.

Taken together, the literature supports an empirical approach that examines exchange-rate volatility alongside firm-specific financial conditions. Leverage, size, sales growth, and liquidity can influence how external shocks are absorbed, and evidence from emerging and Latin American markets indicates that the average effect of exchange-rate risk may conceal substantial firm-level differences (Araujo et al., 2023; Eklou, 2023; Manner et al., 2024). The present study therefore uses a unified panel-data specification to assess whether exchange-rate volatility remains associated with profitability after accounting for these characteristics.

Conceptual Framework and Research Hypotheses

The conceptual framework treats corporate profitability as the outcome of both external conditions and firm-specific financial characteristics. Exchange-rate volatility represents the external source of uncertainty examined here, while leverage, size, sales growth, and liquidity capture internal conditions that may shape firms' responses to that uncertainty. This framework aligns with the firm-level exposure literature, which emphasizes that the effect of currency movements depends on the characteristics of the firms that experience them (Adler & Dumas, 1984; Taylor et al., 2021; Manner et al., 2024).

The empirical model therefore relates ROA to exchange-rate volatility while controlling for leverage, firm size, sales growth, and liquidity. These variables were selected because they capture observable dimensions of firms' financial structure, growth, and short-term financial capacity. Including them allows the association between exchange-rate volatility and profitability to be assessed without treating the macroeconomic variable as the sole explanation for differences in firm performance (Taylor et al., 2021; Geyer-Klingenberg et al., 2021; Sharma, 2024).

The hypotheses follow from the theoretical arguments and empirical findings reviewed above. Because the literature reports differences in both the magnitude and direction of the relationships, the hypotheses are stated as testable expectations rather than as established empirical results. They concern exchange-rate volatility, leverage, firm size, sales growth, liquidity, and corporate profitability among firms listed on the Lima Stock Exchange.

The literature identifies exchange-rate volatility as a key source of macroeconomic uncertainty that can affect corporate profitability. From an international finance perspective, unexpected exchange-rate movements may affect firms' expected cash flows, financing conditions, production costs, and investment decisions, thereby influencing profitability. Although empirical evidence remains mixed on the magnitude and direction of this relationship, particularly in emerging economies, theoretical models generally suggest that greater exchange-rate uncertainty is associated with higher operating and financial risk. Accordingly, the following hypotheses are proposed (Taylor et al., 2021; Manner et al., 2024).

H1. Exchange-rate volatility is negatively associated with corporate profitability.

H2. Leverage is negatively associated with corporate profitability.

H3. Firm size is positively associated with corporate profitability.

H4. Sales growth is positively associated with corporate profitability.

H5. Liquidity is positively associated with corporate profitability.

The hypotheses define the relationships to be tested, and the next section explains how the variables were measured and how the panel model was estimated. The empirical design uses firm-level financial information and annual exchange-rate volatility to distinguish changes driven by the external environment from those attributable to differences in firms' financial conditions.

Hypotheses, Data, and Variables

The empirical design tests whether exchange-rate volatility is associated with corporate profitability after accounting for leverage, firm size, sales growth, and liquidity. These variables are measured consistently across the sampled firms and years, allowing the panel structure to separate temporal variation from firm-level differences.

To test the proposed hypotheses empirically, the study uses an initial balanced panel of 15 non-financial firms listed on the Lima Stock Exchange from 2010 to 2023, yielding 210 firm-year observations. Fifteen observations from 2010 lack the lagged sales data needed to compute annual growth, so the final estimation sample comprises 195 firm-year observations. Firm-level financial information was obtained from audited annual financial statements and official disclosures published by the Superintendencia del Mercado de Valores (SMV; Superintendency of the Securities Market), while exchange-rate data come from the Banco Central de Reserva del Perú (BCRP; Central Reserve Bank of Peru) and are cross-validated with Bloomberg.

ROA is the dependent variable, FXVol is the primary explanatory variable, and leverage, firm size, sales growth, and liquidity are included as controls. Definitions and measurement procedures are provided below and summarized in Table 1.

Table 1. Operational Definition of Variables

Variable	Type	Operational definition	Measurement	Expected sign	Data source
ROA	Dependent variable	Corporate profitability	Net income divided by total assets	N/A	Audited financial statements (SMV)
FXVol	Independent variable	Annual exchange-rate volatility	Annual standard deviation of monthly logarithmic returns of the nominal PEN/USD exchange rate within each calendar year	-	BCRP; Bloomberg (validation)
LEV	Control variable	Financial leverage	Total debt divided by total assets	-	Audited financial statements (SMV)
Size	Control variable	Firm size	Natural logarithm of total assets	+	Audited financial statements (SMV)
Growth	Control variable	Sales growth	Annual percentage change in net sales	+	Audited financial statements (SMV)
LIQ	Control variable	Liquidity (current ratio)	Current assets divided by current liabilities	+	Audited financial statements (SMV)

Note: BCRP: Banco Central de Reserva del Perú; FXVol: annual exchange-rate volatility; LEV: leverage; LIQ: liquidity; PEN: Peruvian sol; ROA: return on assets; SMV: Superintendencia del Mercado de Valores; USD: U.S. dollar.

Source: Own elaboration based on audited financial statements obtained from the SMV, nominal exchange-rate data published by the BCRP, and Bloomberg financial databases.

Hypothesis Development

The conceptual model in Figure 1 summarizes the research hypotheses presented in Section 2. Consistent with the theoretical framework, exchange-rate volatility represents the primary source of external macroeconomic uncertainty, whereas financial leverage, firm size, sales growth, and liquidity are the key firm-specific financial characteristics included in the empirical model. The conceptual model illustrates the proposed relationships among the study variables and provides the theoretical foundation for the panel-data specification estimated in the subsequent sections.



Figure 1. Conceptual Framework of the Study

Note: The conceptual framework illustrates the hypothesized relationships between exchange-rate volatility, firm-specific financial characteristics (financial leverage, firm size, sales growth, and liquidity), and corporate profitability (ROA). ROA: return on assets.

Source: Own elaboration.

Data and Sample

The empirical analysis used a panel dataset of 15 non-financial firms listed on the Lima Stock Exchange from 2010 to 2023. The initial dataset comprised 210 firm-year observations. After excluding observations with missing values required for model estimation, the final analytical sample comprised 195 firm-year observations. Financial institutions were excluded because their capital structure, accounting standards, and regulatory framework differ substantially from those of non-financial firms, potentially affecting the comparability of financial indicators. The selected period spans different macroeconomic environments, including years of relative stability, the COVID-19 pandemic, and the subsequent economic recovery, providing an appropriate setting for examining the relationship between exchange-rate volatility and corporate profitability.

Firm-level financial data were obtained from audited annual financial statements and mandatory disclosures published by the SMV, ensuring reliable and consistent accounting information. Exchange-rate data were obtained from the BCRP and cross-validated against Bloomberg financial databases to verify consistency across data sources. Before estimation, all observations underwent data-cleaning procedures, including consistency checks, missing-value verification, and validation of variable construction. Subsequently, the final panel dataset for the econometric analysis was assembled.

Firms were included in the sample based on three selection criteria. First, each company had to be continuously listed on the Lima Stock Exchange throughout the study period to ensure sufficient longitudinal coverage for panel-data analysis. Second, complete and consistent annual financial information had to be available for the variables used in the empirical analysis, and observations with missing values were excluded at the final estimation stage. Third, firms operating in the financial sector were excluded because their capital structure, accounting practices, and regulatory requirements differ substantially from those of non-financial corporations. Applying these criteria produced a consistent, comparable sample suitable for examining the relationship between exchange-rate volatility and corporate profitability over time.

The resulting panel dataset provides sufficient cross-sectional and temporal variation to estimate firm-level relationships under different macroeconomic conditions. Although the number of firms is limited because the analysis covers non-financial companies continuously listed on the Lima Stock Exchange with complete information over the study period, the 195 firm-year observations provide a balanced estimation panel for these 15 firms over 2011–2023. The findings should therefore be interpreted as evidence for Peruvian listed non-financial firms rather than generalized to all firms operating in emerging economies. The use of audited financial information and official exchange-rate data also supports the transparency and reproducibility of the empirical analysis.

Construction of Variables

The empirical model includes one dependent variable, one principal explanatory variable, and four firm-specific control variables derived from the theoretical framework in Section 2. Corporate profitability, measured by ROA, is the dependent variable, and exchange-rate volatility (FXVol) represents the principal macroeconomic explanatory variable. Financial leverage (LEV), firm size (SIZE), sales growth (GROWTH), and liquidity (LIQ) are included as firm-specific control variables because the empirical literature identifies them as key determinants of corporate profitability under macroeconomic uncertainty (Taylor et al., 2021; Sharma, 2024). Table 1 above summarizes the operational definition, measurement, and expected relationship for each variable.

Corporate profitability is commonly measured by ROA, one of the most widely used accounting-based indicators in the corporate finance literature. ROA evaluates a firm's ability to generate earnings from its total asset base

and provides a comprehensive measure of operational profitability and asset utilization. Compared with market-based indicators, ROA is less sensitive to short-term stock price fluctuations and is therefore particularly suitable for panel-data analyses of firms' operating performance over time. Consistent with the empirical literature, ROA is calculated as net income divided by total assets (Taylor et al., 2021; Sharma, 2024):

$$\text{ROA} = \text{Net income} / \text{Total assets} \quad (1)$$

The principal explanatory variable is exchange-rate volatility (FXVol), which captures the degree of uncertainty associated with fluctuations in the nominal PEN/USD exchange rate. Consistent with the international finance literature, exchange-rate volatility is measured as the annual standard deviation of monthly logarithmic exchange-rate returns. Monthly logarithmic returns are computed as the first difference of the natural logarithm of the nominal exchange rate, expressed as:

$$\Delta \ln (ER_t) = \ln (ER_t) - \ln (ER_{t-1}) \quad (2)$$

Where ER_t denotes the nominal PEN/USD exchange rate in month t .

Annual exchange-rate volatility is computed as the standard deviation of 12 monthly logarithmic returns for each calendar year, providing an annual measure of exchange-rate uncertainty for the panel-data analysis. This procedure captures the magnitude of exchange-rate fluctuations while preserving the statistical properties of financial time series. Exchange-rate data were obtained from the BCRP, whose official statistics constitute the primary source of exchange-rate information for empirical research on the Peruvian economy. The use of logarithmic returns and annual standard deviations follows established practice in international finance, enabling comparability with previous empirical studies and ensuring consistent measurement of exchange-rate uncertainty (Bollerslev, 1986; Andersen et al., 2003; Taylor et al., 2021).

$$\text{FXVol}_y = [(1/11) \sum_{m=1}^{12} (\Delta \ln (ER_m) - \Delta \ln (E\bar{R}))^2]^{1/2} \quad (3)$$

Where FXVol_y denotes the annual exchange-rate volatility for year y ; m represents the month ($m = 1, \dots, 12$); $\Delta \ln (ER_m)$ is the monthly logarithmic return on the nominal PEN/USD exchange rate; and $\Delta \ln (E\bar{R})$ is the annual mean of the monthly logarithmic returns.

Because exchange-rate volatility is measured at the national level, all firms receive the same annual FXVol value within a given year. Its coefficient

is therefore identified from temporal variation rather than cross-sectional differences across firms. This feature aligns with the study's objective of assessing whether changes in the macroeconomic environment are associated with differences in corporate profitability after controlling for firm-specific financial characteristics. The random effects (RE) specification was selected based on the Hausman test, which determines how to treat unobserved firm-specific effects; common time variation in FXVol alone is not, by itself, the reason for choosing the RE model.

Econometric Methodology

To examine the relationship between exchange-rate volatility and corporate profitability, this study employs panel-data econometric techniques on a panel dataset of 15 non-financial firms listed on the Lima Stock Exchange from 2010 to 2023. Panel-data models exploit both the cross-sectional and temporal dimensions of the dataset, allowing the analysis to control for unobservable firm-specific heterogeneity, reduce omitted-variable bias, and improve the efficiency of the estimated coefficients. This approach is particularly appropriate for examining how macroeconomic uncertainty and firm-specific financial characteristics relate to corporate profitability (Baltagi, 2021; Wooldridge, 2020).

Consistent with the theoretical framework and the research hypotheses developed in the previous sections, corporate profitability is modeled as a function of exchange-rate volatility and firm-specific financial characteristics. Exchange-rate volatility (FXVol) is the primary explanatory variable, and financial leverage (LEV), firm size (SIZE), sales growth (GROWTH), and liquidity (LIQ) serve as control variables. The general panel-data specification is expressed as follows:

$$ROA_{it} = \alpha + \beta_1 FXVol_t + \beta_2 LEV_{it} + \beta_3 SIZE_{it} + \beta_4 GROWTH_{it} + \beta_5 LIQ_{it} + \mu_i + \varepsilon_{it} \quad (4)$$

Where ROA_{it} denotes the corporate profitability (return on assets) of firm i in year t ; α denotes the intercept; $FXVol_t$ is annual exchange-rate volatility; LEV_{it} is the financial leverage of firm i in year t ; $SIZE_{it}$ is the firm size of firm i in year t ; $GROWTH_{it}$ is the sales growth of firm i in year t ; LIQ_{it} = liquidity of firm i in year t ; β_1 – β_5 denote parameters to be estimated; μ_i is the unobserved time-invariant firm-specific effect; and ε_{it} is the idiosyncratic error term.

Following the specification of the empirical model, the appropriate panel-data estimator was selected through a sequential model-selection procedure. The analysis initially considered the pooled ordinary least

squares (Pooled OLS), fixed effects (FE), and RE estimators, each of which treats unobserved firm-specific heterogeneity differently. The FE estimator allows firm-specific effects to be correlated with the explanatory variables, whereas the RE estimator assumes these effects are randomly distributed and uncorrelated with the regressors, yielding more efficient estimates when this assumption holds. The selection between the FE and RE specifications was based on the Hausman specification test, which is widely used to evaluate the consistency of panel-data estimators (Hausman, 1978; Baltagi, 2021).

Fixed Effects and Random Effects Models

Panel-data estimation typically uses either the FE or RE estimator to account for unobserved firm-specific heterogeneity. The FE estimator controls for time-invariant firm characteristics by allowing unobserved firm-specific effects to be correlated with the explanatory variables. In contrast, the RE estimator assumes that these firm-specific effects are randomly distributed and uncorrelated with the regressors, thereby allowing both within-firm and between-firm variation to inform coefficient estimation. The choice between these estimators depends on the assumed relationship between unobserved firm-specific heterogeneity and the explanatory variables (Baltagi, 2021; Wooldridge, 2020).

Hausman Test

The Hausman specification test was used to select the appropriate estimator for the panel-data analysis. The test evaluates whether unobserved firm-specific effects are systematically correlated with the explanatory variables by comparing the FE and RE estimators. Under the null hypothesis, the RE estimator is consistent and asymptotically more efficient than the FE estimator. Rejection of the null hypothesis indicates that the FE estimator is preferred because the assumptions underlying the RE model are not satisfied (Hausman, 1978; Baltagi, 2021).

The Hausman test compares the FE and RE estimates to assess whether their differences are statistically significant. Under the maintained assumption that unobserved firm-specific effects are uncorrelated with the regressors, failure to reject the null hypothesis supports RE (Hausman, 1978; Baltagi, 2021). In the present study, the test did not reject the null hypothesis ($p = 0.561$), so RE was retained. The selected model was estimated using HC1 heteroskedasticity-consistent standard errors following Arellano (1987).

Empirical Results

This section presents the empirical analysis in five steps. It first describes the variables, then examines pairwise correlations, presents the panel regression estimates, reports specification and diagnostic tests, and finally considers the graphical evidence. The regression results are based on the selected Random Effects model with HC1 robust standard errors.

Descriptive Statistics

Descriptive statistics provide an initial characterization of the variables in the empirical analysis and offer preliminary evidence on their distributions, central tendencies, and dispersion over the period from 2010 to 2023. Examining these summary measures is an essential first step because it allows assessment of the dataset’s main characteristics, identifies heterogeneity across firms, and verifies sufficient cross-sectional and temporal variation to support subsequent panel-data estimation.

Table 2 presents descriptive statistics for the firm-level variables in the empirical model, reporting measures of central tendency, dispersion, and distributional characteristics. The statistics document heterogeneity across firms and the distributional properties of the variables used in the analysis (Wooldridge, 2020; Baltagi, 2021; Manner et al., 2024).

Table 2. Descriptive Statistics of Firm-Level Variables

Variable	N	Mean	Median	SD	Minimum	Maximum	Skewness	Kurtosis
ROA	210	0.065	0.050	0.105	-0.902	0.325	-3.247	33.170
LEV	210	0.517	0.543	0.145	0.048	0.861	-0.435	0.197
SIZE	210	14.602	14.509	0.779	12.848	16.722	0.677	0.141
GROWTH	195	0.065	0.057	0.171	-0.401	1.210	1.939	10.719
LIQ	210	7.481	1.344	85.620	0.438	1242.224	14.282	202.963

Note: BCRP: Banco Central de Reserva del Perú; FXVol: exchange-rate volatility; LEV: leverage; LIQ: liquidity; PEN: Peruvian sol; ROA: return on assets; SD: standard deviation; SIZE: firm size; smv: Superintendencia del Mercado de Valores; USD: U.S. dollar. Sales growth contains 15 missing observations because the first year (2010) for each firm lacks the previous-year observation required to compute annual growth rates. N reflects available observations for each variable; the regression analysis uses 195 complete firm-year observations.

Source: Own elaboration based on audited financial statements obtained from the smv.

Table 2 shows substantial heterogeneity across the sampled firms, particularly in profitability, sales growth, and liquidity. ROA exhibits considerable dispersion, with negative skewness and high kurtosis indicating extreme observations. Sales growth also varies widely, while liquidity shows the largest dispersion by far. Leverage and firm size are comparatively more stable. These patterns document meaningful cross-sectional heterogeneity in the sample. The subsequent heteroskedasticity test, rather than the distributional shape alone, provides the basis for using heteroskedasticity-consistent standard errors (Baltagi, 2021; Wooldridge, 2020; Manner et al., 2024).

Correlation Matrix

Before estimating the panel-data models, a correlation matrix was used to assess the degree of linear association among the firm-specific explanatory variables and to identify potential multicollinearity concerns (Table 3). Although pairwise correlation coefficients do not constitute a formal test of multicollinearity, they provide preliminary evidence on the strength of linear relationships that may affect the stability and interpretation of regression coefficients. The correlation analysis therefore complements the subsequent panel-data estimation (Baltagi, 2021; Wooldridge, 2020; Kim, 2023).

Table 3. Correlation Matrix

Variable	ROA	LEV	SIZE	GROWTH	LIQ
ROA	1.000	-0.316***	0.013	0.193***	-0.016
LEV	-0.316***	1.000	-0.226***	0.059	-0.051
SIZE	0.013	-0.226***	1.000	-0.032	0.022
GROWTH	0.193***	0.059	-0.032	1.000	0.031
LIQ	-0.016	-0.051	0.022	0.031	1.000

Note: GROWTH: sales growth; LEV: leverage; LIQ: liquidity; ROA: return on assets; SIZE: firm size. Pearson correlation coefficients are reported. Statistical significance is assessed using two-tailed tests ($p < 0.10$, $p < 0.05$, $p < 0.01$). The highest absolute pairwise correlation coefficient ($|r| = 0.316$) is well below the commonly accepted multicollinearity threshold (0.80), indicating that severe multicollinearity is unlikely to affect the regression estimates.

Source: Own elaboration.

Results of the Econometric Model

Table 4 presents the panel regression estimates obtained from the Pooled OLS, FE, and RE estimators. Consistent with the model-selection procedure

described in Section 4, the RE specification, estimated with heteroskedasticity-consistent HC1 robust standard errors following Arellano (1987), serves as the benchmark model for hypothesis testing and interpretation. Presenting the three alternative specifications facilitates comparison across estimators and provides evidence on the stability of the estimated relationships among exchange-rate volatility, firm-specific financial characteristics, and corporate profitability.

Table 4. Panel Regression Results

Variables	Pooled OLS	FE	RE (HC1 robust standard errors)
Intercept	0.305 (0.151)**	---	0.117 (0.288)
Exchange-rate volatility (FXVol)	-0.021 (0.018)	-0.019 (0.020)	-0.020 (0.019)
LEV	-0.228 (0.052)***	-0.436 (0.084)***	-0.355 (0.077) ***
SIZE	-0.009 (0.010)	0.031 (0.025)	0.009 (0.020)
GROWTH	0.130 (0.042)***	0.114 (0.031)***	0.117 (0.031)***
LIQ	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Observations	195	195	195
Firms	15	15	15
R ²	0.127	0.204	0.185

Note: FE: fixed effects; GROWTH: sales growth; LEV: leverage; LIQ: liquidity; OLS: ordinary least squares; RE: random effects; SIZE: firm size. RE estimates are reported with heteroskedasticity-consistent HC1 robust standard errors, following Arellano (1987). Standard errors are in parentheses. Statistical significance is denoted as *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$. The estimation sample comprises 195 firm-year observations because the first observation for each of the 15 firms lacks the lagged information needed to compute annual sales growth.

Source: Own elaboration based on audited financial statements obtained from the smv and exchange-rate data obtained from the BCRP.

In the RE model, leverage and sales growth are statistically significant, whereas exchange-rate volatility, firm size, and liquidity are not. The FXVol coefficient is negative but not statistically different from zero. Thus, the data provide no evidence of a direct association between exchange-rate volatility and ROA after controlling for firm-specific financial characteristics. By contrast, the signs and significance of leverage and sales growth indicate that internal financial conditions are more closely related to profitability among the sampled firms.

Financial leverage is negative and statistically significant across all three specifications. In the RE model, the coefficient indicates that higher debt ratios are associated with lower ROA, supporting H2. This result is consistent with the trade-off view of capital structure: although debt can provide tax advantages, excessive leverage can increase expected financial distress costs and weaken financial performance. Evidence from emerging markets also reports adverse associations between high leverage and firm performance under less favorable financial conditions (Manner et al., 2024; Sharma, 2024; Nguyen et al., 2024).

Sales growth is positive and statistically significant across the three specifications, supporting H4. Firms with stronger revenue growth in the sample report higher ROA. One interpretation is that expanding sales can improve capacity utilization and operating efficiency, though the estimated relationship should be understood as an association rather than a causal effect. Evidence from emerging markets likewise links firm growth to performance differences (Manner et al., 2024; Zhou & Park, 2024; Sharma, 2024).

Firm size is not statistically significant across any of the estimated models, so H3 is not supported. The result may partly reflect the limited variation in asset size among the sampled firms. It also indicates that, within this specification and sample, size adds no measurable explanatory power once other financial characteristics are accounted for (Santoso & Hersugondo, 2023; Manner et al., 2024).

Econometric Robustness Tests

The model-selection procedure used the F test for individual effects, the Breusch–Pagan LM test, and the Hausman test (Table 5). Additional diagnostics assessed heteroskedasticity and serial correlation. These tests were used to select the estimator and the form of statistical inference, not to assess the substantive relationships reported in Table 4 (Baltagi, 2021; Wooldridge, 2020).

The F test rejects Pooled OLS in favor of a model with firm-specific effects, and the Breusch–Pagan LM test favors RE over Pooled OLS. The Hausman statistic does not reject the null hypothesis ($p = 0.561$), so RE is retained. The diagnostics indicate heteroskedasticity but no evidence of serial correlation; therefore, HC1 robust standard errors are used in the reported RE estimates. These results support the selected specification for the purposes of statistical inference, while the substantive conclusions remain conditional on the model and sample used.

Table 5. Model Selection and Diagnostic Tests

Test	Statistic	Df	p-value	Decision
F Test (FE versus Pooled OLS)	13.831	(14, 176)	< 0.001	Reject Pooled OLS
Breusch–Pagan LM Test	251.720	1	< 0.001	Reject Pooled OLS in favor of RE
Hausman Test	2.983	4	0.561	RE favored
Breusch–Pagan Heteroskedasticity Test	12.900	4	0.012	Heteroskedasticity detected
Breusch–Godfrey/Wooldridge Serial Correlation Test	4.590	13	0.983	No serial correlation detected

Note: df: degrees of freedom; FE: fixed effects; OLS: ordinary least squares; RE: random effects. Model selection followed the conventional panel-data specification procedure. The F test rejected the Pooled OLS specification in favor of a model with individual effects. The Breusch–Pagan LM test favored the RE specification over Pooled OLS, and the Hausman test identified RE as the preferred estimator. Because heteroskedasticity was detected but no serial correlation was found, the final regression model used heteroskedasticity-consistent HC1 robust standard errors, following Arellano (1987).

Source: Own elaboration.

Graphical Analysis of Exchange Rate Volatility

Graphical analysis complements the econometric results by visually illustrating how exchange-rate volatility evolved over the study period. Although the panel regression results indicate that exchange-rate volatility does not have a statistically significant association with corporate profitability after controlling for firm-specific financial characteristics, examining the temporal behavior of exchange-rate fluctuations helps contextualize the macroeconomic environment faced by the sampled firms. The graphical evidence therefore serves as a descriptive complement to the econometric analysis, facilitating the interpretation of exchange-rate dynamics over time without implying causal effects.

Figure 2 illustrates the annual evolution of exchange-rate volatility in Peru from 2010 to 2023, measured as the annual standard deviation of monthly logarithmic returns of the nominal PEN/USD exchange rate. The figure shows periods of relatively stable exchange-rate conditions interrupted by episodes of higher volatility linked to external economic shocks and increased uncertainty in international financial markets. Despite these fluctuations, the regression results indicate that exchange-rate volatility does not have a statistically significant association with corporate profitability once firm-specific financial characteristics are included in the empirical model. The graphical evidence is consistent with exchange-rate movements as an important component of the macroeconomic environment, but it does not, by itself, explain differences in firms' profitability during the study period.

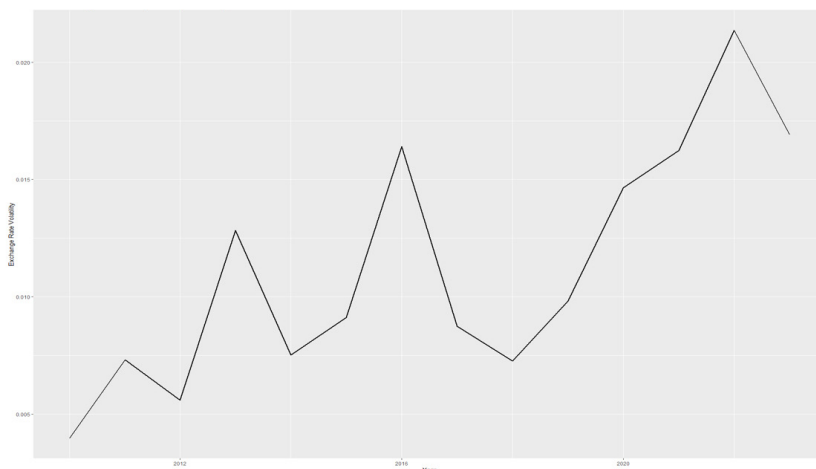


Figure 2. Annual Exchange-Rate Volatility in Peru (2010–2023)

Note: Exchange-rate volatility is measured as the annual standard deviation of monthly logarithmic returns of the nominal PEN/USD exchange rate.

Source: Own elaboration based on exchange-rate data obtained from the BCRP.

Figure 3 presents the annual trend in average ROA for the sampled listed Peruvian firms from 2010 to 2023. The figure shows a marked decline in average ROA in 2020, followed by a recovery in subsequent years.

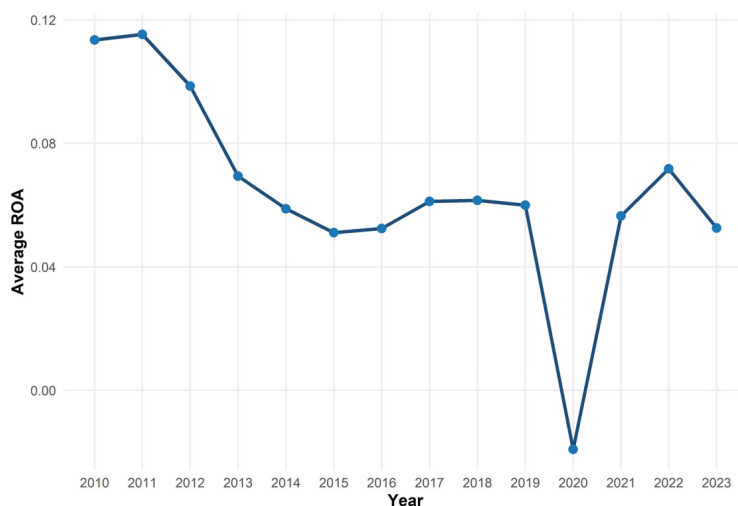


Figure 3. Annual Evolution of Return on Assets (ROA) of Peruvian Listed Firms (2010–2023)

Note: Annual ROA is the average yearly return on assets for the sampled Peruvian listed firms, calculated as net income divided by total assets.

Source: Own elaboration based on firms' financial statements.

Figure 4 shows the bivariate relationship between exchange-rate volatility and corporate profitability, measured by ROA. The fitted regression line has a slightly negative slope, suggesting that periods of higher exchange-rate volatility are associated with lower profitability. However, the dispersion of observations around the fitted line indicates that this relationship is relatively weak. This visual evidence is consistent with the panel regression results reported in Table 4, which show that exchange-rate volatility has no statistically significant effect on corporate profitability after controlling for firms' financial characteristics.

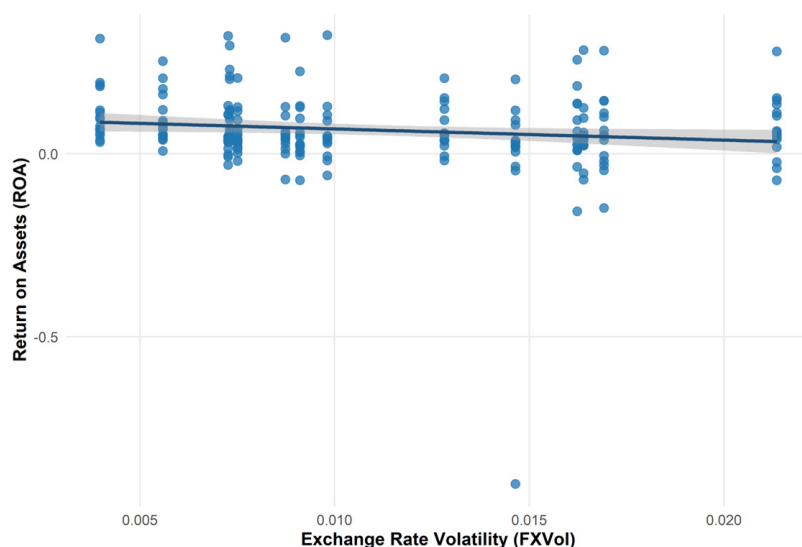


Figure 4. Relationship Between Exchange-Rate Volatility and Return on Assets (ROA)

Source: Own elaboration based on exchange-rate data from the BCRP and on firms' financial statements.

Figure 4 shows a weak negative fitted relationship between exchange-rate volatility and ROA, with considerable dispersion around the fitted line. This pattern aligns with the regression result: the estimated FXVol coefficient is negative but not statistically significant. The figure therefore provides descriptive support for the absence of a clear bivariate relationship, but it should not be treated as an independent test of the panel model.

Figure 5 compares the standardized annual paths of exchange-rate volatility and ROA. Z-scores place both variables on a common scale, making it easier to compare their movements over time.

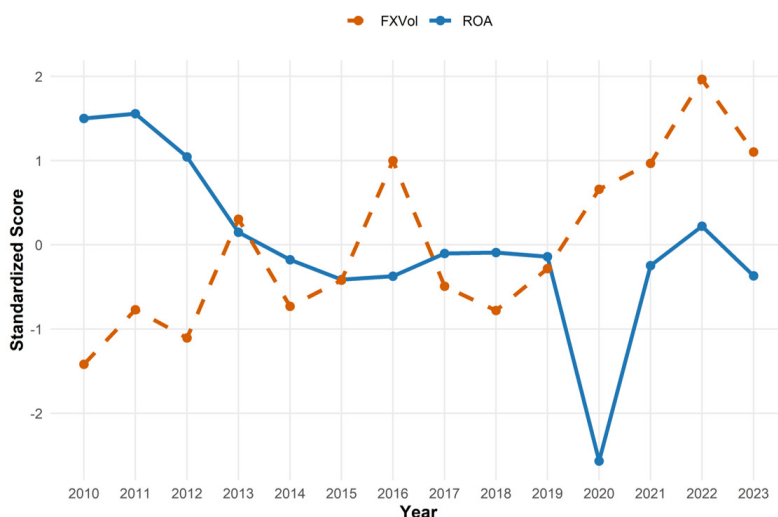


Figure 5. Standardized Trends of Exchange-Rate Volatility and Return on Assets (ROA) (2010–2023)

Note: Both variables are standardized using Z-scores to facilitate comparison of their temporal evolution. Positive values indicate observations above the sample mean, whereas negative values indicate observations below the sample mean.

Source: Own elaboration based on exchange-rate data obtained from the BCRP and on firms' financial statements.

The standardized series also follow different patterns. Exchange-rate volatility rises during periods of heightened macroeconomic uncertainty, including the pandemic, whereas ROA varies in a less synchronized manner. This lack of a common pattern is consistent with the regression results, although the graphical evidence is descriptive and does not establish causality.

Taken together, Figures 2 to 5 offer a visual overview of the exchange-rate series, its volatility, the bivariate relationship with ROA, and the standardized annual paths. The figures are consistent with the main econometric result: changes in FXVol are not systematically associated with changes in profitability across the sampled firms.

The main empirical result is that exchange-rate volatility is not statistically associated with ROA in the RE specification after controlling for leverage, size, sales growth, and liquidity. The graphical results point in the same direction but are used only as complementary evidence. The control variables show a different pattern: leverage is negatively associated with ROA, while sales growth is positively associated with ROA; size and liquidity are not statistically significant.

This result contributes to the debate on exchange-rate exposure in emerging markets. It suggests that aggregate currency volatility may not translate into a uniform change in accounting profitability across firms once differences in financial structure are considered. The result should not be interpreted as evidence that firms are unaffected by exchange-rate risk; it indicates only that the average association between the annual volatility measure used here and ROA is not statistically significant in this sample.

The absence of a significant FXVol coefficient may reflect heterogeneous exposure across firms. Companies with foreign-currency revenues may experience effects that differ from those of firms dependent on imported inputs or foreign-currency liabilities; if these effects move in opposite directions, the aggregate coefficient can be close to zero even when individual firms face currency risk. This interpretation aligns with the literature showing that exchange-rate exposure varies across firms (Dominguez & Tesar, 2006; Bartram et al., 2010). Because these mechanisms are not directly measured in the present study, they remain plausible explanations rather than empirical findings established by the estimated model.

Risk-management practices may also attenuate the transmission of currency movements to profitability. Allayannis and Ofek (2001) document the use of foreign-currency derivatives to manage exchange-rate exposure, while Bartram et al. (2010) show that hedging is associated with lower cash-flow sensitivity among multinational firms. The present study does not observe these practices among the sampled Peruvian firms, so they cannot be treated as a measured mechanism. Instead, they matter because they may explain the absence of a significant average effect.

Among the firm-level variables, leverage and sales growth are the two statistically significant predictors in the benchmark model. Higher leverage is associated with lower ROA, whereas stronger sales growth is associated with higher ROA. These results indicate that financing structure and growth dynamics are more closely related to profitability than the annual exchange-rate volatility measure in the present sample. They should be interpreted as conditional associations, not causal effects.

Firm size and liquidity do not reach conventional significance levels. The lack of significance does not imply that these variables are irrelevant to firm performance; it indicates that their independent associations with ROA are not precisely estimated in the current specification and sample.

The results should also be interpreted in light of the study's limitations. The model does not directly measure foreign-currency exposure, hedging, or industry-specific mechanisms that could mediate the effects of exchange-rate movements. Further work using firm-level exposure measures, information

on risk-management practices, and sector-specific specifications could help identify channels that are not observable in the current dataset.

The macroeconomic context provides an additional interpretive backdrop, particularly during the COVID-19 period. The study includes years with substantial changes in external conditions but does not estimate separate policy or pandemic effects. Accordingly, these episodes are treated as part of the sample environment rather than as identified causes of the estimated relationship.

This distinction is important for interpreting the main result. The absence of a statistically significant FXVol coefficient should not be taken as evidence that macroeconomic conditions were unimportant. It means that, within the estimated model, the annual volatility measure did not show a statistically detectable association with ROA after accounting for the firm-level controls.

Overall, the evidence points to a more heterogeneous relationship than a simple negative effect of exchange-rate volatility on profitability. The benchmark model does not support H1, whereas H2 and H4 receive empirical support. The results therefore favor a cautious interpretation: exchange-rate volatility was not a significant direct correlate of ROA among the sampled firms, whereas selected internal financial characteristics were.

Conclusions

This study examined the association between exchange-rate volatility and corporate profitability using data on 15 non-financial firms listed on the Lima Stock Exchange from 2010 to 2023. The analysis used a panel-data approach, yielding an effective estimation sample of 195 firm-year observations. Model selection favored RE, and the reported estimates used HC1 heteroskedasticity-consistent standard errors.

The central finding is that exchange-rate volatility is not statistically associated with ROA in the benchmark model. The estimated coefficient is negative but not statistically different from zero. By contrast, leverage is negatively associated with ROA, and sales growth is positively associated with it, whereas firm size and liquidity are not statistically significant. Thus, the empirical results support H2 and H4 but not H1, H3, or H5.

The absence of a significant FXVol coefficient may reflect heterogeneous operational and financial exposures across firms. Firms with foreign-currency revenues may experience effects that differ from those of firms dependent on imported inputs or foreign-currency liabilities. Similarly,

hedging and other risk-management practices may attenuate the transmission of exchange-rate movements. Because the study does not directly measure these mechanisms, they should be treated as plausible explanations rather than conclusions established by the econometric analysis (Allayannis & Ofek, 2001; Bartram et al., 2010; Geyer-Klingenberg et al., 2021).

The conclusions are conditional on the firms, period, variables, and estimator used in the analysis. The sample comprises listed non-financial firms in Peru, and the model does not include direct measures of foreign-currency exposure, hedging, industry-specific exposure, or other macroeconomic variables. Therefore, the findings should not be generalized to firms or settings that differ materially from the study population.

The study provides firm-level evidence from Peru by jointly estimating exchange-rate volatility and observable firm-specific financial characteristics in a panel framework covering 2010–2023. The panel structure separates temporal variation in the exchange-rate measure from differences in firm-level financial conditions, while the conclusions remain conditional on the variables, sample, and estimator used. The results add a country-specific case to the literature on heterogeneous exchange-rate exposure in emerging markets (Eklou, 2023; Manner et al., 2024).

For managers and policymakers, the negative association between leverage and ROA indicates that financing structure matters when assessing firm resilience under exchange-rate uncertainty. The absence of a significant FXVol coefficient does not diminish the importance of a stable macroeconomic environment. Because the study does not evaluate specific interventions, the estimates cannot be used to infer policy effects directly.

The study has several limitations. The sample is restricted to 15 publicly listed non-financial firms in Peru, limiting generalizability to private firms, other industries, and other institutional settings. The model also lacks direct measures of foreign-currency exposure, hedging, industry-specific mechanisms, and other macroeconomic variables. Future research could address these limitations by using larger samples, sector-specific measures, firm-level exposure data, and comparative evidence across Latin American economies.

Future research should incorporate firm-level measures of exchange-rate exposure, hedging practices, sector-specific characteristics, and broader macroeconomic variables. Comparative evidence from other Latin American economies could also help determine whether the relationships observed in Peru vary across institutional and financial settings.

Authors' Contributions

Ricardo Hardy Andrade Caldas: Conceptualization, data curation, formal analysis, investigation, methodology, software, validation, visualization, and writing—original draft and review & editing.

Conflict of Interest

The author declares no conflict of interest.

Data and Code Availability

The study uses audited financial statements and official exchange-rate data from the Superintendencia del Mercado de Valores (SMV) and the Banco Central de Reserva del Perú (BCRP), respectively. The analytical procedures were implemented in R, and the code for data preparation and estimation is available from the author upon reasonable request.

Use of Generative AI and AI-Assisted Technologies

During the preparation and revision of this manuscript, the author used OpenAI's ChatGPT and Google's Gemini as AI-assisted language and editorial tools. These tools supported drafting and revision, including language refinement, paraphrasing, translation support, identification of repetitive or formulaic phrasing, and improvements in clarity and coherence. They were not used to fabricate or alter the empirical data, statistical analyses, econometric estimates, or research findings. All theoretical arguments, methodological decisions, interpretations of the results, revisions, and final editorial decisions were made by the author. The author reviewed and verified the manuscript, including its citations, references, methodological procedures, and empirical interpretations, and assumes full responsibility for the final version of the article.

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