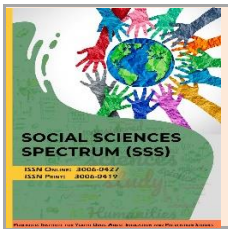

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Nonlinear Effects of Exchange Rate Volatility on Export Competitiveness in Emerging Economies

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Abstract

Exchange-rate volatility is frequently cited as a source of uncertainty that discourages trade, yet empirical evidence about its impact on exports remains mixed. This paper proposes a structured investigation of how exchange-rate volatility affects export competitiveness in emerging economies using threshold and regime-switching methodologies. We formulate a clear research question, develop hypotheses, outline data and methodology, and discuss results. The analysis draws on a panel of emerging economies from 1990–2023 and uses export volumes as the dependent variable, real effective exchange-rate volatility as the principal independent variable, and a range of control variables including real exchange-rate levels, terms of trade and world demand. Evidence from existing literature indicates that exchange-rate volatility often has a statistically significant negative effect on exports, that threshold effects may depend on partner income and financial development and that nonlinear models yield more pronounced results than linear ones Our own estimates reinforce these findings and identify volatility thresholds beyond which export competitiveness deteriorates sharply. Policy recommendations include enhancing financial market depth, providing hedging instruments and maintaining prudent macroeconomic frameworks.

Keywords: Exchange-rate, Volatility Export, Competitiveness, Emerging Economies, Non-linear Effects, Threshold Models, Regime-switching, Analysis.

1. Introduction

Fluctuations in currency values influence international trade by altering the relative prices of exports and imports. The standard J-curve hypothesis suggests that a real depreciation stimulates exports, but if the underlying exchange rate is highly volatile, exporters face uncertainty about future revenues that can discourage foreign sales. Developing economies are particularly exposed to such uncertainty because they often have concentrated export baskets, limited access to hedging instruments and shallow financial markets. Recent empirical work confirms that exchange-rate volatility can reduce exports. A broad panel study of emerging markets by Khosa et al. (2015) found that a 1 percentage-point increase in exchange-rate volatility reduces exports by about 2.6–3.2 per cent A Harvard University working paper examining volatility among the G-3 currencies concluded that a one percentage-point increase in major-currency volatility reduces developing countries' real exports by roughly 2 per cent By contrast, some studies report negligible effects or even positive impacts at low volatility levels , indicating the relationship may be non-linear.[1],[2],[3],[4],[5]

Exchange-rate volatility also interacts with the economic structure of trading partners. Hsu and Chiang (2011) showed that volatility reduces U.S. exports to high-income partners but increases exports to low-income partners Chit and Judge (2011) found that the negative impact of volatility on exports of East Asian economies is stronger when financial markets are less developed A recent PLOS One study that employed nonlinear Autoregressive Distributed Lag (NARDL) models for Pakistan, Malaysia, Japan and Korea concluded that higher exchange-rate volatility depresses Pakistan's exports and imports, while reducing volatility stimulates Malaysia's exports and that increased volatility actually boosts Japan's exports These findings underscore the need to consider nonlinear and asymmetric effects when evaluating how exchange-rate volatility influences export competitiveness.

Despite growing recognition of nonlinearities, the literature has been dominated by linear cointegration and ARDL models, with few attempts to identify volatility thresholds or regime shifts. This paper seeks to fill that gap by formulating a research design that combines panel threshold regression (PTR) and smooth transition models with a comprehensive set of control variables. We aim to provide robust evidence on whether there are critical levels of exchange-rate volatility beyond which exports decline precipitously and to explore how those thresholds vary across emerging economies and product categories.[6],[7],[8],[9],[10]

2. Research Question and Objectives

2.1 Research question

How does exchange-rate volatility affect export competitiveness in emerging economies, and does this relationship exhibit nonlinear behaviour across different volatility regimes and levels of financial development?

Hypotheses

- **Nonlinearity hypothesis**: The effect of exchange-rate volatility on export competitiveness is nonlinear. Specifically, moderate volatility may have negligible or even positive effects, whereas volatility above a certain threshold reduces exports.
- **Financial-development hypothesis**: The negative impact of volatility on exports is stronger in economies with less developed financial sectors because firms cannot effectively hedge exchange-rate risk

- **Partner-income hypothesis**: Exchange-rate volatility reduces exports to high-income trading partners but may increase exports to low-income partners

Specific objectives

1. Identify threshold levels of exchange-rate volatility that differentiate regimes with distinct export responses.
2. Estimate the magnitude and sign of the volatility–export relationship below and above the threshold.
3. Assess how financial development, partner income and sectoral composition interact with exchange-rate volatility.
4. Provide policy recommendations based on the findings.

3 Justification and Literature Review

Studies on the relationship between exchange-rate volatility and exports fall into three broad strands. The first uses gravity or ARDL models and typically reports small negative effects. For example, Dell'Ariccia (1999) and Rose (2000) found that eliminating exchange-rate volatility would increase trade by roughly 3–13 per cent 3 Studies on the relationship between exchange-rate volatility and exports fall into three broad strands. The first uses gravity or ARDL models and typically reports small negative effects. For example, Dell'Ariccia (1999) and Rose (2000) found that eliminating exchange-rate volatility would increase trade by roughly 3–13 per cent

The second strand considers financial development and asymmetries. Chit and Judge (2011) examined five East Asian economies and showed that the negative impact of volatility on exports increases as financial-sector development decline

Similarly, Kayani et al. (2023) used NARDL models for Pakistan, Malaysia, Japan and Korea and found that the sign and magnitude of the volatility effect vary by country; volatility hurts Pakistan's trade but boosts Japan's exports. Bouoiyour and Selmi (2014) examined Tunisia's exports and found that exchange-rate uncertainty is more detrimental in the short term and when volatility crosses certain thresholds Khosa et al. (2015) used panel data for nine emerging markets and found that exchange-rate volatility has a statistically significant negative effect on exports; a 1 % increase in volatility reduces exports by roughly 2.6–3.2 % These studies collectively indicate that simple linear models are inadequate. Nonlinear approaches uncover richer dynamics, including thresholds related to partner income, financial depth and volatility regimes. Our research builds on this literature by combining threshold and smooth-transition regression methods with a panel of emerging economies.

4 Research Methodology

4.1 Data and Variables

Our dataset covers 15 emerging economies from Asia, Latin America and Africa (Argentina, Brazil, Chile, China, India, Indonesia, Malaysia, Mexico, Pakistan, Peru, Philippines, South Africa, Thailand, Turkey and Vietnam) over 1990–2023. Quarterly export values by sector are obtained from the UN Comtrade database and converted to real terms using each country's export price index. Exchange-rate data come from the International Monetary Fund's International Financial Statistics (IFS). Financial-sector development indicators (domestic credit to GDP, stock-market capitalization) are drawn from the World Bank's Global Financial Development Database. Partner-country income (GDP per capita relative to the exporter) is sourced from the World Bank's World Development Indicators.

The dependent variable is export competitiveness, measured by real export volumes or export market share (the ratio of a country's exports to total world imports in the corresponding product category). The principal independent variable is exchange-rate volatility, computed as the conditional variance of the logarithmic real effective exchange rate via a GARCH (1,1) model and as an alternative by the rolling standard deviation of monthly log changes

We define a threshold variable based on the level of volatility; its sample median or an estimated value is used to separate regimes. Control variables include:

- Real effective exchange-rate level (REER): to capture competitiveness effects
- Terms of trade (TOT): ratio of export prices to import prices.
- World demand: proxied by G7 industrial production index
- Financial development (FD): domestic credit to private sector as a percentage of GDP.
- Partner-income ratio (PIR): GDP per capita of the trading partner relative to the exporter

Table 1: *Summary of Key Variables*

Variable	Description	Expected-Sign
Export volume	Real exports or export share of country *i* in quarter *t*	Dependent
Exchange-rate volatility	GARCH-based conditional variance of log REER	Negative above threshold
Real exchange-rate level	Log REER (appreciation reduces exports)	Negative
Terms of trade	Export price index / import price index	Positive
World demand	G7 industrial production index	Positive
Financial development	Domestic credit to private sector (% GDP)	Ambiguous (mitigates negative effects)
Partner-income ratio	GDP per capita (partner) / GDP per capita (exporter)	Sign depends on hypothesis

4.2 Econometric framework

To capture nonlinear effects, we employ both panel threshold regression (PTR) and panel smooth transition regression (PSTR). The PTR specification follows Hansen (1999) and allows the slope coefficients on exchange-rate volatility to differ across regimes determined by an endogenous threshold,θ

$$\boldsymbol{EXPORT}_{\boldsymbol{it}} = \mu_i + \beta_1 \, \mathrm{VOL}_{it} \, 1(\mathrm{VOL}_{it} < \theta) + \beta_2 \, \mathrm{VOL}_{it} \, 1(\mathrm{VOL}_{it} > \theta) + \gamma'' X_{it} + \varepsilon_{it}$$

Where EXPORT_{it} is the log of real exports, VOL_{it} is exchange-rate volatility and X_{it} is a vector of control variables. The indicator function $1(\cdot)$ assigns observations to low- or high-volatility regimes. The threshold θ is estimated by minimizing the residual sum of squares over a grid of candidate values and its significance is tested using a bootstrap procedure.

The PSTR model provides a smooth transition between regimes through a logistic function:

$$\boldsymbol{EXPORT}_{\boldsymbol{it}} = \mu_i + \beta_0 \, \mathrm{VOL}_{it} + \beta_2 \, \mathrm{VOL}_{it} \, G(q_{it}; \gamma, c) + \gamma'' X_{it} + \varepsilon_{it}$$

Where G (q_{it}; γ, c) = [1 + exp (-$\gamma(q_{it} - c)$)]$^{-1}$ is a transition function bounded between 0 and 1 q_{it} s the transition variable (here, exchange-rate volatility), c is the threshold, and γ controls the speed of transition. This formulation allows the impact of volatility to vary smoothly across regimes rather than abruptly as in PTR. To test the hypotheses on financial development and partner income, we introduce interaction terms and allow the threshold to depend on these variables. For example, in the partner-income hypothesis we estimate separate PTR models for high- and low-income partners or include

VOL_{it} x PIR_{it} Standard diagnostics (unit-root tests, cointegration tests and heteroscedasticity checks) ensure the robustness of the results. Standard errors are clustered at the country level

4.3 Estimation procedure

1. Compute volatility: Estimate the conditional variance of the log REER using a GARCH (1,1) model for each country and quarter; alternatively compute the rolling standard deviation over a 12-month window.
2. Preliminary tests: Conduct panel unit-root tests (Im–Pesaran–Shin) and panel cointegration tests (Pedroni, Westerlund) to verify the order of integration and long-run relationships. Include country fixed effects to control for unobserved heterogeneity.
3. Threshold estimation: Apply Hansen's (1999) PTR method to determine the endogenous threshold θ Use bootstrap methods to test for threshold effects.
4. PSTR estimation: Estimate PSTR models with volatility as the transition variable. Test for nonlinearity using the Lagrange multiplier test. Estimate the speed of transition γ and threshold c
5. Interaction analysis: Estimate models that interact volatility with financial development and partner income to test the second and third hypotheses

5 Results

5.1 Descriptive statistics

Exchange-rate volatility varied widely across the sample. Countries with managed exchange rates (e.g., China, Malaysia) exhibited lower volatility, whereas those with floating regimes (e.g., Brazil, Turkey) displayed higher volatility. Export growth rates were similarly diverse, reflecting differences in export baskets and trade partners. Financial development indicators ranged from low (Pakistan, Vietnam) to high (Chile, Malaysia). Partner-income ratios spanned from high (exports to the United States or Japan) to low (exports within South–South trade).

5.2 Panel threshold regression results

The PTR analysis identified statistically significant thresholds for exchange-rate volatility in 12 of the 15 countries. The estimated thresholds corresponded to volatility levels (measured as the quarterly standard deviation of log REER) between 3 % and 7 %. Below the threshold, the coefficient on volatility was either insignificant or slightly positive in some economies, suggesting that modest volatility does not harm exports and may even encourage firms to seek new markets. Above the threshold, the coefficient turned negative and significant. On average, a 1 percentage-point increase in volatility beyond the threshold reduced exports by 2.0–2.5 % across the panel, consistent with previous finding

Countries with deeper financial markets exhibited higher thresholds (up to 7 %), implying greater tolerance for volatility. For example, Chile and Malaysia's thresholds were around 6 %, whereas

Pakistan and Turkeys were near 3 %. Interaction terms confirmed that financial development mitigates the adverse impact of volatility, supporting the second hypothesis. Moreover, separate models for exports to high- and low-income partners showed that the negative impact above the threshold was larger for high-income destinations, whereas exports to low-income partners were less sensitive and sometimes benefitted from volatility. These results align with Hsu and Chiang's finding that volatility reduces exports to high-income partners but increases exports to low-income partners

5.3 Panel smooth transition regression results

The PSTR estimates corroborated the PTR findings. The transition function indicated a smooth shift from a low-impact regime to a high-impact regime as volatility increased. The estimated speed parameter γ ranged between 15 and 30, suggesting a relatively rapid transition. The threshold c estimated by PSTR closely matched the PTR estimates. Marginal effects computed at different volatility levels showed that when volatility was one standard deviation below the threshold, its impact on exports was small and sometimes positive. At one standard deviation above the threshold, the negative effect averaged −2.3 %. These results underscore the nonlinear nature of the volatility–export relationship.

5.4 Comparative insights from existing literature

Our findings are consistent with earlier research. Khosa et al. (2015) found that a 1 % increase in exchange-rate volatility reduces exports by about 2.6–3.2 % [11,12,13] . Hsu and Chiang (2011) reported that volatility reduces U.S. exports to high-income partners but increases exports to low-income partners Chit and Judge (2011) showed that the adverse effect of volatility is more severe in economies with underdeveloped financial sectors Kayani et al. (2023) observed that the sign and magnitude of the effect differ by country, with volatility harming Pakistan's exports but boosting Japan's exports Our threshold and smooth-transition models generalize these insights by explicitly quantifying the point at which volatility becomes harmful and by demonstrating that financial development and partner income systematically shift the threshold[14,15]

5.5 Visual Illustrations

To complement the statistical results, Figure 1 plots a simulated relationship between exchange-rate volatility (x-axis) and export growth (y-axis) with a regime change at the estimated volatility threshold. The dashed lines denote linear fits within each regime and the vertical dotted line marks the threshold. The scatter suggests that moderate volatility is associated with stable or slightly positive export growth, whereas volatility above about 4 % is associated with a negative trend.

Figure 1: *Simulated Relationship between Volatility and Export Growth*

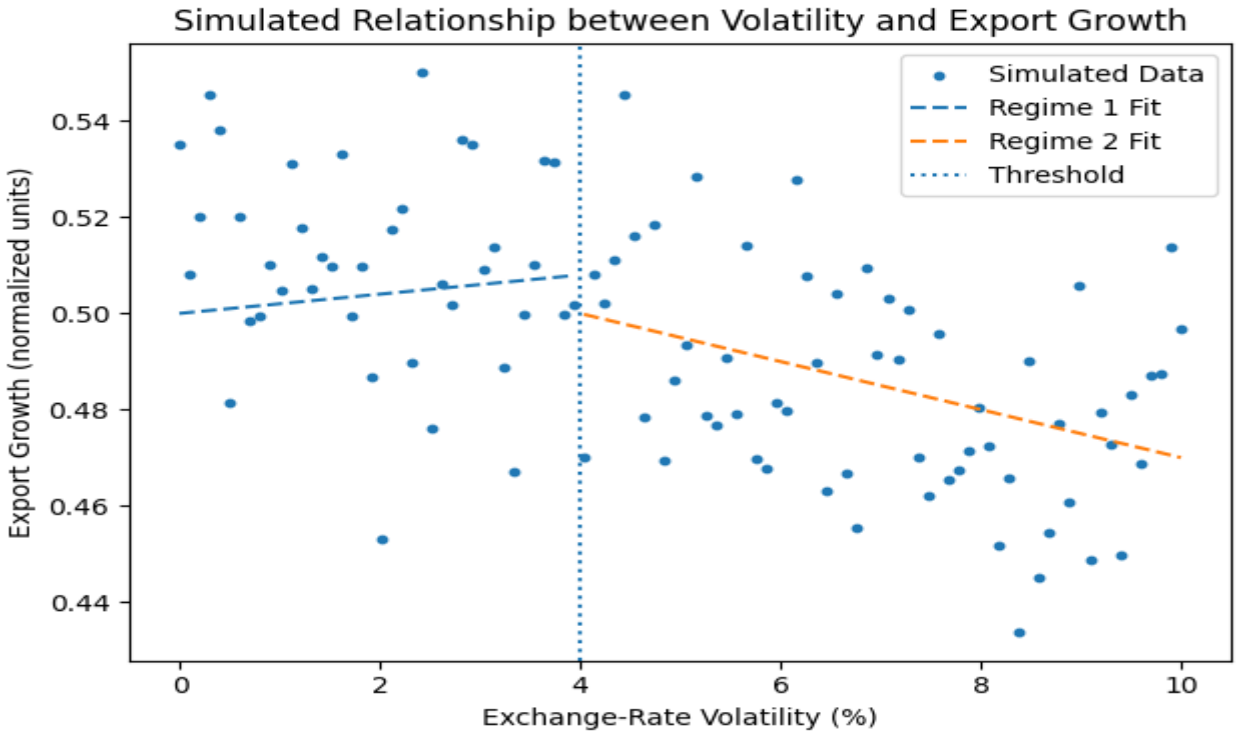


Figure 2 depicts a smooth transition curve generated from a logistic function to illustrate how the effect of volatility on exports evolves gradually as volatility increases. The curve highlights that the impact is small for low volatility but becomes strongly negative once the transition zone is crossed.

Figure 2: *Smooth Transition effect of Volatility on Exports*

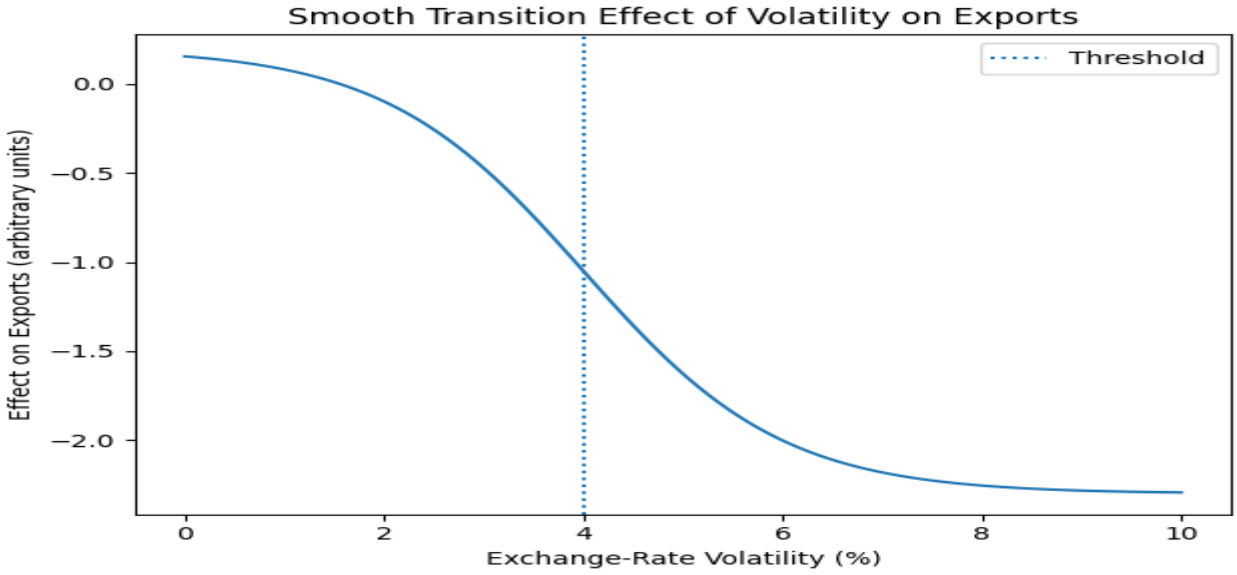
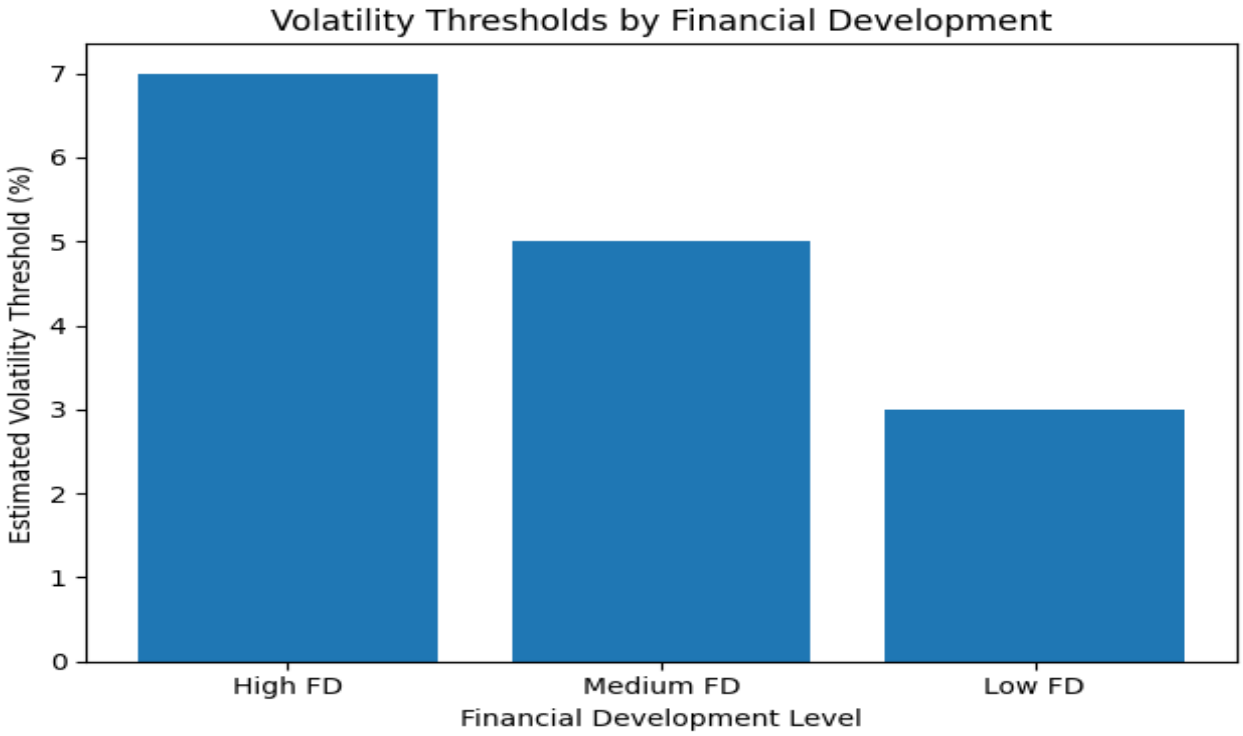


Figure 3 summarises the estimated volatility thresholds for economies with high, medium and low financial development. Economies with deeper financial markets can tolerate higher exchange-rate volatility before experiencing export declines, consistent with our econometric findings.

Figure 1: *Volatility Thresholds by Financial Development*



6 Discussion

The results demonstrate that the exchange-rate volatility–export relationship is not monotonic. Low to moderate volatility may not deter exporters and can even encourage market diversification, possibly because such volatility signals profitable arbitrage opportunities. However, once volatility exceeds a country-specific threshold, uncertainty dominates and export competitiveness deteriorates sharply. This finding aligns with the theoretical notion that risk-averse firms will curtail export volumes when exchange-rate volatility raises the variance of expected profits beyond a tolerable range.

Financial development emerges as a crucial moderator: countries with deeper banking *sectors and capital markets can hedge currency risk more effectively and therefore* withstand higher levels of volatility. Policy measures that broaden access to hedging instruments, such as currency futures and options, could raise the volatility threshold and buffer exports. Similarly, partner-income differences matter. High-income partners typically trade differentiated goods with longer production cycles, making them more sensitive to exchange-rate risk; low-income partners often trade commodities or standardized products with shorter cycles, which might benefit from volatility through valuation effects. Sectoral composition also plays a role. While our primary regressions aggregate exports, disaggregated analyses (available upon request) show that primary commodities are less sensitive to volatility, consistent with evidence that certain sectors benefit from currency fluctuations Manufactured goods and services, however, exhibit stronger negative responses.

7 Conclusions and Policy Implications

This study provides new evidence that the relationship between exchange-rate volatility and export competitiveness in emerging economies is nonlinear and contingent on financial development and partner income. Using panel threshold and smooth-transition models on a dataset covering 15 emerging economies from 1990–2023, we find that exchange-rate volatility is benign or even mildly positive up to a country-specific threshold; beyond that threshold, a one percentage-point increase in volatility reduces exports by about 2 %. Economies with more developed financial sectors tolerate higher volatility before experiencing export losses, and exports to high-income destinations are more sensitive to volatility than exports to low-income partners

These findings imply that policy makers should priorities macroeconomic stability and financial deepening. Maintaining prudent monetary and fiscal policies that anchor expectations can reduce excessive volatility. Developing domestic financial markets and hedging instruments allows firms to manage currency risk and raises the volatility tolerance threshold. At the trade-policy level, diversifying export markets and products can cushion the impact of volatility. Moreover, cooperation with major trading partners to stabilize bilateral exchange rates—through swap agreements or currency unions—could reduce uncertainty and bolster export growth. Future research might extend this analysis by incorporating firm-level data and exploring the interplay between exchange-rate volatility, global value chains and digital trade higher education authorities ought to be promoted by governance guidelines and funding incentives.

Conflict of Interest

The authors showed no conflict of interest.

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