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Unraveling Exchange Rate Volatility Impact on Economic Growth: A Study of Developing Countries through the Lens of Exchange Rate Regimes and Financial Openness

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Abstract

The paper investigates the relationship between exchange rate volatility and economic growth in developing countries. It utilizes a sample of 31 developing countries and covers the period from 1992 to 2022. The study employs the difference and system Generalized Method of Moments estimators (GMM) to conduct an empirical analysis. The findings indicate that both nominal and real effective exchange rate volatility, as measured by the generalized autoregressive conditional heteroskedasticity (GARCH) model, have a negative impact on economic growth. This suggests that higher levels of exchange rate volatility tend to hinder economic growth in the sampled countries. Furthermore, the study suggests that the effect of exchange rate volatility on economic growth is contingent upon two factors: exchange rate regimes and financial openness. Specifically, the negative impact of volatility is more pronounced in countries with flexible exchange rate regimes and higher degrees of financial openness. This implies that countries with flexible exchange rate regimes, where the value of the currency is determined by market forces, are more susceptible to the adverse effects of exchange rate volatility on economic growth. Similarly, countries with higher levels of financial openness, characterized by greater integration with international financial markets, are also more affected by exchange rate volatility. The study highlights the importance of stabilizing exchange rates and managing volatility to promote economic growth, particularly for countries with flexible exchange rate regimes and high financial openness. Policy measures aimed at reducing exchange rate volatility and enhancing stability may help mitigate the negative impact on economic growth in these countries.

Keywords: Exchange rate volatility, Economic growth, Exchange rate regime, Financial openness, GARCH model.

I. Introduction

Since the adoption of financial liberalization policies, many developing countries have been exposed to sharp exchange rate fluctuations. As a result, economists have become interested in examining the effects of exchange rate volatility (ERV) on different aspects of the economy, including trade flows and economic growth. While previous studies have focused on the effects of ERV on trade flows, research on the relationship between ERV and economic growth has yielded mixed results, and this is due to several reasons. Firstly, the effects of ERV on the dynamics of growth are contradictory. On one hand, ERV may be considered a shock absorber and can be more appropriate for countries experiencing frequent real shocks. For example, exchange rate depreciation can help increase the competitiveness of exports, and hence boost economic growth. On the other hand, volatility may be associated with higher macroeconomic volatility in terms of international trade, investment, and economic growth. This can lead to uncertainty and instability, which can have a negative impact on economic growth. Secondly, the relationship between exchange rates and economic growth also depends on other control variables such as financial development. Where financial development can help reduce the negative impact of ERV on economic growth by improving the efficiency of the financial system and reducing the costs of hedging against exchange rate risks.

The purpose of the paper is to investigate the relationship between ERV (nominal and real effective exchange rate volatility) and economic growth in a sample of 31 developing countries over the period from 1992 to 2022. The study aims to shed light on this relationship by considering two important factors: exchange rate regimes (ERR) and financial openness policies.

By considering exchange rate regimes, the study likely wants to analyze how the choice of exchange rate system influences the relationship between

ERV and economic growth. Different exchange rate regimes have different implications for exchange rate stability and flexibility, which can in turn affect the impact of ERV on economic growth.

Financial openness policies refer to the extent to which a country allows cross-border flows of capital, including foreign direct investment, portfolio investment, and financial services. Financial openness can affect the transmission channels through which ERV impacts economic growth. For instance, greater financial openness may expose a country to higher risks and vulnerabilities arising from exchange rate fluctuations, potentially influencing economic growth.

This paper is organized as follows. Section II reviews the relevant literature on the transmission mechanisms between ERV and economic growth. This section provides a critical analysis of the existing literature, identifying gaps and limitations. Section III describes the methodology used to compute the measure of ERV. The paper employs the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model proposed by Bollerslev (1986) to estimate ERV. This section explains the underlying assumptions of the model and describes the steps taken to estimate the measure of exchange rate volatility. Section IV outlines the empirical methodology used to investigate the relationship between ERV and economic growth in the sample of 31 developing countries. The section provides a detailed description of the econometric techniques used in the analysis, including panel data analysis and regression analysis. Section V presents and discusses the empirical results obtained from the analysis. This section provides a comprehensive overview of the relationship between ERV and economic growth in developing countries while taking into account the effects of exchange rate regimes and financial openness policies. Finally, Section VI concludes the paper by summarizing the main findings of the study and highlighting their policy implications.

2. Literature Review

The relationship between exchange rate dynamics and macroeconomic performance is a complex and much-debated topic in economics. On the one hand, some studies have found that exchange rate flexibility can have a positive impact on economic growth by facilitating adjustments to shocks. For example, the classic Mundell-Fleming model suggests that in a small open economy, a flexible exchange rate can help stabilize output and prices in response to external shocks Mundell (1961), Edwards and Levy-Yeyati (2005). On the other hand, other studies have found that ERV can have negative effects on macroeconomic variables such as international trade, investment, and employment. For example, exchange rate fluctuations can increase uncertainty and make it harder for firms to plan and invest in the long term. Additionally, ERV can make exports and imports more expensive, which can reduce trade volumes and hurt employment in industries that rely heavily on international trade Doğanlar (2002), Servén (2003), Demir (2010), Belke and Gros (2001).

The argument for flexible exchange rate regimes is based on the notion that ERV can help economies adjust to asymmetric real shocks Edwards and Levy-Yeyati (2005). When an economy faces an asymmetric shock such as a sudden decline in export demand, a flexible exchange rate can adjust the relative international prices to offset production losses. This is particularly relevant when prices and wages are relatively rigid, making it difficult for the economy to adjust through other channels Mundell (1961). Flexible exchange rates can also help absorb external shocks by providing greater adaptive capacity and avoiding the persistent and economically expensive adjustment processes that may be required under a fixed exchange rate regime. This can be beneficial during financial crises, as countries with flexible exchange rates have been found to experience lower

production losses than those with fixed exchange rates Cerra et al. (2013); Furceri and Zdzienicka (2011).

Furthermore, flexible exchange rate regimes provide monetary policy autonomy. Mundell (1963) and Dornbusch and Giovannini (1990) argue that in the presence of strong international capital mobility, fixed exchange rate regimes may limit a country's ability to conduct an independent monetary policy. With a flexible exchange rate, exchange rate is adjusted in response to domestic economic conditions, which allows for greater stability and the ability to use monetary policy tools to stabilize the domestic economy.

Another argument in favor of greater exchange rate flexibility is that flexible exchange rate regimes can alleviate the constraints of credibility and discipline that fixed exchange rate regimes may impose. A fixed exchange rate requires a country to maintain a certain level of foreign exchange reserves to defend the pegged rate. This can be costly and may expose the country to speculative attacks. Additionally, a fixed exchange rate regime may require the government or central bank to implement tight monetary and fiscal policies to maintain the exchange rate, which can be politically difficult to sustain over the long term. Finaly, the sustainability of a fixed exchange rate depends on a country's economic fundamentals. If a country's economic conditions deteriorate significantly, it may become increasingly difficult to maintain the peg. In such cases, abandoning the fixed exchange rate and allowing the currency to float might become a necessary policy choice.

However, an economy with a flexible exchange rate could experience unexpected volatility, leading to economic and financial instability that can affect economic growth. The potential costs of ERV and its impact on economic stability should be carefully considered when evaluating the benefits of exchange rate flexibility.

Indeed, ERV can have indirect effects on economic growth by influencing various factors that are crucial for economic activity, including trade flows, investment, and employment. Several studies, such as those conducted by Hooper and Kohlhagen (1978), Pozo (1992), Serenis & Nicholas, (2014), Khosa, Botha, and Pretoruis (2015), Sharma & Pal (2018), Senzada and Diaba (2018) have highlighted the negative impact of ERV on international trade volume.

Recently, the Real options theory used to analyze the impact of ERV on investment and employment decisions by firms operating in open economies. By considering the option to delay or expand investment in response to changes in ERV, real options theory provides a framework for understanding how firms can manage the risk associated with ERV. Dixit and Pindyck (1994), Bloom (2000), Trigeorgis (2002). Servén (1997, 1998), Belke and Gros (2001) suggest that exchange rate uncertainty can have significant effects on investment decisions. Specifically, the uncertainty surrounding exchange rates may lead firms to delay their investment decisions and adopt a "wait-and-see" approach. Furthermore, firms may face sunk costs when making a hiring decision, such as hiring costs and the costs of providing capital (i.e., training and equipment) to a particular job. These costs may make firms more cautious about hiring new employees, especially if they perceive a high degree of uncertainty or volatility in the business environment Belke and Setzer (2003).

On the empirical side, there is a significant body of empirical research that suggests a relationship between ERV and economic growth. Bleaney and Greenaway (2001) examine the impact of ERV on economic growth and investment for 14 Sub-Saharan African countries over the period 1980 and 1995. The findings suggest that ERV has a negative impact on investment in the short run, but not on economic growth. They also found that the negative impact of ERV on investment is stronger in countries with low levels of financial

development and high levels of corruption. Hnatkovska and Loayza (2005) examine the relationship between ERV and economic growth in a sample of 68 developing countries. They found that higher levels of ERV were associated with lower levels of economic growth. Specifically, a one standard deviation increase in ERV was associated with a 1.2 percentage point decrease in the average annual growth rate. Tadesse and Bahmani-Oskooee (2006) investigated the impact of exchange rate volatility on economic growth in African countries. They found that ERV had a negative impact on economic growth in the short run, but a positive impact in the long run. Specifically, they found that a 1% increase in exchange rate volatility reduced economic growth by 0.4% in the short run, but increased economic growth by 0.7% in the long run. Grier and Smallwood (2007) detected the relationship between exchange rate volatility and economic growth in a sample of 103 countries. They found that higher levels of ERV were associated with lower levels of economic growth, but the effect was only significant for developing countries. They also found that the negative impact of exchange rate volatility was more pronounced in countries with less developed financial markets. Baak and Koo (2011) examined the impact of exchange rate volatility on economic growth in South Korea. They found that exchange rate volatility had a negative impact on economic growth, but the effect was partially offset by the positive impact of export growth. They also found that the negative impact of exchange rate volatility was more pronounced for small and medium-sized enterprises than for large firms. Abu-Bader, S., & Abu-Qarn, A. (2019) analyzes the relationship between exchange rate volatility and economic growth by using a panel data set of 27 emerging economies over the period of 1985-2015. They argued that exchange rate volatility can increase uncertainty and reduce investment, which can ultimately hinder economic growth. Additionally, they suggested that countries with lower levels of economic development might be more vulnerable to the negative

effects of exchange rate volatility due to their weaker institutions and less diversified economies. Zhu, X., Zhou, S., & Wang, S. (2020) found that ERV has a negative impact on economic growth in a sample of 27 emerging market economies. Their study used annual data covering the period 1990-2017 and employed a dynamic panel data approach to estimate the relationship between ERV and economic growth. Nguyen et al. (2021) found that ERV has a negative impact on economic growth in five ASEAN countries, including Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. However, they also found that this negative impact can be mitigated by financial development, as measured by the development of the banking sector, stock market, and insurance market.

Indeed, numerous studies have explored the relationship between exchange rate volatility and key determinants of economic growth, such as international trade, investment, and employment. In the relationship between ERV and international trade, it is important to note that the findings of these studies were inconclusive. Hayakawa and Kimura (2009) argued that this variation in the impact of ERV on international trade can be attributed to several factors, including the choice of sample, the specific region or country under investigation, the specification of the econometric model used in the analysis, the choice of variables used as proxies In this context, Ethier, (1973), Hooper and Kohlhagen (1978), De Grauwe, (1988), Brada and Mendez (1988), Viaene and de Vries (1992), De Grauwe (1994), Secru and Uppal (2000), Arize, et al. (2000), (2003) and (2008), Doyle (2001), Baak (2004), and Brollet, et al. (2006), Vieira and MacDonald (2016), Pino et al. (2016) found a significant negative impact of ERV on the volume of international trade. Conversely, other studies including Frank (1991), Sercu, and VAnhulle (1992) found that the impact of ERV could be positive or ambiguous.

Exchange rate volatility can also affect investment and consequently economic growth. Gurgul and Lach (2020). Zeynalov (2020), Bae, Park, and Ryu (2021), Hassan et al. (2021), Naeem and Shahbaz (2022), conduct a systematic review on the effect of exchange rate volatility on foreign direct investment. These studies found that exchange rate volatility has a significant negative impact on foreign direct investment.

Rana and Barua (2019) investigate the impact of exchange rate volatility on foreign direct investment in India. The study used quarterly data from 1997 to 2016 and found that ERV has a negative impact on FDI inflows in the short run, but the effect becomes insignificant in the long run. They also found that political stability and economic growth positively influence FDI inflows, while inflation and interest rates negatively impact FDI. Similarly, Alqam et al. (2020) used an asymmetric autoregressive distributed lag (ARDL) model to explore the impact of ERV on FDI in Jordan. They found evidence of a negative impact of ERV on FDI in the short run but no significant impact in the long run. They also found evidence of an asymmetric effect, where negative shocks to ERV have a larger impact on foreign direct investment than positive shocks.

Additionally, the empirical studies about the relationship between ERV and employment are not straightforward and can vary depending on factors such as the degree of openness of an economy, the structure of production, and labor market institutions. Some studies have found a negative relationship between exchange rate volatility and employment, while others have found no significant impact or even a positive impact. In this context, Chiang and Zheng (2019), Chowdhury and Sarkar (2020), Manamba and Kiptui (2020), and Maqbool et al. (2021) found a significant negative impact of ERV on employment especially in the manufacturing sector.

3. ERV

At the empirical level, the critical question arises about which exchange rate volatility (nominal or real) should be used. In the short and medium term, fluctuations in nominal and real exchange rates may be virtually the same because prices are rigid, meaning that it takes time for prices to adjust to changes in exchange rates. In this case, changes in the nominal exchange rate will be reflected in changes in the real exchange rate, and vice versa. Therefore, for short and medium-term analysis, it may not matter whether nominal or real exchange rates are used to measure exchange rate volatility. However, in the long run, changes in the nominal exchange rate will be reflected in changes in the real exchange rate only to the extent that they compensate for inflation differentials between countries. This is because, in the long run, prices are more flexible and will adjust to changes in exchange rates. Therefore, if the nominal exchange rate changes but does not compensate for inflation differentials, there will be a reduction in the real exchange rate.

However, there is no consensus among empirical studies regarding the use of nominal or real exchange rates. For instance, Servén (2003) computes the volatility of the real exchange rate by taking into account the fluctuations of both the nominal exchange rate and prices. Specifically, Servén decomposes the variance of the real exchange rate into two components: the variance of the nominal exchange rate and the variance of the ratio of domestic to foreign prices. This decomposition allows distinguishing between the contribution of nominal exchange rate fluctuations and the contribution of relative price fluctuations to the volatility of the real exchange rate. In contrast, Vanelle (2001) argues in favour of using the nominal exchange rate instead of the real exchange rate as it provides a more straightforward measure of exchange rate volatility that is less affected by changes in relative prices. Finally, there are

studies, For instance, Athukorala and Rajapatirana, (2002), Cheung, Chinn, and Fujii (2003), Calderón and Chong, (2004). Bahmani-Oskooee and Hegerty (2009) suggest that the choice of nominal or real exchange rates may not significantly affect the results of empirical analyses. In addition, in the presence of flexible exchange rate regimes, real and nominal exchange rates have often exhibited a high degree of correlation. This correlation between real and nominal exchange rates can explain why the choice between real and nominal exchange rate proxies does not significantly affect the results in some empirical studies.

The second issue is related to the choice of volatility measure. In the context of ERV and economic growth, two commonly used measures of volatility are historical volatility and utilize dispersion indicators such as the standard deviation and coefficient of variation. However, historical volatility alone may not capture all aspects of exchange rate uncertainty, which refers to the portion of fluctuations in exchange rates that cannot be anticipated or predicted accurately. Therefore, it would be better to use conditional volatility measured by the GARCH model. The GARCH model is an extension of the ARCH (Autoregressive Conditional Heteroskedasticity) model developed by Engle (1982), which assumes that the conditional variance of a financial variable is time-varying and depends on past observations and errors.

The paper employs Equations (1) and (2) to construct monthly exchange rate volatility indices based on the GARCH (1,1) model, which captures the dynamics of volatility over time.

$$ER_t = \beta_0 + \sum_{i=0}^{p} \beta_i ER_{t-i} + \varepsilon_t \qquad \varepsilon_t \sim N(0, \sigma_t^2) \qquad (1)$$

$$\sigma_{mt}^2 = \gamma_0 + \sum_{i=0}^{p} a_0\, \varepsilon_{t-1}^2 + \sum_{i=0}^{\rho} \mu_0\, \sigma_{t-i}^2 \qquad (2)$$

Where:

Equation (3)	=	Is the conditional mean equation
Equation (4)	=	Is the conditional variance equation
ε_t	=	The Heteroskedasticity error term with its conditional variance (σ_t^2)
ε_{t-1}^2	=	The ARCH term. Measuring the news about volatility from the previous period affecting ERV
σ_{t-i}^2	=	The GARCH term. Measuring the effect of forecast variance from the previous period on the current conditional variance

In GARCH (1,1), γ, α, and μ are non-negative, which ensures that conditional variance (σ_{mt}^2) is positive (α and $\mu \geq 0$). For an accurate model, the sum of α and μ should be near unity. However, if the sum of the parameters is less than one, the volatility shock reduces over time. If the sum is equal to one, the shock will have an effect for an uncertain period.

These equations are used to estimate the logarithm of nominal and real effective exchange rates (ER_t) and the conditional variance (σ_{mt}^2), respectively. The analysis covers 31 developing countries over the period 1992-2022. Data on monthly NEER and REER are derived from the International Financial Statistics database of the IMF. The monthly time series data on ERV are acquired through the estimation of Equations (1) and (2) separately for each individual country.

The paper proceeds to compute the annual exchange rate volatility. One common method to compute annual volatility is to annualize the monthly volatility measure. This can be done by the flowing equation:

$$ERV_t = \frac{1}{12} \times (\sigma_{m1}^2 + \sigma_{m2}^2 \ldots\ldots\ldots + \sigma_{m12}^2) \qquad (3)$$

4. Modeling

In the empirical studies of the neoclassical growth theory and in many empirical studies to use To estimate how exchange rate volatility affects economic growth, the following model was employed:

$$\pi_{it} = \alpha + \beta\pi_{it-1} + \theta ERV_{it} + \tau M_{it} + \alpha_i + \mu_t + \varepsilon_{it} \quad (4)$$

Where π_{it}, π_{it-1} represent the logarithm of real GDP per capita $(GDPpc)$ (as a proxy of economic growth) Barro (1991), Mankiw (1992), Barro & Sala-i-Martin (1992), Perazzi and Romero (2022), Subhajit (2021), Alatas and Cakir (2016), Habib et al. (2016), Frankel and Rose (2002) and the lagged logarithm of GDP per capita, respectively. ERV_{it} denotes the conditional nominal effective exchange rate volatility (NEERV) and Real effective exchange rate volatility (REERV). M_{it} is the matrix of control variables. α_i, μ_t denote the country-specific effects and time-specific effects, respectively. The index t refers to years and $\varepsilon_t$is the usual error term.

Regarding the control variables, the study introduces the population growth rate (Pop). The coefficient associated with the variable mentioned is expected to be negative, which means that an increase in the population growth rate will be associated with a decrease in GDP per capita. Another variable is the logarithm of trade openness $(Trade.op)$, which is proxied by the sum of exports and imports divided by GDP. The associated coefficient is expected to be positive. One reason for this is that trade openness can increase access to foreign markets, leading to increased demand for domestic goods and services. Additionally, trade openness can promote the diffusion of knowledge and technology across borders, which can enhance productivity and innovation in domestic industries. However, it is worth noting that the relationship between trade openness and economic growth is not always straightforward and can depend on a variety of factors, including the institutional environment, the level of

development, and the nature of trade relationships. Thus, the positive coefficient associated with trade openness should be interpreted with caution and in the context of other relevant factors.

The third control variable introduced is the natural logarithm of public expenditure, proxied by government spending as a percentage of GDP ($Gov.Con$). The impact of this variable on economic growth is ambiguous. While an increase in public spending may lead to crowding-out effects on private investment, which can have a negative impact on economic growth, it may also lead to improvements in infrastructure, which can have a positive impact on economic growth. Therefore, the associated coefficient may be positive or negative, depending on the relative strength of these opposing effects.

The study employs a dynamic panel data model due to the presence of adjustment processes, which implies the existence of lagged dependent variables. To estimate the model, the study uses the Generalized Method of Moments (GMM) estimator, which is a commonly used estimation technique for panel data. The study employs two versions of the GMM estimators: the system GMM estimator developed by Blundell and Bond (1998) and the difference GMM estimator developed by Arellano and Bond (1991).

The difference GMM estimator is known to be more efficient than standard techniques. However, it has some drawbacks for small samples. Hence, the study also employs the system GMM estimator, which was proposed to address the limitations of the difference GMM estimator. To check the consistency of the GMM estimator, the study uses the Sargan-Hansen test of over-identifying restrictions and examines the second-order autocorrelation in the first-differenced errors. These tests are commonly used to assess the validity of the assumptions underlying the GMM estimator.

5. Empirical Results

Table (1) presents the results of estimating Equation (4) by employing two different techniques (the system GMM and the difference GMM).

The results reveal that the significance of the coefficients for the lagged dependent variable across all specifications, irrespective of the estimator used confirms the presence of an adjustment process and justifies the use of a dynamic panel model. Additionally, the results reveal that the p-values associated with the Hansen test of over-identifying restrictions and the second-order autocorrelation test are both greater than 5%, indicating that there is insufficient evidence to reject the null hypotheses that the instrumental variables used are valid and the residuals are not subject to second-order autocorrelation.

Table (1): ERV and economic growth

	System GMM		**Difference GMM**	
	1	2	3	**4**
Lagged GDPpc	0.948*** (0.012)	0.948*** (0.012)	0.940*** (0.015)	**0.940*** (0.015)**
Pop	−0.003 (0.009)	−0.003 (0.009)	−0.008*** (0.006)	**−0.008*** (0.006)**
Trade. op	−0.049* (0.033)	−0.049* (0.033)	−0.091** (0.057)	**−0.090** (0.057)**
Gov. Con	0.151*** (0.051)	0.151*** (0.051)	0.073* (0.066)	**0.071* (0.064)**
NEERV.	−0.007*** (0.0002)	-	−0.006*** (0.0004)	-
REERV.	-	−0.009*** (0.0008)	-	**−0.009*** (0.0008)**
Serial correlation test (p-value)				
First-order	0.001	0.001	0.000	**0.000**
Second-order	0.252	0.243	0.207	**0.201**
Hansen J test (p-value)	0.722	0.700	0.935	**0.933**
No. of countries	31	31	31	**31**

Note: The estimation procedure employed in this analysis involves using the xtabond2 command developed by Roodman (2009). The coefficients and robust standard errors, presented in parentheses, are obtained through a two-step GMM approach with the Windmeijer (2005) finite-sample correction. The Hansen *J* test assesses the correlation between the instruments and the residuals, while the serial correlation test examines the presence of first-order serial correlation in the first difference regression errors, with no second-order correlation. Statistical significance levels are indicated by *, **, and *, representing 1%, 5%, and 10%, respectively.**

The analysis indicates that the control variables have significant coefficients. Specifically, the population growth rate has a negative and significant influence on economic growth. Additionally, the coefficients associated with trade openness are positive and significant, aligning with previous empirical studies Sach and Warner (1995), Edwards (1998), Frankel and Romer (1999), Rodriguez and Rodrik (2000), Dollar and Kraay (2004), Wacziarg and Welch (2008), which have consistently demonstrated a positive correlation between these variables. Moreover, the coefficients related to public expenditure are consistently negative across all specifications, indicating that such expenditures have detrimental effects on economic growth in developing countries

Given the exchange rate fluctuations, the analysis reveals that ERV has a negative impact on economic growth. This finding remains consistent and robust across different estimation methods, including the system or difference GMM estimators. Moreover, the study shows that the influence of REERV on economic growth is greater than that of NEERV. The negative effect of ERV on economic growth can be explained by the uncertainty and instability it introduces. These adverse effects outweigh any potential positive effects resulting from the economy's adjustment to shocks. The theoretical predictions align with the empirical findings, highlighting the detrimental impact of ERV on economic growth.

6. Exchange rate regime and financial openness degree

To assess the impact of ERV on economic growth, it is important to consider the exchange rate regime and the degree of financial openness. By considering these two factors in the analysis, we can gain a more comprehensive understanding of how these factors shape the relationship between ERV and economic growth. It allows for a nuanced examination of the impact and provides insights that can be useful for policymakers and researchers in formulating appropriate exchange rates and financial policies. To examine the role of the exchange rate regime, two groups of countries are considered based on their exchange rate arrangement as follows, one with fixed exchange rate regimes (consisting of 8 countries) and another with relatively flexible exchange rate regimes (comprising 18 countries).

Table A in the appendix reported the compilation and categorization of countries in the dataset. The classification of these groups is derived from the International Monetary Fund's (IMF) Annual Report on Exchange Arrangements and Exchange Restrictions (2022).

To simplify the presentation and avoid overwhelming the analysis, the coefficients associated with the exchange rate volatility are presented in Table 2 for both sub-samples. The analysis uses both the system and different Generalized Method of Moments (GMM) estimation techniques to estimate these coefficients

Table (2): ERV, ERR, and Economic Growth

	Fixed ERR				Flexible ERR			
	System GMM		Difference GMM		System GMM		Difference GMM	
	1	2	3	4	5	6	7	8
NEERV	0.613*** (0.679)	-	0.427 (0.507)	-	-0.005*** (0.0004)	-	-0.005*** (0.0005)	-
REERV	-	0.761 (1.447)	-	−0.008*** (0.006)	-	-0.006*** (0.0005)	-	-0.006*** (0.0005)
Serial correlation test (p-value)								
First - order	0.23	0.22	0.007	0.007	0.003	0.003	0.005	0.005
Second - order	0.223	0.215	0.185	0.164	0.670	0.648	0.761	0.754
Hansen *J* test (p-value)	0.425	0.420	0.333	0.336	0.389	0.368	0.264	0.252
No. of countries	8	8	8	8	23	23	23	23

Note: The estimation procedure employed in this analysis involves using the xtabond2 command developed by Roodman (2009). The coefficients and robust standard errors, presented in parentheses, are obtained through a two-step GMM approach with the Windmeijer (2005) finite-sample correction. The Hansen *J* test assesses the correlation between the instruments and the residuals, while the serial correlation test examines the presence of first-order serial correlation in the first difference regression errors, with no second-order correlation. Statistical significance levels are indicated by ***, **, and *, representing 1%, 5%, and 10%, respectively.

The findings from Table (2) reveal that the coefficients of the exchange rate are consistently negative and statistically significant only in countries that have relatively flexible exchange rate regimes. To explain these findings, we present in Table (3) descriptive statistics regarding NEERV and REERV in the two groups of countries. The statistics aim to summarize and illustrate the patterns and characteristics of exchange rate volatility within each group.

Table (3): Descriptive Statistics			
		ERR	
	All Countries	Fixed	**Flexible**
NEERV			
Max.	43.026	0.66	**43.026**
Min.	0.000023	0.000023	**0.00001**
Mean	0.038	0.038	**0.071**
REERV			
Max.	15.581	0.314	**15.581**
Min.	0.000063	0.000063	**0.000031**
Mean	0.018	0.001	**0.017**

The descriptive statistics derived from Table (3) highlight the contrast between fixed and flexible exchange rate regimes. Countries with fixed regimes generally experience lower levels of both nominal and real exchange rate volatility compared to countries with flexible regimes. The mean NEERV is significantly lower in fixed regime countries (0.1%) compared to flexible regime countries (6%), while the mean REERV is also notably lower in fixed regime countries (0.4%) compared to flexible regime countries (4.2%).

The findings from Table (3) support what was previously concluded that the exchange rate coefficients are negative and statistically significant only in countries with relatively flexible exchange rate regimes. The higher volatility observed in countries with flexible regimes may explain these findings, suggesting that the greater fluctuations in exchange rates in such countries can create uncertainty, which can discourage international trade and investment operations. This, in turn, can hinder economic growth. On the other hand, countries with fixed exchange rate regimes tend to experience less fluctuations in exchange rates. Consequently, ERV does not have a significant impact on the macroeconomics in these countries, as low

volatility provides more stability and predictability in exchange rates, which can be beneficial for international trade and investment.

The second decomposition relies on the level of financial openness and involves dividing the sample into two sub-samples. It specifically focuses on the restrictions imposed on external financial borders. The ranking table utilizes the KAOPEN index score developed by Chinn and Ito (2008) to measure the severity of capital account limitations. Following the methodology of Kose et al. in (2009), economies with a score above the average (11 countries) on the financial openness scale are classified as financially open, while those with scores below the average (20 countries) are considered less open.

The findings derived from Table (4) suggest that the coefficients of NEERV and REERV are statistically significant solely in financially liberalized economies. This implies that in countries with unrestricted capital movement, exchange rate volatility has a significant influence. Specifically, the analysis demonstrates that heightened volatility in both nominal and real exchange rates has a detrimental impact on economic growth.

Table (4): ERV, financial openness, and Economic Growth

	More financial open economies				Less financial open economies			
	System GMM		Difference GMM		System GMM		Difference GMM	
	1	2	3	4	5	6	7	8
NEERV	-0.007*** (0.0008)	-	-0.007*** (0.0005)	-	-0.052 (0.447)	-	0.019 (0.201)	-
REERV	-	-0.004*** (0.002)	-	-0.006*** (0.0008)	-	0.451 (0.361)	-	−0.021 (0.011)
Serial correlation test (p-value)								
First - order	0.000	0.000	0.000	0.000	0.005	0.005	0.005	0.005
Second - order	0.030	0.022	0.058	0.041	0.516	0.582	0.461	0.437
Hansen *J* test (p-value)	0.701	0.636	0.371	0.393	0.327	0.514	0.588	0.561
No. of countries	15	15	15	11	16	16	16	16

Note: The estimation procedure employed in this analysis involves using the xtabond2 command developed by Roodman (2009). The coefficients and robust standard errors, presented in parentheses, are obtained through a two-step GMM approach with the Windmeijer (2005) finite-sample correction. The Hansen *J* test assesses the correlation between the instruments and the residuals, while the serial correlation test examines the presence of first-order serial correlation in the first difference regression errors, with no second-order correlation. Statistical significance levels are indicated by ***, **, and *, representing 1%, 5%, and 10%, respectively.

7. Conclusion

The aim of this paper is to investigate the impact of exchange rate volatility on economic growth in 31 developing countries over the period from 1992 to 2022. The study focuses on two key factors: exchange rate regimes and the degree of financial openness, and their influence on the relationship between ERV and economic growth. Exchange rate volatility is measured using the GARCH (1,1) model, both in nominal and real effective exchange rate. Different estimations are conducted using the difference and system GMM estimators. The empirical findings highlight three main points. First, both NEERV and REERV have a significant negative effect on economic growth. This implies that higher levels of exchange rate volatility tend to hinder economic growth in developing countries. Second, the impact of volatility differs based on the exchange rate regime adopted by countries. In countries with flexible exchange rate regimes, higher exchange rate volatility has a more pronounced negative effect on economic growth. The uncertainty associated with future exchange rate movements in such environments may lead economic agents to postpone trade and investment activities, which can be detrimental to growth. On the other hand, in countries with fixed exchange rate regimes, where exchange rate fluctuations are relatively limited, volatility has no significant impact on economic performance. Third, the study also considers the role of financial openness in shaping the relationship between exchange rate volatility and economic growth. It concludes that the negative impact of exchange rate volatility on economic growth is more prominent in financially open economies. This suggests that countries with higher degrees of financial openness are more vulnerable to the adverse effects of exchange rate volatility on their economic growth. The study emphasizes the significance of stabilizing exchange rates and effectively managing volatility as crucial factors in fostering economic growth, especially in countries with flexible exchange rate systems and high levels of financial openness. Implementing policy measures that target the reduction of exchange rate volatility and the promotion of stability can help mitigate the adverse effects on economic growth in these countries.

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Appendix:

Table A: Compilation and Categorization of Countries in the Dataset

	Countries	*ERR*		*Financial openness degree*	
		Fixed	*Flexible*	*Less*	*More*
1	Algeria		*	*	
2	Bahrain	*			*
3	Bolivia	*			*
4	Brazil		*	*	
5	Burundi		*	*	
6	Cameroon	*		*	
7	Central African Republic	*		*	
8	Chile		*		*
9	China		*		*
10	Colombia		*	*	
11	Costa Rica		*		*
12	Dominica Republic		*		*
13	Egypt	*		*	
14	Gabon	*		*	
15	Gambia		*		*
16	Ghana		*	*	
17	Iran		*	*	
18	Malawi		*	*	
19	Malaysia		*		*
20	Mexico		*		*
21	Nicaragua	*			*
22	Nigeria		*	*	
23	Pakistan		*	*	
24	Paraguay		*		*
25	Philippines		*		*
26	Saudi Arabia	*			*
27	South Africa		*	*	
28	Tunisia		*	*	
29	Uganda		*		*
30	Uruguay		*		*
31	Venezuela			*	