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Nexus among Exchange Rate Volatility, Inflation, and Economic Growth: A Panel Data Analysis

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ABSTRACT

This study undertakes an examination of the intricate relationships among exchange rate fluctuations, inflation, and economic growth within South Asian nations, namely Pakistan, India, Bangladesh, Sri Lanka, and Nepal. Spanning the temporal horizon from 1990 to 2021, the research endeavors to unveil the repercussions of exchange rate instability on economic growth—a formidable challenge confronted by monetary authorities and policymakers in South Asia. The central focus lies on comprehending the dynamics of exchange rate volatility, inflationary pressures, and their collective impact on economic growth. In the pursuit of these objectives, GDP per capita serves as the yardstick for economic growth, while independent variables encompass a spectrum including broad money supply, exchange rate volatility, inflation, government consumption expenditures, and gross fixed capital formation. The quantification of exchange rate volatility entails the utilization of both the standard deviation and the GARCH (1,1) models. Subsequent to an in-depth analysis, the initial unit test results undergo reevaluation, incorporating the Breusch-Pagan LM, Pesaran CD, and Pesaran scaled LM tests to discern cross-sectional dependence. To address potential data non-stationarity while considering cross-sectional dependence, the Pesaran-CIPS and Pesaran's CADF tests are applied. A pivotal aspect of the research involves the application of a Feasibly Generalized Least Squares (FGLS) regression model. The outcomes of the FGLS panel data regression illuminate a noteworthy finding: exchange rate volatility, quantified through both techniques, significantly and adversely influences economic growth. In contrast, inflation exhibits a statistically insignificant negative impact on economic growth. The study culminates by proffering specific recommendations to policymakers, urging concerted efforts to ensure exchange rate stability and foster sustained economic growth.

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1. Introduction

Economic research has produced diverse responses almost special possessions of inflation & exchange rate on GDP. Fluctuations of currency rates significantly hinder the stability of GDP in developing and growing economies. The relationship among fluctuations in exchange rates, inflation, & regional GDP is essential (Olamide, Ogujiuba, & Maredza, 2022). After implementing financial liberalization measures, numerous developing countries have encountered substantial fluctuations in their currency exchange rates. Volatile exchange rates are characterized by the erratic fluctuations in the relative values of currencies within the economy (Umaru, Aguda, & Davies, 2018). Furthermore, several countries restrict the free movement of their official exchange rate due to concerns about currency devaluation (Morina, Hysa, Ergün, Panait, & Voica, 2020). This is because each country relies on its currency as a medium for acquiring products

and services in global trade. Amidst episodes of fluctuating exchange rates, governments may experience uncertainties pertaining to their agreements with other nations. Volatility refers to the level of risk or uncertainty that arises from unforeseen variations in the currency exchange rate during a specific duration. Unpredictable fluctuations affecting commodity prices, interest rates, portfolio investments, savings, and loans are primarily precipitated by shocks (Clarida & Gali, 1994). The effect of this rising price level on economic growth is a topic of contention, since both theoretical analysis and actual evidence give contradictory perspectives. Structuralists claim that inflation is a prerequisite for economic expansion, whereas monetarists assert that inflation hinders the growth of the economy (Mahmood & Ahmed, 2017). However, there is a lack of agreement regarding precise affiliation b/w inflation and economic performance, the specific effects of inflation on macroeconomic activity. This has ignited a significant discussion, encompassing both theoretical analysis and empirical evidence. The particular result is contingent upon variables such as the employed approach, the analyzed data, and the distinct attributes of each country (Anidiobu, Okolie, & Oleka, 2018; Baharumshah, Slesman, & Wohar, 2016). However, only high levels of inflation have the potential to diminish productivity and economic activities. The divergent results concerning the correlation b/w exchange rate, inflation, and macroeconomic performance can be ascribed to the discrepancies in countries' time periods, methodology, estimate approaches, and economic circumstances. As a result, scholars were unable to come to a consensus. Furthermore, the research has yielded diverse outcomes, so rendering the topic an empirical inquiry necessitating further exploration.

The purpose of this research is showing association in exchange-rate, inflation & economic development in South Asian countries. An in-depth investigation was performed to investigate the connections among volatility in exchange rates, inflation, and growth in the economy. This research distinguishes itself from previous studies by incorporating various volatility measures to ensure more accurate findings. By undertaking this endeavor, it substantively enriches the prevailing comprehension of the intricate dynamics among exchange rate volatility, inflation, and economic growth within South Asian nations. The article notably accentuates in-depth inquiries into the intricate interrelationships involving the fluctuation of exchange rates, inflationary pressures, and the overarching trajectory of economic expansion. It addresses this gap by employing multiple volatility indicators. Additionally, the study proposes strategies to strengthen the relationship b/w exchange rate fluctuations, inflation, and economic development.

2. Literature Review

2.1. Volatility of exchange rate and economic development

Numerous pragmatic inquiries have delved into the effect of fluctuations in currency rates on macroeconomic performance, particularly in the context of economic development, employing both theoretical frameworks and empirical methodologies. The study utilized the GARCH(1,1) method to quantify nominal & volatility aspects of real exchange-rate. The study's findings unveil that variations in both nominal and real exchange rates exert a detrimental influence on economic development. Furthermore, the study observed that the adoption of the euro was correlated with a 0.4 standard deviation reduction in the long-term volatility of the actual operative exchange rate preceding the substantial economic downturn in 2008-2009. An analysis of the correlation between Uganda's currency rate fluctuation and economic development, (Katusiime, Agbola, & Shamsuddin, 2016) utilized time series data spanning from 1960 to 2011, employing the ARCH model. (Alper, 2017) conducted an investigation into the influence of currency rate fluctuations on the movement of goods and services. The panel data regression model employed in the study disclosed adverse effects on export sectors attributable to exchange-rate volatility, whereas import sectors exhibited both positive and negative impacts. (Arratibel, Furceri, Martin, & Zdzienicka, 2011) explored correlation b/w nominal exchange-rate fluctuations and macroeconomic factors in EU member nations of Central and Eastern Europe. Panel estimation from 1995 to 2008 showed a positive connotation b/w reduced exchange-rate fluctuations & increased economic development, higher foreign direct investment (FDI), larger current account deficits, and improved credit availability.

3. Dynamics of Exchange Rate Fluctuations

Regarding the quantification of volatility, presently, there exists a lack of universally acknowledged standards. This investigation evaluated exchange-rate volatility through the application of both the GARCH model and standard deviation method. The GARCH model, developed in 1980, aims to effectively represent the changing volatility in financial returns as time progresses. Numerous scholars have utilized this regression model to quantify exchange

rate volatility. An issue commonly encountered in empirical applications of the ARCH model is the tendency for variance parameter estimations to be excessively pessimistic. In response to this challenge within the ARCH family, (Bollerslev, 1986) introduced the GARCH model:

$$EX_t = \beta_o + \sum_{i=1}^{p} \beta_i EX_{t-1} + \varepsilon_t \quad (1$$

$$\sigma_t{}^2 = \delta_0 + \sum_{i=1}^{p} \vartheta_i \varepsilon_{t-1}^2 + \sum_{j=1}^{q} \varphi_j \sigma_{t-1}^2 \quad (2$$

Finally, according to (Barguellil et al. 2018), we computed annual exchange rate volatility as follows:

$$vet_t = \frac{1}{12} \times (hm1 + hm2 + \cdots + hm12) \quad (3$$

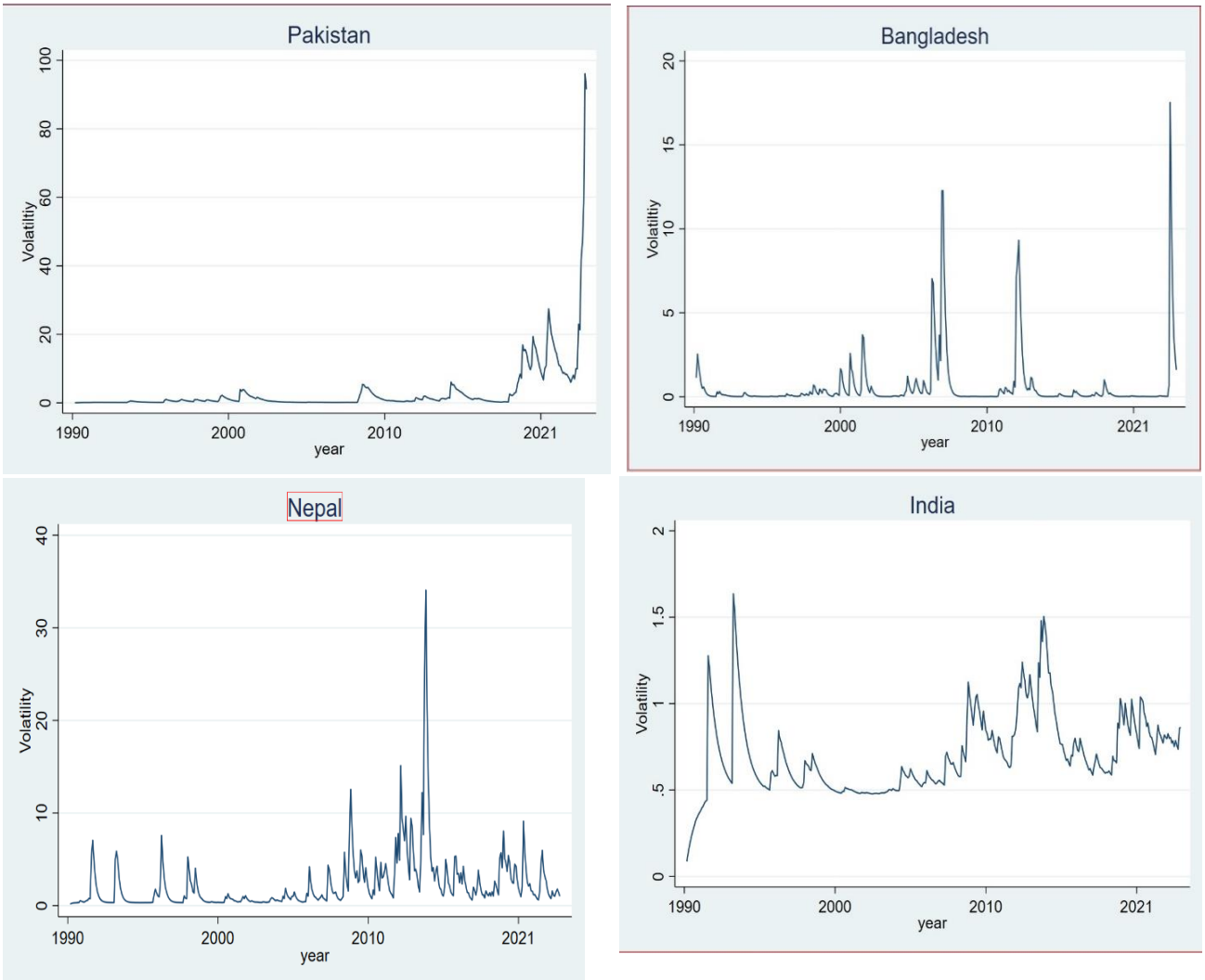
The deviations are squared to determine the Standard Deviation, these values are added and divided by the appropriate number of values, and finally, the square root of this result is,

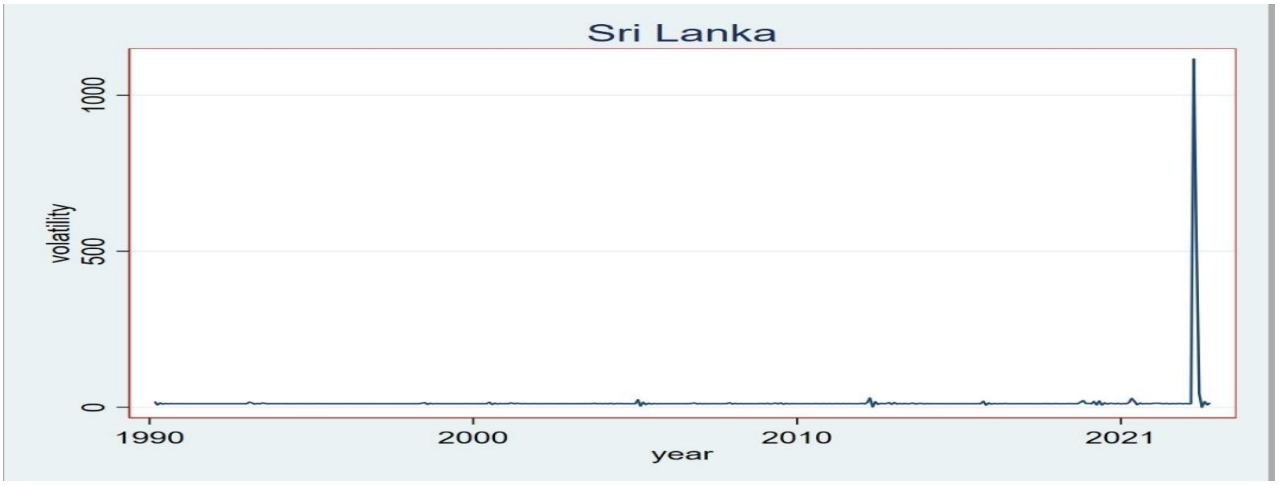
$$\sigma = \sqrt{\frac{(xi - \acute{x})^2}{n-1}} \quad (4$$

Where,

σ = Standard Deviation
xi= nominal exchange rate data of two periods
$\bar{x}$= nominal exchange rate means at two periods
n = time

Figure 1: The GARCH Model is employed to Quantify the Volatility of Currency Rates





4. Methodology

4.1. Data & Sample Collection

The study scrutinizes annual data from distinct South Asian nations to explore the nexus between fluctuations in exchange rates, inflation, & economic growth from 1990 to 2021. The sample encompasses a total of five countries, namely Pakistan, Nepal, Bangladesh, India,and Sri Lanka. Notably, Afghanistan, Bhutan, and the Maldives, although geographically situated in South Asia, were excluded from this investigation due to data unavailability. Following this, monthly nominal foreign exchange data was obtained from a global financial statistics database estimate the volatility exchange rate. In this research, the natural logarithm of GDP/capita served as alternative metric for economic progress. Conversely, the logarithm of inflation was determined using the consumer price index, & logarithm of exchange rate volatility was computed through two methods: the GARCH model & standard deviation methodology. This research aims to offer a thorough understanding of the intricate relationships among these economic variables, specifically focusing on South Asian nations.

4.2. Empirical model

The panel model employed can be expressed as follows:

$$lnY_{it} = a + \beta lnEXVol_{it} + \gamma lnINF_{it} + \delta lnX_{it} + \varepsilon_{it} \quad (5$$

$i = 1, 2, \ldots, 5 \quad t = 1990, 1991, \ldots, 2021$

In this scenario, lnYit signifies the natural logarithm of GDP/capita in country I with time t. Simultaneously, variable lnEXVol quantifies exchange rate volatility through GARCH model and standard deviation methodologies, while lnINF represents the natural logarithm of the inflation rate. Various techniques can be employed to estimate the panel data regression model. However, when dealing with cross-sectional dependency in panel data, the utilization of fixed effect, random effect, and pooled OLS methods may yield biased and inconsistent results. Following the recommendation by (Hsiao, 2022), in cases where N is fixed, T is substantial, & cross-sectional dependence is present, the estimation of slope coefficients can be achieved through either the Feasible Generalized Least-Squares approach (FGLS). Both the Feasible Generalized Least-Squares approach and the Seemingly Unrelated Regression method are statistically consistent and yield precise results. Consequently, we opted for the Feasibly Generalized Least-Squares approach to elucidate the relationship between exchange rate volatility, inflation, and economic growth.

5. Results and Discussion

5.1. Statistical Summary

Table 1 revealed the Statistical summary of variables under consideration. The mean of GDP per capita stands at 1045.75 US$, with a max, 4077.04 US$ and a mini 170.58 US$. The average exchange rate, measured by standard deviation, is 3.76, while the GARCH (1,1) estimation yields an average of 1.76. In terms of inflation, the average (consumer price index) is 7.602%, with a max 22.56 % and a mini 2.00 %.

Table 1: Statistical Overview

Variable	Obser.	Means	Std- Dev.	Mini	Maxi
GDP/ capita	160	1045.75	924.07	170.59	4077.04
Exchange rate volatility (Std. v)	160	1.703	1.759	.0074	9.426
Exchange rate volatility (GARCH)	160	3.428	4.670	.0054	15.56
Inflation (consumer price index)	160	7.602	3.7602	2.007	22.56
Broad money supply % GDP	160	52.3196	17.836	22.45	122.39
The percentage of Gross Domestic Product (GDP) dedicated to final consumer spending by the general government.	160	9.24	2.66	4.05	17.61
Ratio of the formation of total fixed capital to GDP	160	23.51	5.80	12.52	35.81
P(million)	160	303	438	17	1410

5.2. Cross-section Dependence

An integral consideration when choosing an appropriate estimation approach in panel data analysis is the assessment of cross-sectional dependency. In the initial phase of the empirical investigation, tests for cross-sectional dependence (CD) were conducted to examine the simultaneous correlation among nations within the panel. All these tests are designed to assess the null hypothesis, stating that there is no cross-sectional dependency (correlation) in the residuals. The conclusive outcomes of the cross-section dependence test are detailed in Table-2.

Table 2: Results of Cross-Sectional Dependence Testing

Breusch-Pagan LM		Pesaran scaled LM		Pesaran CD	
Statistical value	**p-values**	**Statistical value**	**p-values**	**Statistical value**	**p-value**
206.03	0.0000	43.833	0.0000	14.221	0.0000

The outcomes presented in Table 2 designate that null hypothesis, positing the absence of cross-sectional dependence, convincingly precluded by three test for cross-section dependence. Accordingly, these findings emphasize imperative need to incorporate second-generation panel unit-root testing methodologies to address the identified cross-section dependency.

5.3. Advanced Panel Unit-Root Testing Methods of the Second Generation

The initial unit-root test lose their validity. For evaluating the stationarity properties of the series, we utilized the cross-sectionally augmented im-Pesaran-Shin (CIPS) and Pesaran's CADF panel unit-root tests, as advocated by (Pesaran, 2007). The findings of the unit-root tests are presented in Table 3.

Table 3: Outcomes of Second-Generation Panel Unit-Root Tests

	Pesaran – CIPS		Pesaran's CADF	
Variable	**Level**	**First Difference**	**Level**	**First Difference**
LnGDP per capita	-2.485***	-5.014***	-2.126	-3.466**
Ln Inflation	-4.037***	-6.190***	-3.087**	-5.687***
Ln Exchange rate volatility (GARCH)	-3.747***	-5.758***	-2.477**	-4.768***
Ln Exchange rate volatility (Std. v)	-4.630***	-6.124***	-3.765***	-5.558***
Ln Broad money supply	-1.478	-4.611***	-1.635	-3.238***
Ln General government final consumption expenditure	-1.971	-4.908***	-2.067	-3.519***
Ln Gross fixed capital formation	-1.799	-4.749***	-1.662	-3.253***
Ln Population	-2.766***	-2.8557***	-2.686***	-2.768***

Findings derived from CIPS and CADF tests indicate that, presently, the natural logarithm of broad money supply, Government final consumption expenditure and gross fixed capital formation show non-stationary characteristics in their natural logarithm. In contrast, the remaining variables demonstrate stationarity at their current levels.

Table 4: Autocorrelation Detection in Panel Data

Application of Wooldridge Test for Autocorrelation in Panel Data		
Null-Hypothesis	**F- statistics**	**P- value**
no first-order autocorrelation	F(1, 4) = 20.551	0.0106

5.4. Feasibly Generalized Least Square (FGLS)

In this section, we engaged in an exploration of the intricate interconnections among exchange rates, inflation, and economic development in South Asian countries, employing the sophisticated Feasible Generalized Least Squares (FGLS) method. That analytical approach meticulously addresses complexities such as heteroscedasticity, serial correlation, and cross-sectional dependence. The analysis comprises two distinctive regression models. In the initial model, we utilized the variable representing exchange rate, quantified through the standard deviation method. In the subsequent model, we employed the measure of volatile exchange rate dynamics estimated by GARCH (1,1). The remaining dependent and independent variables maintain consistency across both models.

Table 5: Feasibly Generalized Least Square

	Model-1		**Model-2**	
Explanatory Variable's	**Coeffic**	**P-values**	**Coeffic**	**P-value**
Nominal Exchange rate volatility (Std. v)	-0.0138	0.001		
Nominal Exchange rate volatility (GARCH)			-0.0067	0.036
Inflation	-0.0105	0.339	-0.0125	0.265
Broad money supply	-0.4341	0.000	-0.4386	0.000
General government final consumption expenditure	0.0917	0.062	0.0794	0.119
Population	-0.0049	0.288	-0.0084	0.127
constant	0.1772	0.054	0.2459	0.019
Number of obs	155		155	
Number of groups	5		5	
Periods	31		31	
Wald chi2(6)	85.49		76.11	
Prob > chi2	0.0000		0.0000	

Examining volatility of exchange/currency rates through application of standard deviation & GARCH (1,1) methodologies uncovers a notable adverse stimulus on the economic development of chosen Asian nations spanning from 1990 to 2021, as evidenced in 1 and 2 both models. Model no 1 indicates that when volatility is assessed as the average deviation, it exerts a negative influence on the pecuniary expansion. Model no 2, the GARCH (1,1) model gauges exchange rate, revealing a substantial influence on economic progress. These findings pertaining to inflation indicate a negligible adverse influence on economic progress in both model, aligning with existing research (Madurapperuma, 2016). This phenomenon can be explained by the correlation between a broad money supply and the potential for inflation, which may negatively impact the economic progress of certain nations. These findings are incongruent with previous research (Chude & Chude, 2016). Population growth exhibits statistically insignificant adverse effects on economic growth, holding other variables constant. This effect can be explained by the decrease in GDP per capita when the population increases, consistent with other studies (Dao, 2012).

6. Conclusions

This study delves into the intricate nexus between fluctuations in currency rates, inflations, and economic progress in specific South Asia countries—spanning temporal expanse from 1990 to 2021. Employing two distinct methodologies to measure exchange rate —namely, standard deviation and the application of the GARCH (1,1) model—the findings unveiled a compelling narrative. The expansion of broad money supply emerged as a factor with a statistically significant. Furthermore, fixed capital and govt. final consumption expenditures demonstrated statistically significant & positive influences on economic progress. Conversely, influence of population on economic progress was found to be statistically minor. In essence, the volatility in exchange/currency rates has exerted a detrimental consequence on economic expansion of South Asian nations. This underscores the imperative for the monetary authorities and governments in these regions to accord priority to exchange rate stability by implementing strategies that ensure its steadfastness. The policy implications drawn from this study accentuate the necessity to mitigate exchange rate fluctuations, given their pronounced impact on economic growth. Moreover, officials are urged to exercise stringent control over inflation for sustained economic well-being.

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