






## UNDERSTANDING THE ASYMMETRIC EFFECTS OF EXCHANGE RATE ON ECONOMIC GROWTH: EVIDENCE FROM INDIA

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### Abstract

This study examines the short-term and long-term relationships between economic growth, exchange rate fluctuations, money supply, and government expenditure in India from 1980 to 2022. The study employs econometric techniques such as unit root tests, Nonlinear autoregressive distributed lag (NARDL) model, FMOLS & DOLS tests, and the Granger causality test is used to determine the direction of causal relationships. The data utilized in this study were collected from the Handbook of India's Statistics (RBI) and World Development Indicators (WDI). The unit root tests indicate mixed order of integration for the selected variables. The results of the NARDL model confirm a long-term relationship among economic growth, exchange rate changes, money supply, and government expenditure. The findings indicate that undervaluation negatively affects economic growth in India, whereas overvaluation promotes it. Furthermore, the analysis reveals an asymmetric impact of exchange rate changes on economic growth. The Wald test further supports the presence of asymmetry in both the short-run and long-run. The causality test results show bidirectional causality between exchange rates, government expenditure, and economic growth, while unidirectional causality runs from money supply to economic growth. Based on the empirical findings, some policy implications may be suggested to the government. The exchange rate-controlling organization should emphasize restoring stability and pursue the establishment of a stronger exchange rate to achieve the goal of sustained economic growth and, ultimately, sustainable development

**Keywords:** Asymmetric Impact, Economic Growth, Exchange Rate Fluctuations, Granger Causality Test, Nonlinear Auto-Regressive Distributed Lag (NARDL).



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## INTRODUCTION

The impact of exchange rate, money supply and government expenditure on economic growth has long been recognized as a source of concern. These variables are important predictors of a country's economic growth (Phibian, 2010) and understanding the causal relationship between these variables is critical for achieving desired economic performance in developing countries like India. It is well established that exchange rate stability is critical because it is directly related to macroeconomic variables such as employment and inflation. This variable is also critical for long-term sustainability, with implications for trade and economic growth (Joyce & Kamas, 2003; Mumtaz & Ali, 2020; Hanoum et al., 2024). Therefore, it should be managed properly to avoid economic disequilibrium (Stockman, 1980). Exchange rate fluctuations pose a problem for countries that rely heavily on foreign trade and have a high consumption-to-GDP ratio (Mesagan et al., 2022; Pistaferri, 2015). Therefore, knowing the impact of exchange rates on economic growth is critical for India, which has a higher level of trade openness i.e. 43% (Mumtaz & Ali, 2020). Government expenditure is another factor that has influences on economic growth (Baig et al., 2020; Husain et al., 2023). According to Ram (1986), government spending can influence the economic growth of a country in three forms. Firstly, it may affect governments' ability to mediate conflicts between interest groups. Second, it may allow the government to take a broader view of growth and development while securing the necessary levels of investment. Third, it may ensure that surpluses from investment projects stay in the country rather than being repatriated. In this aspect, authors are in the opinion that government spending is crucial for sustainable development. Therefore, understanding about government expenditure and how it affects economic growth is crucial. In addition to this, money supply has also shown a direct relationship with the economic growth of a country. Money supply, according to conventional studies, is a medium of exchange comprised of public currency plus demand deposits in commercial banks (Band et.al, 2003; Godley et al., 2007; Zakiyah et al., 2024).

Milton Friedman broadened the definition of the money supply to include it as a temporary store of value. He symbolized the term as M2. Their argument is that money should be temporarily stored as a general purchasing power because the economy's money income and spending flow streams are not perfectly synchronized in time (Godley et.al, 2007; Band et.al, 200). Previously, others researchers also have made their significant contribution in establishing the connection between money supply and different other variables. Previous studies reported that output fluctuations have short-term effects on the money supply (Tobin, 1970). It was also found that the money supply influences output in short-run but not in the long period (Liu, 2001). A positive and long term relationship between the money supply with the actual GDP of the Ni-gerian economy has also been observed (Marshal, 2016). Some researchers have also reported no link between the money supply and economic expansion (Wang Yan-liang, 2012; Hammad et al., 2023; Halimah et al., 2024; Melinda et al., 2024). Thus, it is evident that the relationship between the money supply and economic growth has received a considerably scholarly attention, but the findings are contradictory and debatable. Some studies found a positive linkage between the money supply and GDP while others found no relationship. This has opened the door for additional research that will advance our knowledge. This gap was filled by the current study, which also added three new ideas to the body of knowledge. Firstly, the study evaluates the effect of exchange rate changes on India's economic expansion. The second emphasis of the study is on the connection between the money supply and Indian economic growth. Lastly, the study assesses the relationship between government spending and economic growth.

Although there has been much discussion about the relationship between exchange rate volatility and economic expansion, the Indian context has particular characteristics that are not well represented in traditional linear analyses, such as a high reliance on oil imports, sizable remittance inflows, and a developing service export industry. Current research in India frequently assumes a symmetric link between macroeconomic variables and currency rate changes, ignoring their directional sensitivity. But depending on sectoral exposure, inflationary pressures, and monetary policy positions, currency depreciation may encourage export-led growth while appreciation may hinder competitiveness, or vice versa. Most notably, threshold effects, sectoral imbalances, and nonlinear dynamics have received little attention, particularly in the years following liberalization. When growth responds differentially to changes in the exchange rate, either upward or downward, this leaves a vacuum in our knowledge of how policy interventions should be created.

The present study is the first among the earlier studies that seek to test for the possible non-linear effect of the exchange rate on GDP growth in a developing country like India. The study undertakes the influence of the appreciation of Indian currency on GDP growth to be different from depreciation. The study applies a recently developed Non-Linear ARDL approach suggested by Shin et al. (2014) to test for the asymmetric impact of ex-change changes on G.D.P. in the context of India. In recent years, the complexity of economic interactions has highlighted the limitations of traditional symmetric models, particularly when studying the dynamics of exchange rates and economic growth. Nonlinear relationships often prevail in macroeconomic contexts, where the impact of variables such as exchange rates, government expenditure, and money supply does not follow a uniform pattern across time or conditions. The Nonlinear Autoregressive Distributed Lag (NARDL) model, provides a robust framework for capturing these asymmetries by allowing for different effects during the appreciation and depreciation phases of the exchange rate, thereby offering a more accurate understanding of their impact on economic growth.

The application of nonlinear analysis is particularly relevant for developing economies like India, where structural shifts and policy changes create environments in which macroeconomic variables are highly sensitive to both internal and external shocks. Studies like Bahmani-Oskooee and Mohammadian (2017) have emphasized that relying solely on linear models can obscure critical asymmetries in the way that currency fluctuations, monetary policy, and fiscal actions influence growth trajectories. Nonlinear models, including the NARDL approach, enable researchers to distinguish between the potentially different impacts of positive and negative shocks, thus providing more nuanced insights into policy effectiveness in such economies.

In the current global economic landscape, volatility has become an increasingly pressing issue for emerging markets. With rising inflationary pressures, fluctuating commodity prices, and geopolitical tensions, managing exchange rates has grown even more critical for developing nations. For countries like India, which have a high degree of trade openness (Mumtaz & Ali, 2020; Elpianora et al., 2024; Miharja et al., 2024; Wirnayanti et al., 2024), fluctuations in exchange rates can exert a significant influence on both short-term and long-term economic performance. Exchange rate volatility can exacerbate trade imbalances, affect capital flows, and complicate inflation management, all of which are vital to sustaining economic growth.

Recent global events, such as the economic disruptions caused by the COVID-19 pandemic and ongoing geopolitical conflicts, have further underscored the importance of understanding the asymmetric impacts of exchange rate movements. For instance, while a weaker currency may boost exports, it can simultaneously raise import costs, contributing to inflationary pressures (Ahmad et al., 2022; Firmansyah et al., 2024; Hasibuan et al., 2024). As such, policymakers in emerging markets must balance the short-term benefits of depreciation against its potential long-term economic costs. This study's use of the NARDL approach allows for a detailed exploration of these complex dynamics, offering insights into how exchange rate management strategies can better align with broader economic objectives in the face of global uncertainty. To the best of our knowledge, no such study has examined the asymmetric effect of exchange rates on economic growth in India. The study aims to test the following major objectives: To investigate how changes in the exchange rate (appreciation vs. depreciation) have differing impacts on India's economic growth. To distinguish between the short-term and long-term impacts of exchange rate fluctuations on economic growth.

### *Exchange Rate and Economic Growth*

Previous studies on the relationship between exchange rate changes and economic growth often relied on symmetric models, which assume that the effects of currency appreciation and depreciation are equal but in opposite directions. For instance, early studies such as Ghura and Grennes (1993) and Rodrik (2008) assumed a symmetric relationship, where the impact of an overvalued currency mirrors the effects of an undervalued one. These models, however, fail to account for the complex, nonlinear interactions present in real-world economic dynamics. Symmetric models typically oversimplify the relationship between macroeconomic variables. They assume that an identical percentage change in the exchange rate will have the same magnitude of effect on economic growth, regardless of whether the change is appreciation or depreciation. However, in practice, appreciation and depreciation often have asymmetric effects due to factors like inflationary pressures, import/export structures, and investor behavior.

As Bahmani-Oskooee & Mohammadian (2017) demonstrated in their study of Japan, symmetric models overlook how depreciation can disproportionately affect inflation and trade balances, thus negatively impacting economic growth. Similarly, Nusair (2017) found that depreciation generally has a stronger negative impact on economic growth in the short term, compared to the positive effects of appreciation in the long term. In the context of India, relying on symmetric models can lead to incomplete or misleading policy implications, particularly given the country's high dependence on imports for raw materials and its susceptibility to inflationary shocks.

Moreover, symmetric models do not account for the possibility that economic agents—such as consumers and firms—react differently to positive and negative shocks in the exchange rate. Shaik & Gona (2021), in their empirical analysis of the Indian economy, highlighted that depreciation exacerbated inflation and reduced domestic purchasing power, while appreciation did not lead to proportional gains in consumption or economic activity. This kind of asymmetry is critical in developing economies, where exchange rate movements can have far-reaching implications for trade balances, inflation, and overall economic stability. A growing body of literature now suggests that asymmetric models, such as the Non-Linear Autoregressive Distributed Lag (NARDL) model, are better suited to capture the true nature of exchange rate fluctuations. In emerging economies, such as those in the BRICS group, the use of asymmetric models has yielded more accurate insights into the relationship between exchange rates and economic performance.

For example, Lawal et al. (2022), in their study on African economies, used dynamic panel models to reveal that currency depreciation had a much stronger contractionary effect on economic growth than appreciation had in stimulating growth. Similarly, Mesagan et al. (2022) examined the BRICS countries and found that the effects of exchange rate changes on economic growth were highly asymmetric, with depreciation severely harming trade balances and economic output, while appreciation provided only modest economic benefits. These findings underscore the need for more nuanced models that can differentiate between the impacts of currency appreciation and depreciation.

In India, where exchange rate volatility is a persistent concern due to its high degree of trade openness (Mumtaz & Ali, 2020), adopting an asymmetric model like NARDL is critical. The country's frequent currency fluctuations—driven by external factors like global commodity prices and capital flows—can lead to starkly different outcomes depending on whether the rupee appreciates or depreciates. As such, models that ignore this asymmetry risk misguiding policy decision aimed at stabilizing economic growth. In their comparative study on BRICS economies, Bahmani-Oskooee & Nasir (2020) also highlighted the importance of considering asymmetric effects. They found that the traditional symmetric models failed to capture the differential impact of exchange rate changes on economic growth and trade balances, particularly during periods of significant depreciation. For India, these findings are highly relevant, as the country has experienced similar economic pressures, particularly during episodes of currency volatility.

In light of these findings, it becomes clear that symmetric models are inadequate for analyzing the exchange rate-economic growth nexus, especially in emerging markets like India. Asymmetric models like NARDL provide a more detailed and accurate understanding of how exchange rate fluctuations affect growth. By accounting for the differing impacts of appreciation and depreciation, these models offer more reliable guidance for policymakers aiming to foster sustained economic growth.

To ensure a country's economic growth, the exchange rate must be properly managed (Seraja & Coskuner, 2021; Muis et al., 2024). Many researchers have the same opinion and state that exchange rates play an important role in an economy's growth (Cottan et al., 1990; Ghura & Grennes, 1993; Rodrik, 2008; Rapetti, 2020; Kapciu et al., 2024). It is well evident that an exchange rate's instability from its equilibrium can have an impact on a country's economy in both positive and negative ways (Rodrik, 2008). However, exchange rate overvaluation and undervaluation must be carefully examined, as overvaluation harms an economy's growth rate (Rodrik, 2008). In the current scenario also, researchers have shifted their focus to analyze the impact of exchange rate on economic growth because exchange rate inflation has a significant impact on the domestic economy and foreign trade (Seraja and Coskuner, 2021). Ahmad et al. (2022) examined the impact of exchange rates on trade and economic growth by employing robust econometric techniques in Pakistan. They concluded that the exchange rate retarded economic growth and improved the trade balance economy. Recently, very few studies successfully applied a more advanced econometric method in the form of N.A.R.D.L. This technique is more significant in assessing the dynamic asymmetric nexus between two variables which is

representative of many social phenomena including economic variables. Bahmani-Oskooee & Mohammadian (2017) examined and established the asymmetric effect of the exchange rate on economic output in Japan by employing Shin et al. (2014) N.A.R.D.L. approach. In the light of earlier empirical studies, the following hypothesis is made for the present study: Hypothesis 1 (H1): The exchange rate is supposed to have an ambiguous impact on economic growth.

### *Money Supply and Economic Growth*

According to Keynesians, the money supply has a positive relationship with economic growth (Mansoor et al., 2018). A similar outcome was found in another study where Irving Fisher used the exchange equation  $MV = PY$  to establish a positive relationship between money supply and economic growth (Van, 2019). In their research, a regression model was used to assess the relationship between the money supply and inflation using data from two countries i.e. Vietnam and China (Van, 2019). Another study made by (Aslam, 2016) found a similar result in which a positive relationship between money supply and economic growth was discovered. To investigate the relationship between the two variables, the authors used a regression model and time series data from 1959 to 2013. Based on these studies the following hypothesis is suggested: Hypothesis 2 (H2): Money supply promotes economic growth.

### *Government Expenditure and Economic Growth*

One of the most crucial factors in managing state operations in the direction of reaching advanced levels of growth and offering recipients high-quality services is government spending. Although scholars concur that there is no direct correlation between government spending & economic growth, and various non-financial factors have a significant impact on how the two are related (Albassam, 2020). Also, some economists have varying views on this aspect. According to the crowding-out effect and classical economic theory, there are no consistent links between government spending and economic growth (Carrasco, 1998; Schick, 1998). Wagner's law, on the other hand, postulates that economic expansion (i.e. producing greater national revenues) results in a rise in government spending (Wijeweera & Garis, 2009). According to Wagner's law critics, government expenditure frequently has a negative influence on economic growth, such as the crowding-out effect (Dilrukshini, 2009; Mitchell, 2005). As an alternative, the Keynesian theory contends that governments must step in to promote economic growth by, investing more in social programs, and spending on public goods like in-frastructure, healthcare, and education, etc. (Palley, 2013; Ansari et al., 1997; Mulyanti et al., 2025). Given the findings of the above literature, the following statement is hypothesized: Hypothesis 3 (H3): The government expenditure is expected to increase economic growth.

In India, the disequilibrium in the balance of payments is attributed to the money supply component and macroeconomics (Kumar, 2021). According to the study's findings, India's balance of payments is directly correlated with money supply and foreign exchange rates (Kumar, 2021). In the framework of the Indian economy, the post-reform era saw significant economic changes. Also, it has been noted that a number of macroeconomic factors directly affect India's economic expansion. In addition, several Indian sectors have seen continuous development as a result of recent economic reforms, including poverty reduction, financial inclusion, an increase in literacy rates, etc. (Sharma et al., 2018). Although an imbalanced growth pattern has been noticed in the context of regional expansion. Thus, it is essential to assess macroeconomic factors affecting India's economy, such as the exchange rate, the money supply, and government expenditure. To better comprehend this topic, many research studies are compiled in Table 1 that show the association between these variables in different countries.

Table 1. Relationship between Economic growth, Exchange Rate, Money Supply, and Government Expenditure

Authors	Time Period	Country	Methods	Findings
Lawal et al. (2022)	1980-2018	African countries	DH panel causality	Economic growth, the exchange rate, trade, and remittances are all causally linked in two ways.
Wang et al. (2021)	1980- 2017	China	Two-regime threshold model	Real exchange rate fluctuations and structural discontinuities in China's have a nonlinear effect on economic growth
Kumar (2021)	1991-2020	India	ANOVA and Multiple Regression	Money supply and foreign exchange rate are directly related to BOP.
Mumtaz& Ali (2020)	1980-2018	India & Pakistan	Autoregressive distributive lag Co-integration method	An increase in the real exchange rate leads to increased consumption, whereas an increase in the nominal exchange rate leads to decreased consumption, indicating inflation pass-through.
Samargandi, et al. (2020)	1989Q1 – 2012Q4	BRICS economies	Global Vector Autoregressive (GVAR) framework	Money supply factors do not Forecast BRICS member's financial development and economic growth.
Patel & Mah ( 2018)	1980-2015	South Africa	VECM	The impact of economic growth and exports on the exchange rate was negative and significant.
Sharma et al. (2018)	1971-2016	India	ARLD model	An inverse relationship between economic growth and exchange rate was found.
Mohamed Aslam (2016)	1959- 2013	Sri Lanka	A regression model	Economic growth is impacted by the money supply.
Ahmed et al. (2014)	1972-1973 to 2012- 2013	Pakistan	Johansen co-integration technique	The outcome of study demonstrates a long-term link between the studied factor i.e. .Consumer Price Index , Exchange Rate, Government Borrowing , Money Supply etc.
Ono (2012)	1999– 2008	Russia	VEC model	The findings indicated that money supply increases economic growth.
Morley &Perdikis (2007)	1995-96	Egypt	Co-integration and error correction models	There is a long-run relationship between government spending and economic growth, with reforms acting as a variable relationship between two positive changes.

In conclusion of the above-mentioned previous studies, we reached the point that there is a different effect in different directions and at different intensities in the link between growth, exchange rate changes, money supply, and expenditure. Moreover, on the basis of the aforementioned studies, we reached the conclusion that the link between economic growth, exchange rate, money supply, and government expenditures has a variety of effects, varying in intensity and direction. In summary, the previous empirical research findings are still confusing in the Indian context. Therefore, further research into how it affects economic growth is required. The present study seeks to fill this gap by employing the most recent data series for the period of 1980–2022 to examine the asymmetric impact of the exchange rate, money supply, and expenditure on economic growth. The primary objectives of this study are 1) to examine asymmetric short-term and long-term nexus among the identified variables by applying a robust econometric method, NARDL, and 2) to check a causal relationship among variables

by applying the granger causality test. Figure 1 depicts the conceptual framework to capture the effects of both negative and positive shocks on India’s economic growth.

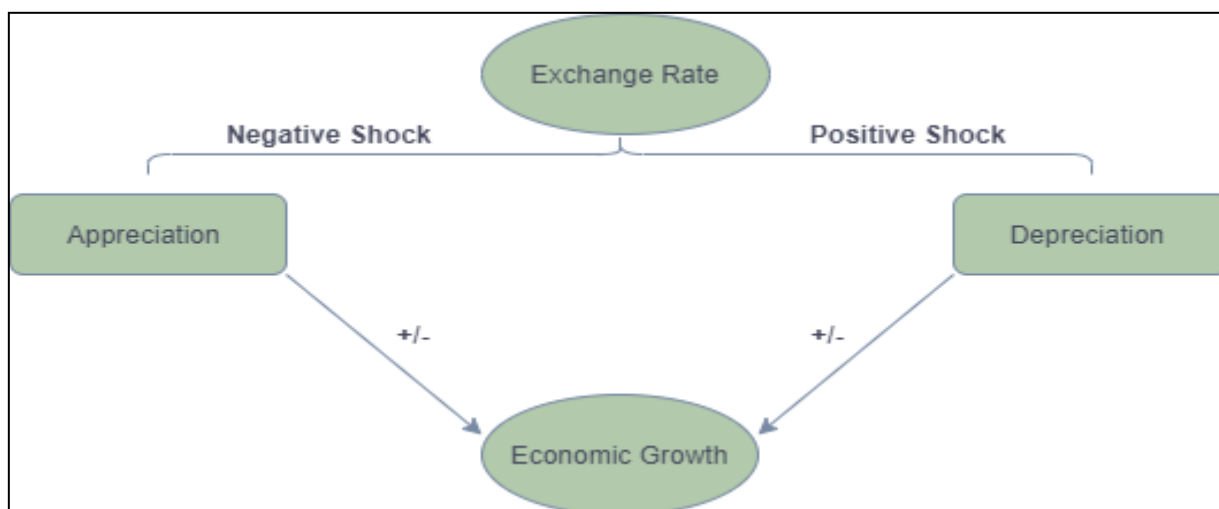


Figure 1. Conceptual framework of exchange rate asymmetries and economic growth.

The AD (Aggregate demand) – AS (Aggregate supply) model can be used to investigate the effect of currency depreciation on economic expansion. Devaluation, on the other hand, can affect AD and AS in a variety of ways (Cooper, 1971; Taylor & Krugman, 1978; Van Wijnbergen, 1986). The conventional view holds that devaluation is expansionary because it raises net exports, which raises AD and output. Nonetheless, this assessment expects that the Marshall-Lerner condition is confirmed. Devaluations may be contractionary in the absence of a justification for this condition. Additionally, AD can be brought on by devaluations' effect on income reallocation. According to Krugman & Taylor (1978), a common hypothesis is that the inflationary effects of devaluations can shift income from those with a high marginal propensity to consume (MPC) to those with a low MPC, resulting in lower AD and lower aggregate consumption. Domestic output may decrease, resulting in contractionary devaluation, if the decrease in AD caused by a decrease in aggregate consumption is greater than the increase in AD caused by an increase in net exports. However, domestic output could rise, resulting in expansionary devaluation, if the increase in AD due to the increase in net exports is greater than the decrease in AD due to the decrease in aggregate consumption.

Devaluation may also have its effects on AS. Particularly, countries that depend mostly on imports for the manufacturing sector face rising costs of production due to devaluation, resulting in a decreased AS (Krugman & Taylor 1978). Therefore, devaluation can be expansionary or contractionary and it can affect AD and/or AS. Thus, whether devaluations are expansionary or contractionary is an empirical concern.

In accordance with prior research, Bahmani-Oskooee & Mohammadian, (2016); Bahmani-Oskooee & Arize, (2020), the theoretical model was utilized in this article due to the presence of additional variables that have an impact on economic expansion. According to Bahmani-Oskooee & Mohammadian (2017), the model used in this investigation is a reduced-form model derived by Mills & Pentecost (2001) from the IS-LM model. In this model, the underlying variables that have an effect on output are real money supply, real exchange rate, and real wage. However, Bahmani-Oskooee & Mohammadian (2017) alter this model by incorporating a measure of oil prices on the supply side and a measure of fiscal policy on the demand side. As opposed to the model used by Bahmani-Oskooee in his analysis, this study focuses on the A.D. side only. The reason behind this is that the inclusion of A.S. side variables may reduce the degree of freedom for the data series. Furthermore, to avoid the problem of serial correlation among the independent variables, the present study takes only A.D. side variables to examine the objectives. Thus, the modified model is as follows:

$$GDP = f(EXR, LMS, GEXP) \dots (1)$$

GDP = Gross domestic product

EXR = Exchange rate in terms of US dollar

LMS = Broad money supply (in log form)

GEXP = Govt. expenditure as a percent of GDP

**RESEARCH METHOD**

This section presents the data collection and description, specified model specification, and analysis techniques employed to check the effects of exchange rate fluctuations and economic growth in India using time series data spanning from 1980 to 2022. Economic growth is used as a dependent variable, and other variables, including the exchange rate (in terms of US\$), Money supply (in log form), and government expenditure (as a percent of GDP) are used as explanatory variables to explore the inter-connotation among the variables. The trends of the underlying variables used in this study are presented in Figures (2).

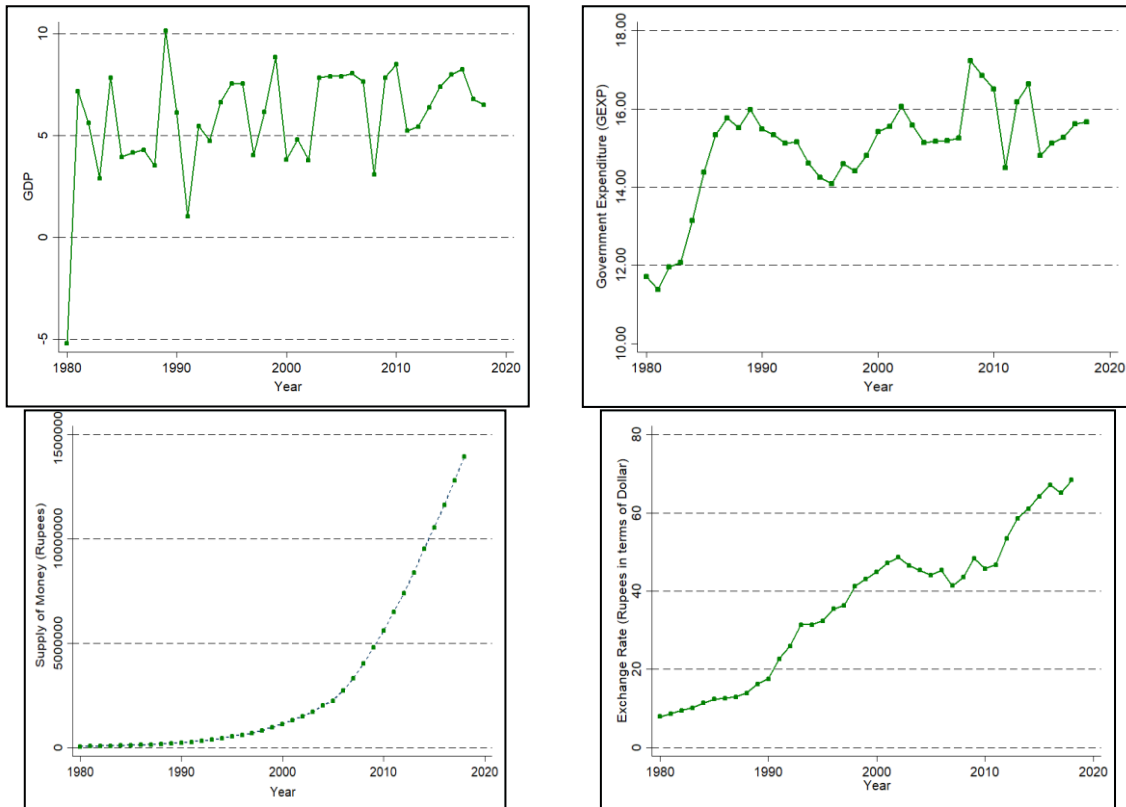


Figure 2: Trends of underlying variables used

The data on all the selected variables have been collected from the Handbook of India’s Statistics (RBI) and World Development Indicators (WDI). The Sources and description of data and justification of the variables are also reported in Table 2.

Table 2. Measurement, Data sources, and justification for the variables

Variables	Symbols	Unit	Sources	Justification
Economic growth	GDP	% of GDP	RBI	(Shaik & Gona 2022; Mesagan et al., 2022.)
Exchange rate	EXR	US (\$)	RBI	(Husain et al., 2019; Bhat & Bhat, 2016.)
Broad money	LMS	Indian rupee	RBI	(Bahmani-Oskooee, 2017)
Govt. expenditure	GEXP	% of GDP	WDI	(Husain et al., 2019)

Note: WDI=World development indicator, RBI= Reserve bank of India, \$ US= United States dollar.

A numerous study such as Shaik & Gona (2020), Husain et.al (2019), Bahmani-Oskooee (2017) and Mohammadian (2017) consider following model to inspect the impact of exchange rate on economic growth.

$$GDP_t = \alpha_0 + \beta_1 EXR_t + \beta_2 LMS_t + \beta_3 GEXP_t + u_t \dots (2)$$

Where,

GDP = Gross domestic product

EXR = Exchange rate in terms of US dollar

LMS = Broad money supply (in log form)

GEXP = Govt. expenditure as a percent of GDP

u = error term

t = Time period

For analyzing the data series, we should check whether it is stationary or non-stationary. Firstly, the data series were checked for stationary using the Augmented Dickey-Fuller (ADF) and PP (Philips Peron) unit root tests. Further, this study used NARDL (Shin et.al 2014) model to estimate the effects of depreciation and appreciation on economic growth because this model is useful for handling the non-linear impact of independent variables on dependent variables and tracing the long-run and short-run effects. According to Husain & Asif (2021), the NARDL approach is a robust technique to avoid misleading results from the linear ARDL model suggested by Pesaran et al. (2001). The linear ARDL of equation 2 is as follows.

$$\begin{aligned} \Delta GDP_t = & \alpha_0 + \sum_{i=1}^n \beta_{1i} \Delta GDP_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta EXR^+_{t-i} + \sum_{i=0}^n \beta_{3i} \Delta EXR^-_{t-i} + \sum_{i=0}^n \beta_{4i} \Delta LMS_{t-i} \\ & + \sum_{i=0}^n \beta_{5i} \Delta GEXP^+_{t-i} + \sum_{i=0}^n \beta_{6i} \Delta GEXP^-_{t-i} + \theta_1 GDP_{t-1} + \theta_2 EXR^+_{t-1} \\ & + \theta_3 EXR^-_{t-1} + \theta_4 LMS_{t-1} + \theta_5 GEXP^+_{t-1} + \theta_6 GEXP^-_{t-1} + e_t \dots (3) \end{aligned}$$

The parameters with summation ( $\beta$ 's) represent short-run effects and coefficients without summation ( $\theta$ 's) denote long-run effects and  $e_t$  is the error term at time t. The ARDL bound test is based on the following hypothesis.

H0:  $\theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$  (No Co-integration relationship in the long run).

H1:  $\theta_1 = \theta_2 = \theta_3 = \theta_4 \neq 0$  (Co-integration relationship in the long run).

Pesaran et al (2021) provided two critical values which are upper bound and lower bound values. If the calculated F statistic value exceeds the upper bound value, then a co-integration relationship exists among the underlying variables. On the contrary, when the calculated F statistic value is less than the lower bound value then no co-integration relationship exists among the variables (Khan et al., 2021; Subhan et al., 2021; Husain & Asif, 2021; Shaik et al., 2024). However, the result remains inconclusive if the F statistic value lies between the upper and lower bounds. In Equation 3, the independents are assumed to have a linear impact on a dependent variable. The linear impact of the exchange rate means that A% depreciation influences G.D.P. by B%, and then A% appreciation impacts G.D.P. by the same B% in the opposite direction. Many studies often do not follow such a linear nexus. The impact of exchange rate changes on GDP happens from the reaction of net exports on the aggregate side (Bahmani- Oskooee & Mohammadian, 2017). The effect of depreciation on economic growth differs from appreciation due to changes in traders' prospects (Bahmani-Oskooee & Fariditavana, 2016). Another important explanation of the asymmetric impact of exchange rate changes on trade balance and output growth has been made by (Mesagan et al., 2022). In this study, we test the asymmetric effects of exchange rate changes on gross domestic product in India. To estimate and test whether the exchange rate has a linear or non-linear effect on GDP, we employed Shin et al. (2014) NARDL technique. Further, first changes in the exchange rate are constructed which would include positive changes and negative changes. After this, two new time series variables are developed, one represents devaluation denoted by EXR+ and the other represents revaluation denoted by EXR- as a partial sum of positive and negative changes respectively. Further, we also generated positive and negative partial sums for government expenditure.

$$EXR^+_t = \sum_{i=0}^t \Delta EXR^+_t = \sum_{i=0}^t \max(\Delta EXR^+_i, 0) \dots (4)$$

$$EXR^-_t = \sum_{i=0}^t \Delta EXR^-_t = \sum_{i=0}^t \max(\Delta EXR^-_i, 0) \dots (5)$$

$$GEXP^+_t = \sum_{i=0}^t \Delta GEXP^+_t = \sum_{i=0}^t \max(\Delta GEXP^+_i, 0) \dots (6)$$

$$GEXP_t = \sum_{i=0}^t \Delta GEXP_t = \sum_{i=0}^t \max(\Delta GEXP_i, 0) \dots (7)$$

Following, Shin et al. (2014), by incorporating positive and negative changes, equation 8 will be written as follows:

$$\begin{aligned} \Delta GDP_t = & \alpha_0 + \sum_{i=1}^n \beta_{1i} \Delta GDP_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta EXR^+_{t-i} + \sum_{i=0}^n \beta_{3i} \Delta EXR^-_{t-i} + \sum_{i=0}^n \beta_{4i} \Delta LMS_{t-i} \\ & + \sum_{i=0}^n \beta_{5i} \Delta GEXP^+_{t-i} + \sum_{i=0}^n \beta_{6i} \Delta GEXP^-_{t-i} + \theta_1 GDP_{t-1} + \theta_2 EXR^+_{t-1} \\ & + \theta_3 EXR^-_{t-1} + \theta_4 LMS_{t-1} + \theta_5 GEXP^+_{t-1} + \theta_6 GEXP^-_{t-1} + e_t \end{aligned}$$

The NARDL model estimation can go through O.L.S. and Pesaran et al. (2001) bound testing method which is suitable to it and is like NARDL as against the linear ARDL (Shin et al., 2014). Besides these, this technique is simple in investigating response, impact, and adjustment asymmetry (Bahmani-Oskooee & Fariditavana, 2016). Once, we get a co-integration relationship, and then both the short-run and long-run asymmetries can be tested accordingly. These statements are to be verified as follows:

1. Null:  $\theta_2 = \theta_3 = 0, \theta_5 = \theta_6 = 0$  (No Asymmetry in the long run).

Alternative:  $\theta_2 = \theta_3 \neq 0, \theta_5 = \theta_6 \neq 0$  (Asymmetry in the long run).

2. Null:  $\beta_{2i} = \beta_{3i} = 0, \beta_{5i} = \beta_{6i} = 0$  (No Asymmetry in the short run).

Alternative:  $\beta_{2i} = \beta_{3i} \neq 0, \beta_{5i} = \beta_{6i} \neq 0$  (Asymmetry in the short run).

The null hypothesis of long-run asymmetry that is  $\theta_2 = \theta_3 = 0$ , where  $\theta_2 = \theta_2 / \theta_1$  and  $\theta_3 = \theta_3 / \theta_1$ . The short-run asymmetries can be tested through parameters i.e.  $\beta_{2i}$  &  $\beta_{3i}$ . Moreover, short-run asymmetric can be found if at a given lag coefficients  $\beta_{2i}$  and  $\beta_{3i}$  have different values Nusair (2017). In the same way, null hypothesis of long-run and short-run asymmetries are designed for government expenditure i.e.  $\theta_5 = \theta_6 = 0$  in long-run and  $\beta_{5i} = \beta_{6i} = 0$  for the short run.

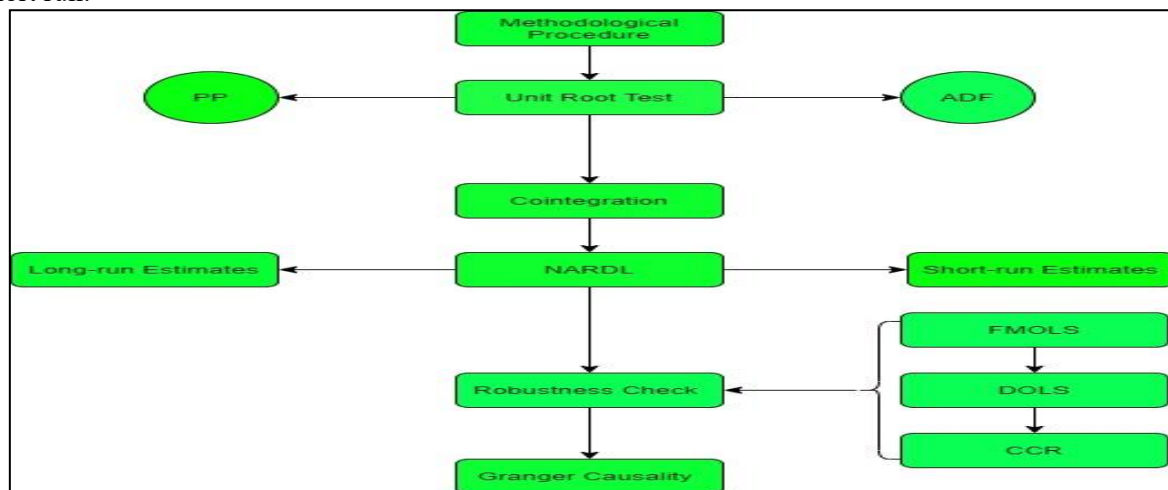


Figure 3: Graphic representation of Estimating Methodology

## RESULTS AND DISCUSSION

### The Circuit Design

Table 3 represents the nature and description of the selected variables. As per descriptive statistics results, we can see that all the variables are normally distributed.

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	39	.753	.185	.024	1.007
EXR	39	1.509	.276	.939	1.848
LMS	39	6.03	.762	4.746	7.188
GEXP	39	1.176	.038	1.056	1.236

The results of the correlation (preliminary analysis) shown in Table 4 indicate that economic growth is weakly associated with the exchange rate (EXR), money supply (LMS), and government expenditure (GEXP) between the range of 25 to 30 percent. On the other hand, the exchange rate is highly associated with LMS followed by government expenditure, more than 60 percent. Furthermore, the money supply has a 60 percent association with government expenditure.

Table 4. Matrix of correlations

Variables	(GDP)	(EXR)	(LMS)	(GEXP)
GDP	1.000			
EXR	0.257	1.000		
LMS	0.279	0.942	1.000	
GEXP	-0.023	0.610	0.599	1.000

The present study employed time-series data, so it is a prerequisite to check the variables for unit root. In the unit root test, we used ADF and PP tests. The results of the unit root test are reported in Table 5. The unit root tests show that economic growth (GDP) and government expenditures (GEXP) are stationary at the level while money supply (LMS) and exchange rates are stationary at the first difference at a 5 % level of significance. Hence, the mixed order of integration lets us use the ARDL co-integration test to investigate the long-run and short-run relationship among the identified variables.

Table 5: Result of unit root test

Variables	ADF		PP	
	I(0)	I(1)	I(0)	I(1)
GDP	8.262***	-10.104***	-38.074***	-40.534***
EXR	0.023	-5.161***	-0.088	-33.594***
GEXP	-2.746**	-6.307***	-7.630	-37.090***
LNMS	-2.696*	-3.167***	-0.265	-20.324***

Notes: (\*\*\*), (\*\*), and (\*) indicate 1%, 5%, and 10% level of significance.

**Results of NARDL bound test**

After primary analysis, our emphasis is on the findings of regression analysis, i.e., the NARDL bounds test, as reported in Table 6. The calculated F-statistics, i.e., 8.65 which is more than the upper bound value  $\{F > I(1)\}$ , implies the existence of a co-integration relationship among the variables which implies that the null hypothesis of no co-integration among the variables is rejected. Therefore, we can examine the long-and short-term coefficients of economic growth due to changes in independent variables (EXR, LMS, and GEXP).

Table 6. Results of NARDL bound test and long-run coefficients.

Variables	Coefficients	Std. Error	P-value	
GDP(-1)*	-1.277	0.178	0.002***	
EXR <sup>+</sup>	-0.041	0.303	0.032**	
EXR <sup>-</sup>	0.243	1.629	0.051**	
GEXP <sup>+</sup>	1.567	1.436	0.024**	
GEXP <sup>-</sup>	-0.827	1.546	0.596	
LMS**	0.217	0.045	0.001***	
D(EXR_POS)	-2.547	1.334	0.065*	
CointEq(-1)*	-0.780	0.164	0.000***	
R-squared	0.634			
Adjusted R-squared	0.624			

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	8.6578***	10%	1.81	2.93
k	5	5%	2.14	3.34
		2.5%	2.44	3.71
		1%	2.82	4.21

The long-term coefficients are reported in Table 6. The increase in exchange rate (depreciation) and decrease in exchange rate (appreciation) have negative and positive effects on economic growth. The findings of this study indicate that currency appreciation has a positive effect on economic growth, while depreciation has a negative effect. Specifically, the results show that an appreciation of the Indian rupee boosts economic growth by 0.24 percentage points, whereas depreciation reduces growth by 0.04 per-centage points. These results can be contextualized within India's economic history, where periods of currency strength have often been associated with enhanced export performance, higher capital inflows, and improved investor confidence. For example, between 2003 and 2008, the Indian rupee appreciated against the U.S. dollar, coinciding with a period of robust economic growth, which saw average annual GDP growth of over 8%. This period was marked by strong export performance, especially in sectors like information technology (IT) and services, which benefited from reduced costs of importing capital goods and intermediate inputs. At the same time, Foreign Direct Investment (FDI) inflows surged, reaching \$34 billion by 2007, as a stronger rupee signaled economic stability to international investors (Ministry of Commerce, 2008). The appreciation of the rupee made India an attractive destination for foreign capital, supporting growth through both direct investment and portfolio inflows.

In contrast, periods of significant depreciation, such as during the 2013 currency crisis when the rupee depreciated by over 20% against the dollar, led to increased inflationary pressures, rising import costs, and reduced investor confidence. The depreciation exacerbated India's trade deficit, as the cost of imported crude oil surged, leading to inflation that reduced domestic consumption and constrained growth (RBI, 2014). These real-world examples align with the findings of this study, confirming that currency depreciation can weaken economic growth, while appreciation supports it by encouraging capital inflows and reducing inflationary pressures. The present results are in line with (Nusair, 2021; Husain et al., 2019), who examined that strong currency boosted economic growth and weak currency reduced economic growth in Pakistan. It is clear from the findings that depreciation and appreciation are negatively and positively related to economic growth in India, such effects may be due to the persistent trade deficit, and the same conclusion was found by (Bahmani- Oskooee & Mohammadian, 2017) in their study.

Further, a positive change in government expenditure impacts economic growth positively, and a negative change in government expenditure impacts economic growth negatively. The outcome of this variable is the same as the findings of (Shaik & Gona, 2020). These results are different from the findings of (Ahmad et al., 2022), who found that the exchange rate impedes economic growth and boosts to trade balance respectively in Pakistan. Moving to another controlled variable, money supply also has a positive significant effect on economic growth. An increase in money supply by one percent leads to economic growth by 0.21 percentage points.

The outcome of long-run and short-run asymmetries is reported in Table 7. It is clear from the table that asymmetries are found in the long run as well as the short run, which implies that both positive and negative changes affect economic growth differently. Therefore, the hypothesis of no asymmetric relationship is rejected. The results of asymmetries for economic growth and exchange rate in short-run as well as long run are within the line of (Bahmani- Oskooee & Nasir, 2020; Bahmani-Oskooee et al., 2021), which investigated an asymmetric relationship between exchange rate volatility and trade balance. It is also within the line of (Mesagan et al., 2022), which found an asymmetric nexus between exchange rate, economic growth, and trade balance in African countries.

Table 7. Long-run and short-run asymmetries

Variable	Long-run asymmetry		Short run asymmetry	
	Coeff.	P-value	Coeff.	P-value
EXR	3.562	0.073	0.865	0.06
GEXP	2.232	0.050	0.859	0.04

Notes: (\*\*\*), (\*\*), and (\*) indicates 1%, 5 % and 10 % level of significance

Our findings from the NARDL reached the point that depreciations reduce, and appreciation boosts economic growth in India. It may be due to India’s persistent trade deficit for very long. If a country relies on many imported goods, currency depreciation can reduce living standards, weaken economic growth, and increase inflation. The outcome of this study has been compared with several other related studies (Bahma-ni-Oskooee & Mohammadian, 2017; Bahmani- Oskooee et al., 2021; Shaik & Gona, 2021; Mesagan et al., 2022 and Ahmad et al., 2022) who examined the effects of exchange rate changes on economic growth in different regions or countries using the ARDL/NARDL model. The results of exchange rate, and economic growth of the present study are with those of (Bahmani-Oskooee & Mohammadian 2017; Bahmani- Oskooee et al., 2021; Shaik & Gona, 2020), who found that depreciation and appreciation are negatively and positively related to economic growth. The results of short-run and long-run asymmetries are within the line of (Mesagan et al., 2022), who found an asymmetric relationship between the variables in African countries. However, our findings using the NARDL model are not consistent with those of (Ahmad, M. et.al, 2022), who found that the exchange rate impedes economic growth and boosts the trade balance respectively in Paki-stan.

The findings from this study indicate that an increase in the money supply has a positive and significant effect on economic growth. Specifically, a 1% increase in the money supply leads to a 0.21 percentage rise in economic growth, highlighting the critical role that monetary expansion plays in stimulating economic activity. These findings can be contextualized within India’s economic history, where monetary policy has been a key tool for promoting growth, particularly during periods of economic downturn.

One notable example is India’s response to the global financial crisis in 2008-2009. During this period, the Reserve Bank of India (RBI) adopted an expansionary monetary policy to mitigate the effects of the global recession on India’s economy. The RBI significantly increased liquidity in the financial system by lowering the policy repo rate and reducing the cash reserve ratio (CRR) for banks, which allowed for greater lending capacity. These measures increased the money supply, which stimulated investment and consumption, helping India achieve an impressive GDP growth rate of 7.9% in 2009 despite the global slowdown (RBI, 2010).

Similarly, during the COVID-19 pandemic, the RBI once again resorted to aggressive monetary expansion to support the economy. The central bank introduced liquidity measures such as long-term repo operations (LTROs) and special liquidity schemes for non-banking financial companies (NBFCs), resulting in an expanded money supply. This policy helped stabilize the financial system, support economic recovery, and avoid a prolonged downturn, with India's economy rebounding to a growth rate of 8.7% in FY 2021-22 (RBI, 2021).

**Robustness check using FMOLS, DOLS and CCR**

The long-run effects of the exchange rate, government expenditure, and money supply on economic growth in India from 1981 to 2022 were examined employing the FMOLS, DOLS, and CCR long-run estimation method to validate the results of the NARDL long-run estimations. The results of the FMOLS and DOLS and CCR are reported in Table 8. The results show that an increase in the

exchange rate (Depreciation) reduces economic growth while an increase in government expenditure and money supply improves economic growth in India. Therefore, these results support the outcome of the NARDL long-run estimations.

Table 8. Result of FMOLS, DOLS and CCR

Variables	FMOLS Coefficients	DOLS Coefficients	CCR Coefficients
EXR	-0.15***	-0.501**	-0.12**
GEXP	1.233***	3.365**	-1.317***
LNMS	0.047**	0.174**	1.73***
Constant	1.676***	4.731***	1.73***

Notes: (\*\*\*), (\*\*) and (\*) indicate 1%, 5%, and 10 % level of significance.

Finally, we performed dynamic adjustments, the results of which are presented in Figures 4 and 5. These dynamic effects show the pattern of economic growth adjustment toward its new long-term equilibrium as a result of negative or positive shocks in the exchange rate and government expenditure, respectively. The dynamic adjustments are calculated using the AIC's best-fit NARDL model. A particular prediction horizon's economic growth adjustment to positive (black line) and negative (dashed black line) shocks is taken by the positive and negative curves. As reported in the figure, the asymmetric line (dashed red line) represents the difference between the dynamic effects for positive and negative shocks, respectively. There is a 95 percent confidence interval between the lower and upper bands (dotted red lines) of this curve. The response of economic growth due to positive shock and negative shocks in the exchange rate is not the same in the long run and short run, as represented in Figure 4. Therefore, the differences between these two shocks suggest clear evidence of asymmetric adjustment of the growth variable. Furthermore, the impact of negative shocks on economic growth is dominant over the positive shocks throughout the horizon. Moreover, the asymmetric adjustment shown in dynamic effects figures is already determined in our empirical analysis by using the Wald test. Likewise, Figure 5 can also be interpreted.

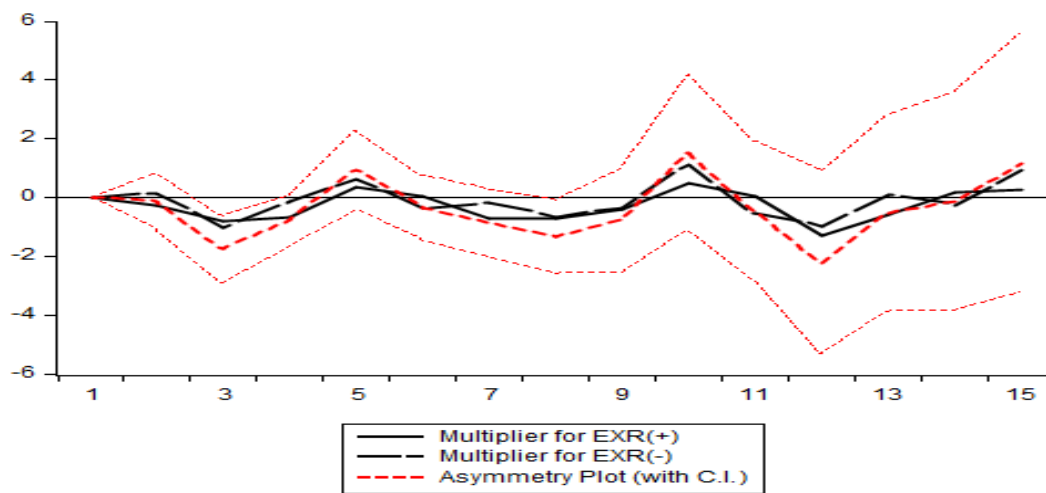


Figure 4. Dynamic effects of exchange rates on economic growth

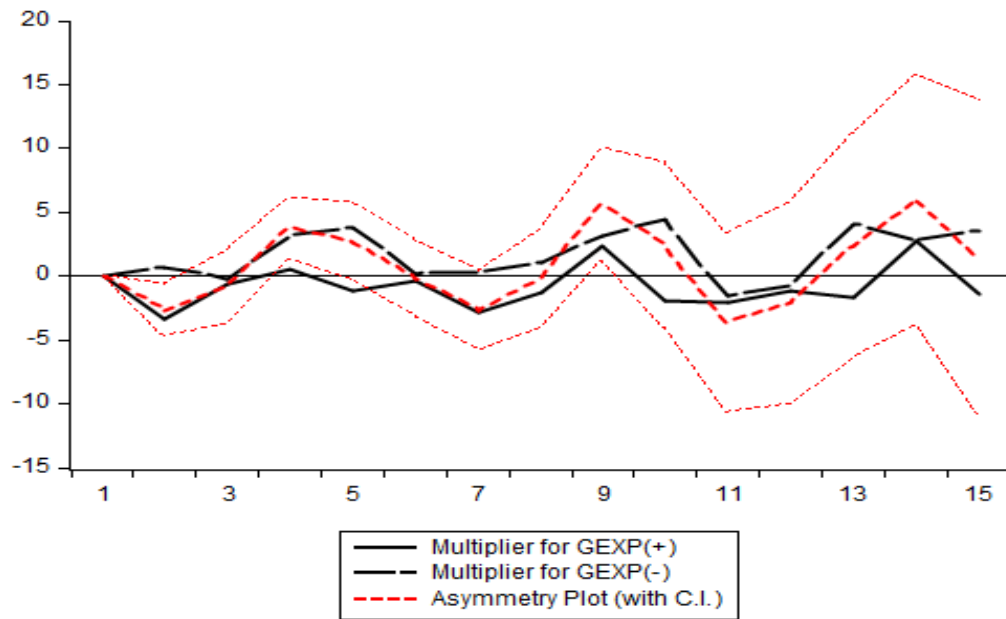


Figure 5. Dynamic effects of exchange rates on economic growth

Table 9 shows the results of different diagnostic tests used to calculate the model's reliability (normality, autocorrelation, heteroscedasticity, and Ramsey RESET). Further, for parameter stability CUSUM and CUSUMQ tests have been used to assess model stability. Figure 6 (A & B), reveals that the predicted line is within the crucial values at the 5% level of significance, which implies that the identified model is highly stable.

Table 9. Diagnostic test results

Diagnostic Test	Statistics	P-valve
Jarque-Bera	3.05	0.15
Auto Correlation	6.06	0.17
BPG Test	0.17	0.8
Ramsey Reset	0.72	0.9

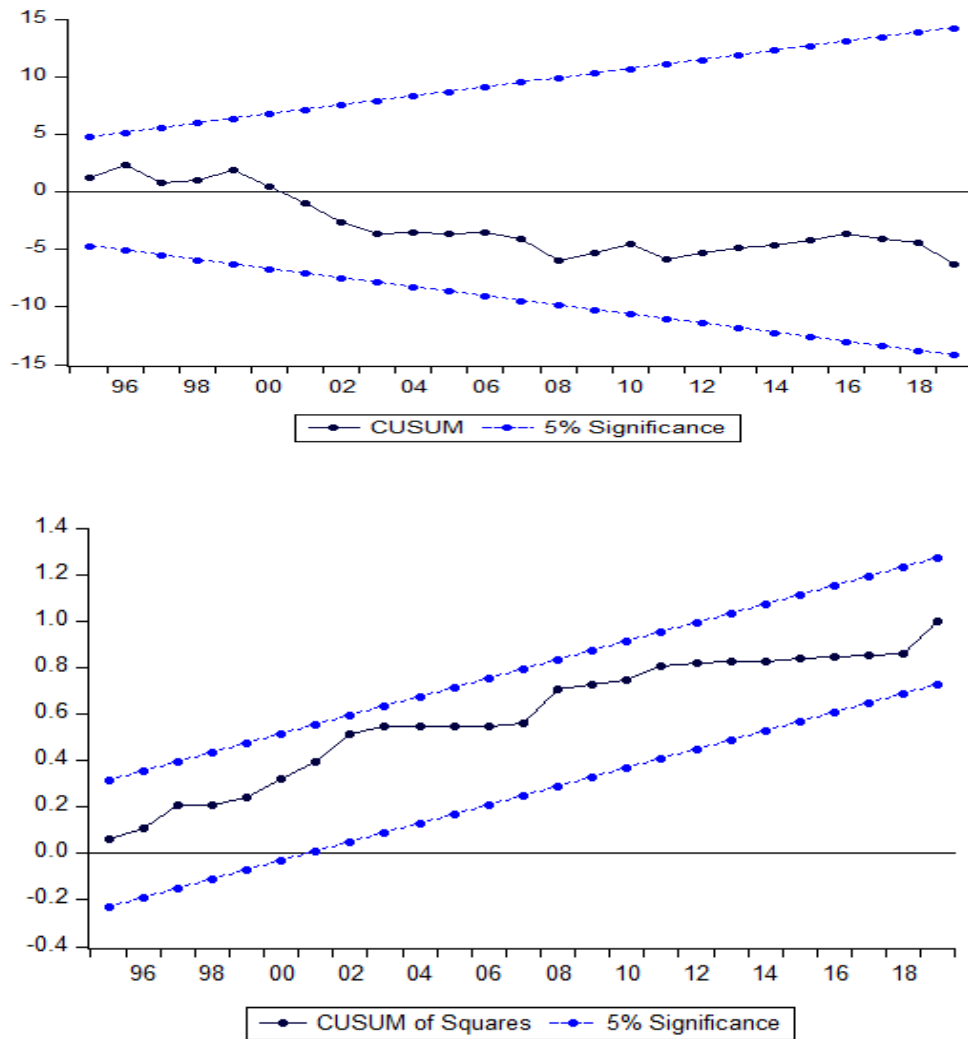


Figure 6. (A&B). Stability of the model CUSUM and CUSUM Square

**Granger Causality Test Results**

The results of asymmetrical causality between dependent and independent variables are presented in Table 10. We found a bidirectional impact between positive and negative shocks in exchange rates and economic growth. Further, a bidirectional causal relationship is observed from positive shocks in government expenditure and economic growth, while no causality runs from negative shocks to government expenditure and economic growth. In contrast, one-way causality is found between money supply and economic growth. No causal relationship is found between positive shocks to government expenditure and positive shocks to exchange rate; from negative shocks to government expenditure and positive shocks to exchange rate; from negative shocks to exchange rate and positive shocks to government expenditure and from money supply to positive shocks to exchange rate. In addition, we found bi-directional asymmetrical causality among money supply and negative shocks to government expenditure. Furthermore, a one-way causal relationship exists between negative shocks in the exchange rate and positive change in government expenditure; from negative shocks to exchange rate and negative shocks to government expenditure, from money supply to a negative change in the exchange rate, and from money supply to positive change in government expenditure.

Table 10: Result of Granger Causality Test

Null Hypothesis	Prob.	Remarks
EXR <sup>+</sup> does not Granger Cause GDP	0.005 <sup>**</sup>	Bidirectional Causality
GDP does not Granger Cause EXR <sup>+</sup>	0.043	
EXR <sup>-</sup> does not Granger Cause GDP	0.022	Bidirectional Causality
GDP does not Granger Cause EXR <sup>-</sup>	0.050 <sup>**</sup>	
GEXP <sup>-</sup> does not Granger Cause GDP	0.126	No causality
GDP does not Granger Cause GEXP <sup>-</sup>	0.906	
LNMS does not Granger Cause GDP	0.037 <sup>**</sup>	One way causality
GDP does not Granger Cause LNMS	0.795	
GEXP <sup>+</sup> does not Granger Cause GDP	0.022 <sup>**</sup>	Bidirectional Causality
GDP does not Granger Cause GEXP <sup>+</sup>	0.052 <sup>**</sup>	
LNMS does not Granger Cause GDP	0.010 <sup>***</sup>	One way causality
GDP does not Granger Cause LNMS	0.383	
GEXP <sup>+</sup> does not Granger Cause EXR <sup>+</sup>	0.438	No causality
EXR <sup>+</sup> does not Granger Cause GEXP <sup>+</sup>	0.672	
GEXP <sup>-</sup> does not Granger Cause EXR <sup>+</sup>	0.133	No causality
EXR <sup>+</sup> does not Granger Cause GEXP <sup>-</sup>	0.401	
LNMS does not Granger Cause EXR <sup>+</sup>	0.343	No causality
EXR <sup>+</sup> does not Granger Cause LNMS	0.831	
GEXP <sup>+</sup> does not Granger Cause EXR <sup>+</sup>	0.481	No causality
EXR <sup>+</sup> does not Granger Cause GEXP <sup>+</sup>	0.506	
GEXP <sup>-</sup> does not Granger Cause EXR <sup>+</sup>	0.435	One way causality
EXR <sup>+</sup> does not Granger Cause GEXP <sup>-</sup>	0.080 <sup>*</sup>	
LNMS does not Granger Cause EXR <sup>+</sup>	0.358	No causality
EXR <sup>+</sup> does not Granger Cause LNMS	0.635	
GEXP <sup>+</sup> does not Granger Cause LNEXR <sup>-</sup>	0.352	One way causality
EXR <sup>-</sup> does not Granger Cause GEXP <sup>+</sup>	0.000 <sup>***</sup>	
GEXP <sup>-</sup> does not Granger Cause EXR <sup>-</sup>	0.816	One way causality
EXR <sup>-</sup> does not Granger Cause GEXP <sup>-</sup>	0.061 <sup>*</sup>	
LNMS does not Granger Cause EXR <sup>-</sup>	0.033 <sup>**</sup>	One way causality
EXR <sup>-</sup> does not Granger Cause LNMS	0.216	
LNMS does not Granger Cause GEXP <sup>+</sup>	0.040 <sup>**</sup>	One way causality
GEXP <sup>+</sup> does not Granger Cause LNMS	0.111	
LNMS does not Granger Cause GEXP <sup>-</sup>	0.077 <sup>*</sup>	Bidirectional Causality
GEXP <sup>-</sup> does not Granger Cause LNMS	0.005 <sup>***</sup>	

(\*\*\*), (\*\*) and (\*) indicates 1%, 5 % and 10 % level of significance.

Additionally, the graphical representation of the causality outcome is reported in figure 7. The line with a double arrow indicates bidirectional causality, the line with a single arrow indicates unidirectional causality and the line without any arrow indicates no causality between the variables.

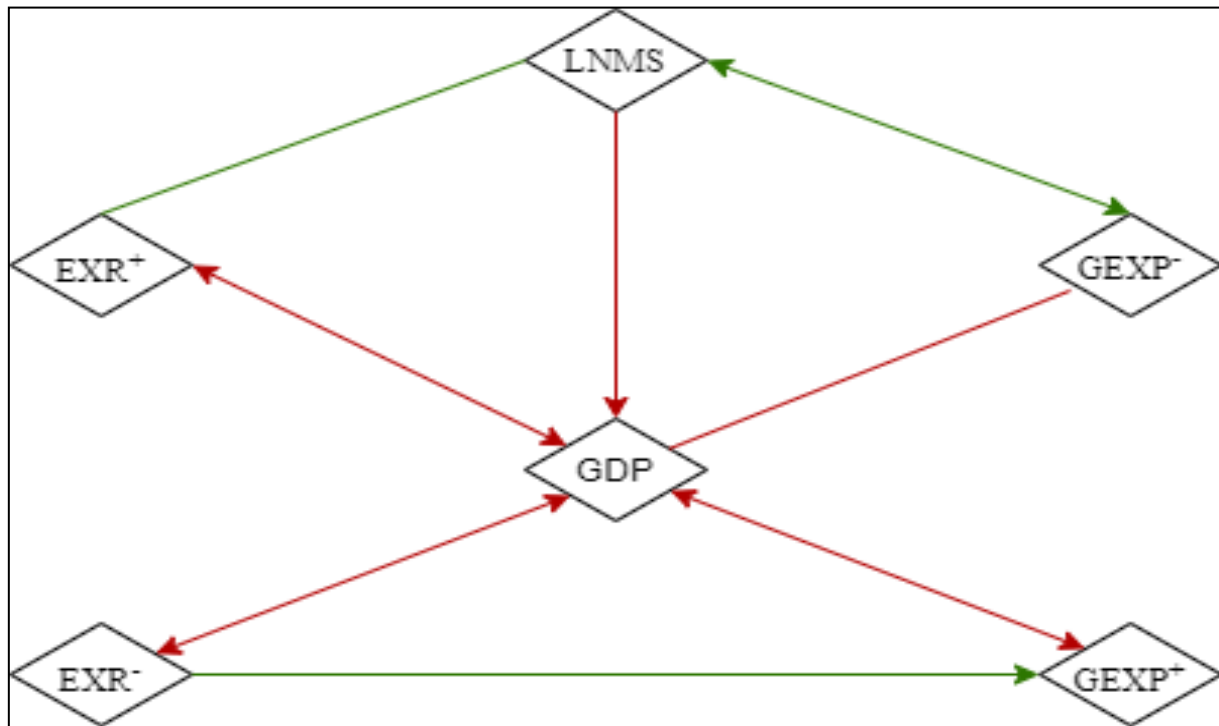


Figure 7. Graphic Representation of Granger Causality Results

Volatility in exchange rates shows a vigorous role in inducing macroeconomic variables comprising economic growth through the channels of net exports and investments. Therefore, the primary aim of the present study is to examine the asymmetric long-term and short-term association among economic growth, and exchange rate changes, along with control variables (money supply and government expenditure) for a period of 1980-2022 in India. To examine short- and long-run asymmetry, the present study is encouraged by and adopts the hypothetical method of A.D.-A.S. by Bahmani-Oskooee & Mohammadian (2017) with focusing on A.D. To examine asymmetric short-term and long-term nexus among the identified variables, the study used the NARDL method suggested by Shin et al. (2014). Further, for robustness checks, we employ econometric models such as FMOLS, DOLS CCR, and causal relationships among variables applying the Granger causality test.

### CONCLUSION

The results of NARDL show that the increase in the exchange rate (depreciation) and decrease in the exchange rate (appreciation) have negative and positive effects on economic growth respectively. Economic growth is boosted by 0.24 percentage points when the exchange rate is appreciated, while economic growth is slowed by 0.04 percentage points when the exchange rate is depreciated. The estimated outcomes of the control variables show that economic growth is positively correlated with both the money supply and government spending. In addition, the short-term and long-term asymmetry of the identified variable is confirmed by the findings. The results were also confirmed by robustness check tests like the Granger Causality Test, DOLS CCR, and FMOLS. According to the findings of FMOLS, DOLS, and CCR, economic growth in India is boosted by an increase in government spending and money supply, whereas economic growth is slowed by an increase in exchange rate (Depreciation). The outcome of the NARDL long-run estimations is supported by these results. We observed a bidirectional relationship between exchange rate growth and positive and negative shocks in the causality results. Additionally, positive shocks to government spending and economic expansion exhibit a bidirectional causal relationship, whereas negative shocks to government spending and economic expansion exhibit no such relationship. In contrast, money supply and economic expansion are found to be one-way causal. No causal relationship is found from positive shocks to government expenditure and positive shocks to exchange rate; from negative shocks to government expenditure and positive shocks to exchange rate; from negative shocks to exchange rate and positive shocks to government expenditure and from money supply to positive shocks to exchange rate. Based on the empirical findings some policy implications may be suggested to the government. The exchange

rate-controlling organization should emphasize restoring stability and pursue the establishment of a stronger exchange rate to achieve the goal of sustained economic growth and ultimately, sustainable development.

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### AUTHOR CONTRIBUTIONS

Conceptualization,.; Shah Husain , Imran Ali baig and Minakshi Rana Methodology; Shah Husain, Mohammad Noor Alam.; Software, Shah Husain, Imran Ali baig, Minakshi Rana.; Validation, Mohammad Noor Alam, Shah Husain; Formal Analysis, Shah Husain, Mohammad Noor Alam, Zakir Hossen Shaikh.; Investigation, Imran Ali baig, Minakshi Rana.; Resources, Mohammad Noor Alam , Zakir Hossen Shaikh.; Data Curation, Shah Husain, Imran Ali baig, Minakshi Rana; Writing – Original Draft Preparation, Shah Husain; Writing – Review & Editing, Mohammad Noor Alam, Zakir Hossen Shaikh; Visualization, Shah Husain, Mohammad Noor Alam.; Supervision, Mohammad Noor Alam.; Project Funding Acquisition, Zakir Hossen Shaikh.”.

### CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

### REFERENCES

- Ahmed, Q.M., Muhammad, S.D., Noman, M. and Lakhan, G.R. (2014), Determinants of recent inflation in Pakistan: revisit, Pakistan, *Journal of Commerce and Social Science*, 8, 170-184. <http://www.jespk.net/publications/170-184.pdf>
- Albassam, B. A. (2022). Government spending and economic growth in the Middle East and North Africa region. *International Review of Administrative Sciences*, 88(4), 1124-1140. and Social Measurement, 40(1–4), 123–149. <https://doi.org/10.1177/00208523211015279>
- Ansari, M. I., Gordon, D. V., & Akuamoah, C. (1997). Keynes versus Wagner: public expenditure and national income for three African countries. *Applied Economics*, 29(4), 543-550. <https://doi.org/10.1080/000368497326678>
- Bahmani-Oskooee, M., & Mohammadian, A. (2016). Asymmetry effects of exchange rate changes on domestic production: evidence from nonlinear ARDL approach. *Australian Economic Papers*, 55(3), 181-191. <https://doi.org/10.1111/1467-8454.12079>.
- Bahmani-Oskooee, M., & Mohammadian, A. (2017). Asymmetry effects of exchange rate changes on domestic production in Japan. *International Review of Applied Economics*, 31(6), 774-790. <https://doi.org/10.1080/02692171.2017.1291163>
- Bhat, J. A., & Bhat, S. A. (2022). On the dynamics of exchange rate pass-through: asymmetric evidence from India. *International Journal of Emerging Markets*, 17(8), <https://doi.org/10.1108/IJOEM-04-2020-0411>
- Baig, I. A., Ali, M. S., Salam, A., & Khan, S. M. (2020). Agriculture, manufacturing and economic growth in India: a co-integration analysis. *Journal of Economics and Business*, 3(3). [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3644729](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3644729)
- Bin Liu, B (2002). Empirical research on the relationship among money supply, output and prices, *Journal of Finance*, 27(7), 10-16
- Carrasco, M. (1998) Crowding out and government spending. University Avenue Undergraduate *Journal of Economics* 2: Article 1. <https://digitalcommons.iwu.edu/uauje/vol2/iss1/1>
- Cottani, J. A., Cavallo, D. F., & Khan, M. S. (1990). Real exchange rate behavior and economic performance in LDCs. *Economic Development and Cultural Change*, 39(1), 61–76. <https://doi.org/10.1086/451829>
- Elpianora, E., Berou, M., Kong, X., Hun, K., & Azadegan, E. (2024). Fourth order runge-kutta and gill methods in numerical analysis of predator-prey models. *Interval: Indonesian Journal of Mathematical Education*, 2(2), 164-177. <https://doi.org/10.37251/ijome.v2i2.1366>
- Dilrukshini, W. A. (2009). Public expenditure and economic growth in Sri Lanka: Cointegration analysis and causality testing. *Staff Studies*, 34(1), 1–14.
- Firmansyah, E., Baluta, I. B., & Elfaituri, K. (2024). The correlation between students' problem-solving

- abilities and their mathematical thinking in high school mathematics education. *Interval: Indonesian Journal of Mathematical Education*, 2(2), 132-140. <https://doi.org/10.37251/ijome.v2i2.1343>
- Ghura, D., & Grennes, T. J. (1993). The real exchange rate and macroeconomic performance in Sub-Saharan Africa. *Journal of development economics*, 42(1), 155-174. [https://doi.org/10.1016/0304-3878\(93\)90077-Z](https://doi.org/10.1016/0304-3878(93)90077-Z).
- Godley, W., & Lavoie, M. (2006). Monetary economics: an integrated approach to credit, money, income, production and wealth. *Springer*. <https://doi.org/10.1057/9780230626546>
- Halimah, H., Putri, D. E., Wulandari, W., Adewumi, S. E., & Arce-Calderón, X. (2024). Contextual pop up book as an innovative learning media in social science subjects in elementary schools. *Journal of Educational Technology and Learning Creativity*, 2(2), 209-216. <https://doi.org/10.37251/jetlc.v2i2.1121>
- Hammad Naem, M., Subhan, M., Alam, M. S., Al-Faryan, M. A. S., & Yameen, M. (2023). Examining the role of financial innovation on economic growth: Fresh empirical evidence from developing and developed countries. *Cogent Economics & Finance*, 11(1), 2170000. <https://doi.org/10.1080/23322039.2023.2170000>
- Hanoum, N. A., Villaverde, K., Saputra, Y., Nuhuyeva, Åəhla, & Ye, T. (2024). Design and development of tempe fermentation tool based on fuzzy method to determine tempe maturity level. *Journal of Educational Technology and Learning Creativity*, 2(2), 235-255. <https://doi.org/10.37251/jetlc.v2i2.1418>
- Hasibuan, S., Chu, C. T., & Godh, W. A. (2024). Enhancing creative thinking in circle topics through the realistic mathematics learning approach. *Interval: Indonesian Journal of Mathematical Education*, 2(2), 106-114. <https://doi.org/10.37251/ijome.v2i2.1148>
- Husain, S., & Asif, M. (2021). Asymmetric effects of fiscal deficit on inflation: Evidence from India. *Indian Journal of Economics and Development*, 17(4), <https://doi.org/10.17485/IJED/v17i4.149>
- Husain, S., Baig, I. A., Asif, M., & Gupta, Y. (2023). Does Twin Deficit Hypothesis Exist in India? A Structural Break Co-Integration Analysis. *Millennial Asia*, 09763996231169136. <https://doi.org/10.1177/09763996231169136>
- Hussain, I., Hussain, J., Ali Khan, A., & Khan, Y. (2019). An analysis of the asymmetric impact of exchange rate changes on GDP in Pakistan: application of non-linear ARDL. *Economic research-Ekonomska istraživanja*, 32(1), 3094-3111. <https://doi.org/10.1080/1331677X.2019.1653217>
- Iwedi, M. (2016). The link between money supply and economic growth in Nigeria: An econometric investigation. *IIARD International Journal of Economics and Business Management*, 2(3), 42-51.
- Joyce, J., & Kamas, L. (2003). Real and nominal determinants of real exchange rates in Latin America: Short-run dynamics and long-run equilibrium. *Journal of Development Studies*, 39(6), 155-182. <https://doi.org/10.1080/00220380412331322741>
- Kapciu, R., Preni, B., Kalluci, E., & Kosova, R. (2024). Modeling inflation dynamics using the logistic model: insights and findings. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, 8(1), 364-378. <https://doi.org/10.22437/jiituj.v8i1.3260>
- Khan, M. A., Adil, M. H., & Husain, S. (2021). The impact of economic uncertainty, stock market uncertainty and monetary uncertainty on money demand in India. *International journal of emerging market*. <https://doi.org/10.1108/IJOEM-07-2020-0770>
- Krugman, P., & Taylor, L. (1978). Contractionary effects of devaluation. *Journal of International Economics*, 8(3), 445-456. [https://doi.org/10.1016/0022-1996\(78\)90007-7](https://doi.org/10.1016/0022-1996(78)90007-7)
- Kumar, P. (2021). Balance of payment, money supply and exchange rate linkage in India. [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3987193](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3987193).
- Lawal, A. I., Salisu, A. A., Asaleye, A. J., Oseni, E., Lawal-Adedoyin, B. B., Dahunsi, S. O., & Babajide, A. A. (2022). Economic growth, exchange rate and remittance nexus: Evidence from Africa. *Journal of Risk and Financial Management*, 15(6), <https://doi.org/10.3390/jrfm15060235>
- Mansoor, A., Shoukat, Q., Bibi, S. H. A. G. U. F. T. A., Iqbal, K., Saeed, R. O. M. A. N. A., & Zaman, K. (2018). The relationship between money supply, price level and economic growth in Pakistan: Keynesian versus monetarist view. *Review of Economic and Business Studies*, 11(2),

- 49-64. <https://doi.org/10.1515/rebs-2018-0072>
- Melinda, S., Feizi, F., & Monfared, P. N. (2024). Transforming religious learning with macromedia flash 8: Improving students' understanding of the material on faith in the apostles. *Journal of Educational Technology and Learning Creativity*, 2(2), 201-208. <https://doi.org/10.37251/jetlc.v2i2.1100>
- Mesagan, E. P., Osuji, E., & Agbonrofo, H. (2022). Comparative analysis of the growth impact of pollution and energy use in selected West African nations. *Environmental Science and Pollution Research*, 29(44), 66438-66449. <https://doi.org/10.1007/s11356-022-20532-3>
- Mesagan, E. P., Alimi, O. Y., & Vo, X. V. (2022). The asymmetric effects of exchange rate on trade balance and output growth. *The Journal of Economic Asymmetries*, 26, e00272. <https://doi.org/10.1016/j.jeca.2022.e00272>.
- Miharja, M. A., Bulayi, M., & Triet, L. V. M. (2024). Realistic mathematics education: Unlocking problem-solving potential in students. *Interval: Indonesian Journal of Mathematical Education*, 2(1), 50-59. <https://doi.org/10.37251/ijome.v2i1.1344>
- Mitchell, D.J. (2005). The Impact of Government Spending on Economic Growth, Backgrounder No. 1831. Washington: *The Heritage Foundation*. <https://www.heritage.org/budget-and-spending/report/the-impact-government-spending-economic-growth>
- Mohamed Aslam, A.L.M. (2016). Impact of money supply on Sri Lankan economy: an econometric analysis. *International Letters of Social and Humanistic Sciences*, 67, 11-17. [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3018650](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3018650)
- Morley, B., & Perdikis, N. (2000). Trade liberalisation, government expenditure and economic growth in Egypt. *The Journal of Development Studies*, 36(4), 38-54. <https://doi.org/10.1080/00220380008422642>
- Muis, A., Pholboon, M., & Kamali, A. N. (2024). Geomics as interactive geography learning media: a development study on environmental material in high schools. *Journal of Educational Technology and Learning Creativity*, 2(2), 192-200. <https://doi.org/10.37251/jetlc.v2i2.1089>
- Mulyanti, R. Y., Wati, L. N., & Suhana, S. (2025). What factors influence the internationalization of small and medium enterprises (smes)? a gender-based approach. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, 9(1), 253-272. <https://doi.org/10.22437/jiituj.v9i1.38816>
- Mumtaz, S., & Ali, M. (2022). Impact of exchange rate and its volatility on domestic consumption in India and Pakistan. *Journal of Public Affairs*, 22(2), e2479. <https://doi.org/10.1002/pa.2479>
- Nusair, S. A. (2017). The J-curve phenomenon in European transition economies: A nonlinear ARDL approach. *International Review of Applied Economics*, <https://doi.org/10.1080/02692171.2016.1214109>
- Ono, S. (2012). Financial development and economic growth: Evidence from Russia. *Europe-Asia Studies*, 64(2), 247-256. <https://doi.org/10.1080/09668136.2012.635484>
- Palley, T. I. (2013). Keynesian, classical and new Keynesian approaches to fiscal policy: Comparison and critique. *Review of Political Economy*, 25(2), 179-204. <https://doi.org/10.1080/09538259.2013.775821>
- Patel, D., & Mah, G. (2018). Relationship between real exchange rate and economic growth: the case of South Africa. *Journal of Economics and Behavioral Studies*, 10(1 (J)), 146-158. [https://doi.org/10.22610/jebbs.v10i1\(J\).2098](https://doi.org/10.22610/jebbs.v10i1(J).2098)
- Phibian, N. O. (2010). The quantity theory of money: Evidence from Nigeria. *Economic and Financial Review, Central Bank of Nigeria*. <https://www.cbn.gov.ng/Out/2012/publications/reports/rsd/efr-2010/Economic%20and%20Financial%20Review%20Vol%2048%20No%202%2C%20June%202010/The%20Quantity%20Theory%20of%20Money.pdf>
- Pistaferri, L. (2015). Household consumption: Research questions, measurement issues, and data collection strategies. *Journal of Economic and Social Measurement*, vol. 40, no. 1-4, pp. 123-149, 2015. <https://doi.org/0.3233/JEM-150401>
- Ram, R., (1986). Government Size and Economic Growth: A New Framework and Some Evidence from Cross-Section and Time-Series Data. *American Economic Review*, 76(1). <https://doi.org/10.1257/aer.76.1.191>
- Rapetti, Martin. "The Real Exchange Rate and Economic Growth: A Survey" *Journal of Globalization and Development*, vol. 11, no. 2, 2020, pp. 20190024. <https://doi.org/10.1515/jgd-2019-0024>
-

- Rodrik, D. (2008). The real exchange rate and economic growth. *Brookings Papers on Economic Activity*, 39(Fall 2008), 365–439. <https://doi.org/10.1353/eca.0.0020>
- Samargandi, N., Kutan, A. M., Sohag, K., & Alqahtani, F. (2020). Equity market and money supply spillovers and economic growth in BRICS economies: A global vector autoregressive approach. *The North American Journal of Economics and Finance*, 51, 101060. <https://doi.org/10.1016/j.naj>
- Schick, A. (1998). A contemporary approach to public expenditure management (World Bank Institute Working Paper No. 68, pp. 2–111). *World Bank*. <https://documents1.worldbank.org/curated/en/7390>
- Seraj, M., & Coskuner, C. (2021). Real exchange rate effect on economic growth: comparison of fundamental equilibrium exchange rate and Balassa–Samuelson based Rodrik approach. *Journal of Applied Economics*, 24(1), 541-554. <https://doi.org/10.1080/15140326.2021.1977083>
- Sharma, R., Kautish, P., & Kumar, D. S. (2018). Impact of selected macroeconomic determinants on economic growth in India: An empirical study. <https://doi.org/10.1177/0972262918803173>
- Shaik, K., & Gona, B. R. (2021). Exchange rate and the economic growth in India: An empirical analysis. *Journal of Public Affairs*, 21(2), e2177. <https://doi.org/10.1002/pa.2177>
- Shaikh, Z. H., Irfan, M., Nomran, N. M., & Abey, J. (2024). DOES COVID-19 AFFECT SHARIAH COMPLIANT STOCK? EVIDENCE FROM SELECTED OIC COUNTRIES. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, 8(2), 720–731. <https://doi.org/10.22437/jiituj.v8i2.33159>
- Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In R. Sickles & W. Horrace (Eds.), *Festschrift in Honor of Peter Schmidt* (pp. 281-314). New York, NY: Springer. [https://doi.org/10.1007/978-1-4899-8008-3\\_9](https://doi.org/10.1007/978-1-4899-8008-3_9)
- Stockman, A. C. (1980). A theory of exchange rate determination. *Journal of Political Economy*, 88(4), 673–698. <https://doi.org/10.1086/260888>.
- Subhan, M., alharthi, M., alam, M. S., thoudam, P., & khan, K. (2021). Relationship between exports, economic growth and other economic activities in India: Evidence from VAR model. *The Journal of Asian Finance, Economics and Business*, <https://doi.org/10.13106/jafeb.2021.vol8.no12.0271>
- Tobin, J. (1970). Money and income: post hoc ergo propter hoc? *The Quarterly Journal of Economics*, 84(2), 301-317. <https://doi.org/10.2307/1883019>.
- Van, D. D. (2019). Money supply and inflation impact on economic growth. *Journal of Financial Economic Policy*. <https://doi.org/10.1108/JFEP-10-2017-0093>.
- Wang Yan-liang. (2012). Relationship Research on Money Supply, Economic Growth and Inflation. *Journal of Convergence Information Technology (JCIT)*. <https://doi.org/10.4156/jcit.vol7.issue1.3>
- Wang, Y., Yu, H., Zhang, H., & Chen, T. (2021). Non-linear analysis of effects of energy consumption on economic growth in China: Role of real exchange rate. *Economic Modelling*, 104, 105623. <https://doi.org/10.1016/j.econmod.2021.105623>
- Wijeweera, A., & Garis, T. (2009). Wagner’s law and social welfare: The case of the Kingdom of Saudi Arabia. *Applied Econometrics and International Development*, 9(2), 199-209. [https://ideas.repec.org/a/eea/aeinde/v9y2009i2\\_16.html](https://ideas.repec.org/a/eea/aeinde/v9y2009i2_16.html)
- Wirnayanti, W., Craig, J., & Malatjie, J. F. (2024). Comparing the impact of problem solving vs. problem posing approaches on mathematics achievement in junior high school. *Interval: Indonesian Journal of Mathematical Education*, 2(2), 90-98. <https://doi.org/10.37251/ijome.v2i2.1094>
- Zakiyah, Z., Boonma, K., & Collado, R. (2024). Physics learning innovation: song and animation-based media as a learning solution for mirrors and lenses for junior high school students. *Journal of Educational Technology and Learning Creativity*, 2(2), 183-191. <https://doi.org/10.37251/jetlc.v2i2.1062>
- Zhu, W., Ahmad, F., Draz, M. U., Ozturk, I., & Rehman, A. (2022). Revisiting the nexus between exchange rate, exports and economic growth: further evidence from Asia. *Economic research-Ekonomska istraživanja*, 35(1), 7128-7146. <https://doi.org/10.1080/1331677X.2022.2059692>