

Exchange Rate Dynamics In An Emerging Economy: Monetary Policy Transmission And Macroeconomic Influences On India's Nominal Exchange Rate



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ABSTRACT

This study examines the macroeconomic determinants of the Nominal Exchange Rate (NER) in India using the data in the year-on-year from 1991-2024 within an ARDL framework. Drawing upon the monetary approach and contemporary exchange rate theories, the study investigates the influence of Money Supply, Interest Rate, Trade Openness, and Output Gap on the NER. The results confirm the existence of a long-run cointegration within the variables. In the long-run, monetary expansion & interest rate movements exert a positive & significant impact on the NER, while trade openness & output gap have a negative effect. In the short run, monetary policy variables show moderate significance, whereas the output gap exhibits a significant negative influence. Diagnostic tests confirm the robustness of the model. The findings highlight the importance of distinguishing between short-run and long-run dynamics and highlight the complex nature of monetary policy transmission (MPT) in shaping exchange rate behaviour in an emerging economy like India. Overall, the study provides an integrated assessment of monetary, external, and real-sector determinants of the nominal exchange rate, contributing to the literature by jointly analysing money supply, interest rate, trade openness, and output gap within a integrated framework and provide valuable insights for policymakers in designing appropriate monetary & exchange rate policies.

Keywords: Nominal Exchange Rate, Monetary, Interest Rate, Trade Openness, Output Gap, India.

INTRODUCTION

Exchange rates (ER) constitute a pivotal element of open economies, shaping international trade, capital mobility, inflation dynamics, external competitiveness, and overall macroeconomic equilibrium. As global integration deepens through expanding trade and financial linkages, exchange rate fluctuations have become a primary conduit for the transmission of both domestic and external shocks. Variations in currency values influence export and import prices, investment behaviour, cross-border capital flows, and the balance of payments, thereby rendering exchange rate stability a central objective of macroeconomic management. Accordingly, identifying and analysing the determinants of exchange rate movements has emerged as a critical domain of inquiry within international economics and monetary policy (MP). India's nominal exchange rate has depreciated from approximately ₹17.9 per US dollar during the 1991 economic reforms to over ₹86, a trajectory that has rarely moved in a straight line. The rupee's path has tracked global oil price shocks, reversals in foreign portfolio investment, and, arguably most persistently, the stance of India's own monetary policy. Operating under a managed float rather than

a fixed peg, the RBI faces a structurally difficult position; it must anchor domestic inflation through interest rate and money supply decisions while simultaneously accounting for how those same decisions transmit to the currency, since a poorly calibrated policy stance can destabilize the exchange rate in ways that ultimately work against the inflation objective it was meant to serve.

This tension is not exclusive to India, though the country's institutional history gives it a particular shape worth studying in its own right. The 1991 Balance of Payments crisis forced a decisive departure from four decades of administered exchange rate management, initiating a transition toward a market determined, RBI supervised float. Trade liberalization opened the current account to global price and demand conditions, while gradual capital account liberalization created channels through which portfolio flows respond quickly to interest rate differentials. The RBI's Annual Report documents this evolving exposure in detail, tracking how the current account balance, capital flows, and reserve adequacy have shifted in response to both domestic policy and global conditions over the post reform period. An economy that was largely insulated from global monetary conditions at the

start of the 1990s had become, by the following decades, considerably more exposed to them, which raises the empirical question central to this paper; how have domestic monetary policy variables, alongside structural features such as trade openness and cyclical output conditions, shaped the rupee's nominal value across this extended period.

The theoretical literature offers several frameworks through which this question can be approached, and these frameworks do not always agree on direction or magnitude. The monetary approach treats the exchange rate as fundamentally a monetary phenomenon, in which money supply growth in excess of output growth depreciates the currency through relative inflation differentials (Friedman, 1968) (Mundell, 1963). Dornbusch (1976) complicates this account by demonstrating that because goods prices adjust more slowly than asset prices, a monetary shock causing exchange rate (ER) to overshoot its eventual long run equilibrium before correcting, implying that short run & long run responses to the same underlying shock can differ substantially, and even move in opposite directions. The uncovered interest rate parity condition introduces a related but distinct mechanism, linking interest rate differentials to expected exchange rate movements through the reallocation of capital across borders. None of these frameworks, taken individually, accounts for the structural dimension of exchange rate determination, namely how an economy's degree of trade openness or its position in the business cycle mediates the strength of these monetary transmission channels, which is where trade openness and the output gap enter this study as complementary explanatory variables.

Empirical research on India has examined various aspects of exchange rate determination, though rarely within a unified framework. Existing studies primarily focus on the REER, foreign exchange intervention, or the role of macroeconomic fundamentals like productivity, government expenditure, capital flows, & foreign institutional investment. While these studies provide valuable insights, they generally examine either the effectiveness of policy responses or selected determinants rather than the underlying drivers of nominal exchange rate movements. Consequently, limited evidence exists that jointly examines the influence of policy interest rate, money supply, trade openness, and output gap on India's nominal exchange rate within a single empirical framework. This study seeks to address this gap by providing a comprehensive analysis of the macroeconomic determinants of India's nominal exchange rate during the post-liberalisation period. It jointly examines the role of the call money rate, money supply, trade openness, and output gap within a single analytical framework, thereby integrating

monetary, external, and real-sector factors that are being examined in isolation in previous studies. By considering these determinants together over an extended period, the study offers a more comprehensive interpretation of the forces shaping India's nominal exchange rate and contributes to the literature on exchange rate determination in emerging economies.

The remainder of the paper is organised as Section 2 presents the theoretical and empirical literature, Section 3 sets out the data sources, variable construction, and the model specification, Section 4 reports the results and the findings consisting the long run & short run coefficients in relation to the theoretical channels discussed and Section 6 concludes with a discussion of the study.

REVIEW OF LITERATURE

Theoretical Perspectives on Exchange Rate Determination

The determination of exchange rates has been one of the central themes in international macroeconomics because exchange rates influence international trade, capital flows, inflation, and overall economic stability. Over time, economists have proposed several theoretical frameworks to explain exchange rate movements, each emphasizing different aspects of economic activity. While early theories focused primarily on price differentials and monetary conditions, subsequent developments incorporated financial markets, expectations, and external sector dynamics, reflecting the increasing complexity of modern open economies.

One of the earliest explanations is provided by the PPP theory, which argues that exchange rates adjust over time to equalize the purchasing power of currencies across countries (Cassel, 1918); (Cassel, 1923). Under this framework, inflation differentials are regarded as the primary driver of exchange rate movements, with relatively higher domestic inflation leading to currency depreciation. Although PPP provides a useful benchmark for understanding long-run ER behaviour, its explanatory power is often limited in the short run because exchange rates are also influenced by financial market conditions, policy interventions, and capital mobility. Recognizing these limitations, later theories shifted attention from goods markets to financial markets. The Interest Rate Parity (IRP) framework posits that ER adjust to reflect differences in domestic and foreign interest rates, thereby preventing arbitrage opportunities in international financial markets. Extending this idea, the Uncovered Interest Rate Parity (UIP) hypothesis proposed by Chinn and Meredith (2004) highlights that changes in interest rate differentials influence investors' portfolio decisions and international capital flows, making interest rates an important channel through which

MP affects exchange rate movements. These theories underline the growing importance of financial integration in explaining currency dynamics, particularly in economies with increasing capital mobility.

The role of monetary policy becomes more explicit under the Monetary Approach to Exchange Rate Determination, developed by Mundell (1963) and Friedman (1968). This approach argues that ER are fundamentally monetary phenomena, where an expansion in the domestic money supply, if not matched by growth in real output, generates excess liquidity and inflationary pressures that ultimately weaken the domestic currency. Building on this monetary perspective, Dornbusch (1976) introduced the Overshooting Model, demonstrating that because financial markets respond more quickly than goods markets, monetary shocks often cause exchange rates to deviate sharply from their long-run equilibrium before gradually adjusting as prices respond. Together, these theories explain why exchange rates frequently exhibit pronounced short-run volatility despite maintaining long-run relationships with macroeconomic fundamentals.

Beyond monetary factors, the Balance of Payments (BoP) Approach emphasizes the importance of external sector conditions in exchange rate determination. According to this perspective, exchange rates adjust to restore equilibrium between a country's international receipts and payments. Improvements in export performance, capital inflows, and external competitiveness increase demand for the domestic currency, whereas persistent trade deficits and capital outflows place downward pressure on its value. This framework is particularly relevant for emerging economies such as India, where trade liberalization and greater integration with global financial markets have strengthened the relationship between external sector performance and exchange rate movements.

More recent theoretical developments recognize that exchange rates are influenced not only by macroeconomic fundamentals but also by the credibility of monetary policy and market expectations. Gali & Monacelli (2005) argued that credible inflation-targeting frameworks reduce exchange rate volatility by anchoring inflation expectations and strengthening policy credibility. In contrast, Spisso et al. (2025) demonstrate that unconventional monetary policies, particularly during periods of financial stress, can increase exchange rate volatility by altering global liquidity conditions and capital flows. These studies suggest that exchange rate behaviour reflects a complex interaction between domestic policy actions, investor expectations, and international financial conditions.

The theoretical literature indicates that no single framework is sufficient to explain exchange rate dynamics. Rather, exchange rates are shaped by the interaction of monetary policy, macroeconomic fundamentals, and external sector conditions. While the Monetary Approach and Interest Rate Parity theories emphasize the roles of money supply and interest rates, the Balance of Payments framework highlights the importance of trade openness, and contemporary monetary theories underscore the influence of policy credibility and market expectations.

Monetary Policy and Exchange Rate Dynamics

Empirical research on the relationship between monetary policy and exchange rates has evolved alongside significant changes in monetary policy frameworks and exchange rate regimes across countries. Early studies primarily examined the effectiveness of monetary policy under alternative exchange rate arrangements, whereas more recent research has focused on the role of inflation targeting, monetary policy credibility, financial market development, and expectations in shaping exchange rate dynamics. Although the literature consistently identifies monetary policy as a key determinant of exchange rate movements, its effectiveness differs considerably between advanced and emerging economies owing to variations in institutional structures, financial market development, and the degree of exchange rate flexibility.

The early empirical literature established that the effectiveness of monetary policy depends critically on the prevailing exchange rate regime. Fleming (1962) demonstrated that expansionary monetary policy is considerably more effective under floating exchange rate systems because currency depreciation reinforces the effects of monetary expansion on domestic output and aggregate demand. In contrast, under fixed exchange rate regimes, the need to maintain external balance substantially constrains the autonomy of monetary policy, limiting its overall effectiveness.

Subsequent studies shifted attention from exchange rate regimes to the operational framework of monetary policy. Clarida et al. (1999) argued that systematic interest-rate rules enhance policy credibility by anchoring inflation expectations and reducing macroeconomic volatility, thereby strengthening monetary transmission. Similarly, Mishkin (2001) showed that monetary policy affects the economy through multiple interconnected channels including interest rates, exchange rates, asset prices, and expectations rather than through a single mechanism, highlighting the increasing importance of financial market expectations in modern monetary policy. Extending this analysis to open economies, Galí and Monacelli (2005)

demonstrated that inflation-targeting regimes provide greater macroeconomic stability by allowing exchange rates to absorb external shocks while maintaining domestic price stability. More recently, Spisso et al. (2025) argued that unconventional monetary policy measures adopted following major global crises have altered traditional transmission mechanisms by influencing global liquidity conditions and financial market expectations, thereby increasing the complexity of exchange rate responses to policy actions.

Evidence from emerging and developing economies suggests that monetary policy transmission is shaped by additional structural and institutional constraints that distinguish these economies from advanced countries. Mohanty & Klau (2004) found that central banks in emerging market economies respond not only to inflation and output fluctuations but also to exchange rate movements, reflecting the widespread prevalence of the “fear of floating” phenomenon. Exchange rate stability, therefore, often becomes an implicit objective of monetary policy despite officially adopting flexible exchange rate regimes.

Further evidence indicates that weak financial systems and institutional limitations can significantly reduce the effectiveness of conventional monetary policy transmission. Mishra et al. (2010) argued that underdeveloped financial markets, limited competition within the banking sector, and frequent central bank intervention in foreign exchange markets weaken the traditional interest rate, bank lending, and exchange rate channels in developing economies. Using a broader sample of emerging and developing economies, Brandao-Marques et al. (2020) found that monetary policy tightening effectively reduces inflation and output once exchange rate movements are explicitly incorporated into the analysis. Their findings further suggest that transparent and independent monetary policy frameworks, particularly inflation-targeting regimes, contribute more to effective monetary transmission than financial development alone. Addressing long-standing empirical inconsistencies, Ha et al. (2025) demonstrated that incorporating forward-looking expectations into empirical models largely resolves both the price puzzle and the foreign exchange puzzle commonly observed in emerging economies, thereby providing a more accurate assessment of monetary policy transmission. Collectively, these studies suggest that policy credibility, exchange rate behaviour, and expectations play a more prominent role in emerging economies than in advanced countries.

The Indian experience broadly reflects these international developments while exhibiting distinct institutional characteristics. As financial liberalisation progressed, India’s monetary policy framework gradually shifted from monetary

targeting to a multiple-indicator approach and eventually to an interest rate-based operating framework centred on the policy repo rate. Mohan & Patra (2009) argued that the effectiveness of monetary transmission in India depends on the interaction of interest rate, credit, exchange rate, asset price, and expectations channels, with their relative importance evolving alongside financial market development and increasing openness of the economy.

Empirical evidence consistently identifies the interest rate channel as the dominant mechanism of monetary policy transmission in India, although exchange rate management continues to influence overall policy effectiveness. Using a Structural VAR framework, Khundrakpam & Jain (2012) found that interest rates account for the largest proportion of monetary policy transmission to output and inflation, while the exchange rate channel has a comparatively weaker influence on output but remains relevant for inflation dynamics. Extending this evidence, Goyal & Agarwal (2017) found that the interest rate channel remains the principal transmission mechanism in India, while liquidity management significantly enhances the pass-through of policy rate changes to financial markets, indicating that both price and quantity channels jointly determine the effectiveness of monetary policy.

The empirical literature suggests that while monetary policy remains a key determinant of exchange rate dynamics, its transmission varies across countries due to differences in exchange rate regimes, financial market development, institutional quality, and policy credibility. In India, monetary policy transmission has strengthened following financial sector reforms, although exchange rate movements continue to be shaped by a broader set of domestic and external macroeconomic factors.

Determinants of Nominal Exchange Rate

The empirical literature on exchange rate determination has gradually evolved from emphasizing individual monetary variables to adopting a broader macroeconomic perspective that incorporates monetary, external, and real-sector factors. Early studies were primarily influenced by the monetary approach, which viewed exchange rate movements as the outcome of changes in money supply, income, and interest rates. Frenkel (1976) demonstrated that expansion in the money supply creates excess liquidity and inflationary pressures, leading to the depreciation of the domestic currency. Extending this framework, Bilson (1978) argued that exchange rates respond not only to current monetary conditions but also to expectations regarding future monetary policy, highlighting the forward-looking nature of foreign exchange markets. These studies established

monetary fundamentals as the cornerstone of exchange rate determination under flexible exchange rate regimes. However, subsequent research suggested that while monetary variables remain important, their influence varies across different time horizons and institutional settings. MacDonald & Taylor (1992) observed that monetary models are more successful in explaining long-run exchange rate behaviour than short-run fluctuations, whereas Engel & West (2005) argued that exchange rates behave like forward-looking asset prices, incorporating expectations about future economic conditions rather than responding solely to contemporaneous macroeconomic fundamentals. Together, these studies indicate that money supply continues to be an important determinant of exchange rate movements, although its effects are mediated through market expectations and long-run equilibrium relationships rather than providing reliable short-run forecasts.

Parallel to the development of monetary models, considerable attention has been devoted to understanding the role of interest rates in influencing exchange rate dynamics. Conventional international finance theory suggests that differences in interest rates alter international capital flows and, consequently, exchange rate movements. While early empirical work focused on testing the validity of the Uncovered Interest Parity (UIP) hypothesis, later studies demonstrated that the relationship between interest rates and exchange rates is considerably more complex. Chinn & Meredith (2004) found stronger empirical support for UIP over longer investment horizons, whereas Eichenbaum & Evans (1995) and Faust et al. (2003) showed that exchange rates respond rapidly to unexpected monetary policy shocks and changes in market expectations. More recent contributions by Engel (2016) and Tenderere & Mishi (2025) further highlighted the importance of foreign exchange risk premia, financial integration, and institutional quality in shaping exchange rate responses to interest rate changes. Consequently, the literature increasingly recognises that interest rates influence exchange rates not only through capital flows but also through investor expectations, policy credibility, and financial market conditions.

Another important strand of the literature emphasises the growing role of external sector integration in exchange rate determination. As economies become increasingly integrated into global trade and financial markets, exchange rates are influenced not only by domestic monetary conditions but also by trade openness, export competitiveness, and external demand. Frankel & Romer (1999) demonstrated that greater trade integration contributes positively to economic performance, while Rodrik (2008) argued that maintaining a competitive exchange rate is essential

for promoting exports, industrial development, and long-term economic growth. More recent studies extend this perspective by suggesting that the impact of trade openness depends on broader macroeconomic conditions, including productivity, capital accumulation, and current account sustainability. Greater openness strengthens the interaction between domestic and international markets, making exchange rates more responsive to external shocks and changes in global economic conditions. This evidence highlights trade openness as an important channel through which macroeconomic fundamentals influence nominal exchange rate movements, particularly in economies that have undergone significant economic liberalisation.

Recent empirical research has also broadened the scope of exchange rate analysis by incorporating indicators of macroeconomic stability, particularly the output gap. Unlike traditional studies that focused primarily on inflation and monetary aggregates, modern macroeconomic literature recognises the output gap as an important indicator of cyclical economic conditions that influences inflation expectations, monetary policy decisions, and financial market behaviour. Taylor (1993) established the importance of the output gap within the monetary policy framework by proposing that central banks systematically adjust interest rates in response to deviations of output from its potential level. Subsequent contributions by Svensson (2000), Woodford (2003), and Galí (2008) further demonstrated that monetary authorities in open economies simultaneously consider inflation, output fluctuations, and exchange rate stability when formulating policy. Although Orphanides (2001) highlighted the empirical challenges associated with measuring the output gap in real time, the literature consistently recognises it as an important indicator of macroeconomic conditions and future policy expectations. As a result, exchange rate movements increasingly reflect not only current monetary and external sector fundamentals but also expectations regarding future economic performance and policy responses.

The literature indicates that exchange rate determination extends beyond monetary aggregates to encompass monetary policy, external sector integration, and macroeconomic conditions. While money supply and interest rates remain the principal monetary determinants, trade openness and the output gap capture the influence of external competitiveness and cyclical economic activity. Together, these factors provide an integrated framework for understanding nominal exchange rate dynamics and form the conceptual basis of the present study.

Empirical Evidence from India

Empirical research on exchange rate determination in India has expanded significantly since the adoption of the market-determined exchange rate system in 1993. Financial liberalisation and greater trade openness shifted research from traditional purchasing power parity and balance of payments approaches towards broader analyses incorporating monetary, real, and external sector variables.

Early studies identified macroeconomic fundamentals as the principal determinants of exchange rate movements. Ranadive & Burange (2015) found that productivity differentials, government expenditure, foreign institutional investment, trade openness, interest rate differentials, inflation, foreign exchange reserves, and net foreign assets collectively explain India's real exchange rate, confirming a stable long-run relationship. Extending this evidence, Das and Roy (2025) showed that interest rate differentials, money supply, relative income, foreign exchange reserves, and trade balance significantly influence the rupee-US dollar exchange rate, highlighting the importance of integrating monetary, external, and financial factors within a single analytical framework.

Another stream of research focuses on the role of monetary policy in exchange rate dynamics. Patra & Kapur (2012) demonstrated that monetary policy affects inflation, aggregate demand, and exchange rate movements simultaneously, emphasising that exchange rate behaviour cannot be analysed independently of the broader monetary policy framework. Similarly, Hossain & Maitra (2019) found that the effectiveness of monetary policy depends on financial market development, trade openness, and exchange rate flexibility, suggesting that exchange rate dynamics are shaped by broader macroeconomic conditions.

Recent studies also emphasise the role of policy intervention. Rishad et al. (2021) showed that RBI intervention significantly influences exchange rate behaviour, particularly in reducing excessive short-run volatility, while long-run movements continue to reflect underlying macroeconomic fundamentals. Overall, the Indian literature has evolved from examining individual macroeconomic determinants to adopting more comprehensive perspectives that integrate monetary policy, external sector variables, and institutional factors. However, existing studies largely focus on the real exchange rate, foreign exchange intervention, or selected monetary variables. Comparatively limited attention has been given to jointly analysing money supply, call money rate, trade openness, and output gap as determinants of India's nominal exchange rate, thereby motivating the present study.

The foregoing review indicates that the Indian literature has made significant progress in identifying the macroeconomic and policy factors

influencing exchange rate movements. Nevertheless, several gaps remain. Most empirical studies focus on the real exchange rate or the rupee-US dollar exchange rate, while relatively limited attention has been devoted to the determinants of the nominal exchange rate. In addition, existing research has largely examined monetary and external sector variables in isolation, with comparatively little emphasis on their combined influence. The output gap, despite its importance in monetary policy transmission and business cycle analysis, has received limited attention in studies of India's exchange rate dynamics. Consequently, there remains a need for a comprehensive analysis that jointly examines the role of money supply, call money rate, trade openness, and output gap in explaining movements in India's nominal exchange rate. This research aims to fill this gap by providing updated empirical evidence on the macroeconomic determinants of the NER during the post-liberalisation period.

DATA AND METHODOLOGY

The study undertakes year-on-year data for the period ranging from the year 1991-2024. This period efficiently captures India's post-liberalization period, onset with the economic reforms of 1991. The study period captures important developments in the Indian economy, including financial sector reforms, increasing trade openness, the global financial crisis, the adoption of flexible inflation targeting, and the COVID-19 pandemic, thereby providing a comprehensive framework for analysing exchange rate dynamics under varying macroeconomic conditions. The data set is sourced from the Reserve Bank of India's Database on the Indian Economy (DBIE). The Nominal Exchange Rate (*NER*) measured as LCU per USD representing the dependent variable. The Independent variables constitute the Call Money which is used for Interest rate (*IR*) proxy and Broad Money (*M3*) as the proxy for Money supply (*MS*) representing the monetary policy stance, Trade Openness (*OP*) measured through the ratio of trade to gross domestic product & the Output Gap (*OG*), constructed using HP filter to capture deviations from potential output of actual output, thereby representing cyclical demand pressures in the economy (Hodrick & Prescott, 1997).

The empirical model of this research is grounded in the monetary model of exchange rate determination. The baseline long-run relationship to be estimated is specified as follows:

$$NER_t = \beta_0 + \beta_1 IR_t + \beta_2 OG_t + \beta_3 OP_t + \beta_4 MS_t + u_t$$

Where,

- NER_t = Nominal Exchange Rate
- IR_t = Interest Rate
- OG_t = Output Gap
- OP_t = Trade Openness

- MS_t = Money Supply
- u_t = random disturbance term

The empirical strategy is based on estimating a dynamic relationship among the NER & selected macroeconomic fundamentals, namely interest rate, output gap, trade openness & money supply. Prior to the estimation of the ARDL model, the time series properties of the variables are analysed using unit root tests to ensure that no series is integrated of order two or higher using the Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) unit root. Accordingly, the ARDL modelling framework is employed, which allows simultaneous estimation of long-run relationships and short-run dynamic adjustments within a unified econometric structure. To ensure consistency and minimise scale effects, all

variables except the call money rate are transformed into their natural logarithmic form prior to estimation.

To assess the adequacy and reliability of the model that is estimated, a series of post-estimation diagnostic procedures are undertaken. Collectively, the diagnostics ensure that the model confirms to the fundamental assumptions of time-series econometric analysis and provides robust, credible evidence regarding the determinants of India's nominal exchange rate.

RESULTS AND INTERPRETATION

This section elaborates the study's empirical results and discusses the implications for comprehending the determinants of India's nominal exchange rate.

TABLE 1. SUMMARY OF THE UNIT ROOT TEST RESULTS

Variables	Level	First difference	Conclusion
NER	-3.4203	-7.1525***	I (1)
INT	-6.0915***	-	I (0)
M	-4.0827	-6.4503***	I (1)
OG	-3.468**	-	I (0)
OP	-2.957	-5.1358**	I (1)

Source: Author's computation using R; **Note:** *, **, *** denote significance at 10%, 5%, and 1%.

Prior to further estimation, it is important to examine the stationarity properties of the variables to tackle spurious regression results. For this objective, ADF test was utilized to ascertain the order of integration of the variables. The *Table 1* presents ADF test outcomes.

The results show a mixed order integration among the selected macro-economic variables. The Interest Rate (*INT*) and Output Gap (*OG*) are stationary at level [I (0)]. Whereas, the Nominal Exchange Rate (*NER*), Money Supply (*M*) & Trade Openness (*OP*)

are stationary at first Difference [I (1)]. The existence of both I(0) & I(1) variables affirms the appropriateness of employing the ARDL Bounds Test Approach (Pesaran et al., 2001). The stationarity results confirm the ARDL framework's use for estimating long-run & short-run determinants of India's NER. Moreover, the mixed order integration of the variables offers the essential econometric foundations for continuing with the cointegration analysis and following estimation of the ARDL Error Correction Model.

TABLE 2. COINTEGRATION TEST OF ARDL BOUND TEST

TABLE 2. COINTEGRATION TEST OF TRADE EQUITY TEST			
Test Statistic		Value	
<i>F</i> -statistic		24.136	
Number of Regressors (<i>k</i>)		4	
Case		III (Unrestricted Intercept, No Trend)	
Observations		32	
Critical Values			
Significance Level	I(0)	I(1)	Decision
10%	2.696	3.898	Cointegration
5%	3.276	4.630	Cointegration
1%	4.590	6.368	Cointegration

Source: Author's computation using R

The Bounds test results shown in *Table 2* confirms the presence of a stable long-run equilibrium association among the NER & the selected macroeconomics determinants, namely the Interest

Rate (IR), Trade Openness (OP), Output Gap (OG), and Money Supply (M). The calculated F-Statistics substantially exceeds the upper-bounds critical value at the 1% significance level, providing the

strong statistical evidence against the null hypothesis stating no cointegration. This points toward a very strong long-run cointegrating relationship, indicating that although short-run fluctuations may cause short-run deviation, the ER & the macro-economic fundamentals move together

over time towards a stable equilibrium. The outcome validates the ARDL Error Correction framework's application of and establishes that the selected macro-economic variables constitute significant long-run determinants of India's Nominal Exchange Rate.

TABLE 3. LONG-RUN ARDL ESTIMATES

Variable	Coefficient	Std. Error	t-Statistic	p-value	Significance
Constant	-84.959	18.474	-4.599	0.0008	***
NER (-1)	-0.313	0.093	-3.355	0.0064	***
Interest Rate	-1.485	0.491	3.026	0.0115	**
Output Gap	63.490	24.992	-2.540	0.0275	**
Trade Openness	-0.102	0.029	-3.506	0.0049	***
Money Supply	7.690	1.475	5.213	0.0003	***
Model Statistics					
Statistic	Value				
R ²	0.8227				
Adjusted R ²	0.6572				
F-statistic	4.971				
Prob(F-statistic)	0.0019				

Note: Standard errors are Newey-West HAC corrected.

Source: Author's computation using R; **Note:** *, **, *** denote significance at 10%, 5%, and 1%.

Prior to estimating the long-run relationship, the appropriate ARDL model specification and optimal lag structure were determined using the Akaike Information Criterion (AIC), which identifies the model with the best balance between goodness-of-fit and model parsimony. The long-run coefficient estimates show in Table 3, shows that the NER is highly affected by the selected macroeconomics determinants. The estimated coefficient suggests that both MP variables & the real sector fundamentals have a critical role in outlining the long-run behaviour of India's Exchange Rate. The statistical significance of all the explanatory variables further reinforces the presence of stable long-run equilibrium relation formed through ARDL Bounds Test.

Among the estimated coefficients, the Interest Rate shows a negatively significant coefficient, showing that 1 percent increase in the domestic interest rate causes approximately 1.49% decrease in NER. The outcome is consistent with the interest rate channel of monetary policy transmission, advocates that change in monetary policy significantly affect exchange rate fluctuations in the long-run. A higher domestic interest rate reflects tighter monetary conditions, which changes the relative return on financial assets and influencing capital market behaviour. The higher interest is expected to attract foreign capital as it will enhance the attractiveness of the domestic financial asset, encourage the capital flow and strengthen the local currency.

The Output Gap is displaying the positively significant coefficient of 63.490 where 1% increase

in the output gap will result in the approximately 63% rise in the NER (depreciation of domestic currency) which points out that the economic expansion period is related with the depreciating NER. A positive output gap generally reflects stronger domestic demand, which can push up the import demand generating inflationary pressures and weakening the domestic currency over time. The finding indicates that cyclical fluctuations in economic activity constitute an important determinant of exchange rate behaviour in India.

Similarly, Trade Openness reveals a negatively significant coefficient meaning greater integration with international trade is associated with long-run exchange rate appreciation. Development in trade facilities higher export earning, strengthen foreign exchange availability, and improves the country's external sector position. Increased Openness also elevates market efficiency and international competitiveness, thereby reducing pressure on the local currency. The negative relation therefore, denotes that economies with stronger trade integration experience relatively greater exchange rate stability over the long run.

In contrast Money Supply administer a positively and highly significant influence on the NER. The positive co-efficient shows that expansionary monetary conditions contribute towards depreciation of domestic currency. An increment in money supply raises liquidity within the economy, which may promote inflationary pressure and diminish the purchasing power of domestic currency. As domestic price rise relative to foreign

prices, demand of foreign currency increases, leading to an increment in NER. This finding is aligned with the Quantity Theory of Money and conventional monetary model, which suggest that excessive monetary expansion weakens the external

value of the domestic currency through inflationary and exchange market channels. The long-run estimates indicate that both monetary policy variables and macroeconomic fundamentals significantly influence India's nominal exchange rate.

Table 4. Short-Run Error Correction Model (ECM)

Variable	Coefficient	Std. Error	t-Statistic	p-value	Significance
<i>ECM (-1)</i>	-0.313	0.063	-4.989	0.0002	***
ΔIR	0.371	0.169	2.200	0.0439	**
$\Delta IR (-1)$	-0.448	0.169	-2.644	0.0184	**
$\Delta IR (-2)$	-0.375	0.042	-8.962	0.0000	***
ΔOG	-39.980	8.062	-4.959	0.0002	***
$\Delta OG (-1)$	34.717	7.017	4.947	0.0002	***
ΔOP	-0.032	0.022	-1.432	0.1726	NS
$\Delta OP (-1)$	0.084	0.013	6.650	0.0000	***
$\Delta OP (-2)$	0.055	0.012	4.451	0.0005	***
$\Delta \ln M$	15.822	6.449	-2.453	0.0269	**
$\Delta \ln M (-1)$	14.964	5.302	-2.822	0.0129	**
$\Delta \ln M (-2)$	35.381	4.512	-7.842	0.0000	***
$\Delta NER (-1)$	-0.210	0.118	-1.778	0.0956	*
$\Delta NER (-2)$	-0.295	0.106	-2.777	0.0141	**

Source: Author's computation using R; **Note:** *, **, *** denote significance at 10%, 5%, and 1%.

The Table 4 presents the short-run estimates which highlights that the NER addresses to both contemporaneous & lagged variations in the macro-economic variables, showing that exchange rate corrections occur slowly rather than instantaneously. The estimated short-run coefficient exhibits that MP variables along with domestic economic situations continue to employ significant impact on exchange rate fluctuations before the economy converges towards its long-run equilibrium.

The estimated ECT is negative & highly significant at 1% level, gratifying the ARDL error correction model's theoretical expectation. The coefficient demonstrates that approximately 31.3% of the short-run disequilibrium in the NER is corrected during every period following any shock. The moderate speed adjustment suggests that even though there is temporary deviation from the equilibrium of the long-run emerges because of the adjustment in other variables, these disruptions are gradually corrected as the exchange rate move towards the long-run equilibrium path.

The Interest Rate shows simultaneous and delayed effect on the NER. While the concurrent coefficient is positive, whereas first and second lagged coefficients are negatively statistically significant. It states that MP actions mainly influence exchange

rate fluctuations before financial markets slowly adjust through changes in capital flows and market expectations. Similarly, the Output Gap significantly affects the NER in the short-run. The immediate negative coefficient indicates that stronger economic activities will firstly appreciate the local currency and the positive lagged effect represent following adjustments in aggregate demand and external sector dynamics, resulting in momentary exchange rate movements.

The results additionally exhibits that Trade Openness doesn't exercise an immediate impact on NER, while it's the lagged effect is positive and highly significant. This shows that the effects of trade integration on the exchange rate occurs gradually as export earnings and import payments are conveyed through the foreign exchange market. Likewise, Money Supply explains a considerable short-run impact on the NER. The simultaneous and second lagged coefficient are statistically positive coefficient, indicating that expansionary monetary conditions contribute to depreciation of the domestic currency both immediately and over subsequent periods. Finally, the lagged changes in the NER are negative and statistically significant, indicating persistence in exchange rate adjustments and supporting the presence of gradual convergence following short-run disturbances.

TABLE 5. DIAGNOSTIC AND STABILITY TESTS

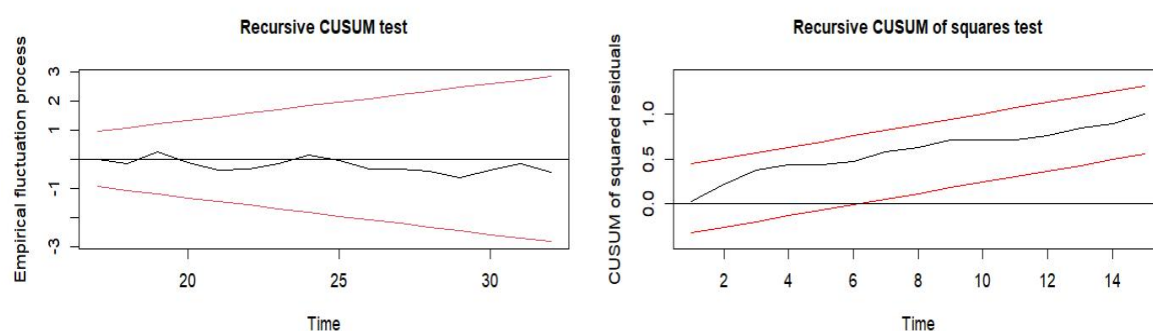
Diagnostic Test	Test Statistic	p-value	Decision
<i>Breusch-Godfrey (Serial Correlation)</i>	0.0011	0.9743	No serial correlation

LM Test

<i>Ljung-Box Q Test</i>	0.0015	0.9690	No autocorrelation
<i>Breusch-Pagan (Heteroskedasticity) Test</i>	18.188	0.4433	Homoskedastic residuals
<i>Shapiro-Wilk (Normality) Test</i>	W = 0.9395	0.0881	Residuals normally distributed
<i>Ramsey RESET Test</i>	0.3461	0.7138	Model correctly specified

Source: Author's computation using R; **Note:** *, **, *** denote significance at 10%, 5%, and 1%.

FIGURE 1. CUSUM & CUSUMQ STABILITY TESTS



Source: Author's computation using R

As per the ARDL Models, various post-estimation diagnostic test was performed to examine the statistical suitability & reliability on the computed results. The result shown in Table 5 display the estimated model's diagnostic test.

The Ljung-Box and Breusch-Godfrey LM both shows statistically insignificant p-values, validates the non-existence of serial correlation and residual autocorrelation. The Bruesch-Pagan test similarly indicates homoskedastic residuals, proposing that the error term variance remains constant throughout the computation period. The Shapiro-Wilk normality test validates an approximate normal distribution followed by residuals, whereas Ramsey RESET test shows no empirical support of functional form misspecifications. These diagnostic findings establish that the evaluated ARDL model is statistically robust. The CUSUM and CUSUMQ stability tests (Figure 1) remains within the critical bounds, representing stable model parameters and no structural instability.

CONCLUSION

This research deals with the determinants of India's NER in the post-liberalization period which starts from 1991 to 2024 with ARDL Bound testing Framework. The results affirms that there is presence of the robust long-run cointegrating association among the ER and the selected macroeconomic variables of interest rate, money supply, trade openness and the output gap. A negative & significant ECT shows that even though

the pace is moderate, following the shocks of short-run nature, the exchange rate reverts to its long-run equilibrium. The findings reveal that increase in money supply & the interest rate representing the MP stance results in the domestic currency's depreciation, that is, rise in the NER. Trade openness & output gap, whereas have a negative impact on the NER as increase in both variables will result in the appreciation of the domestic currency. The analysis supports the recognized economic theory, including the monetary approach, the balance of payments theory, and uncovered interest rate parity, pointing its relevance to India's exchange rate movements. The short-run dynamics add nuance to this research though as the interest rate reverses sign across periods, which suggests the overshooting-type adjustment, while trade openness operates with a lag.

These findings suggest that monetary authorities should weigh not only the long-run effect of policy decisions but also the short-run implications as they both move in opposite directions. Careful MP calibration is essential to prevent inflation-driven depreciation risks while ensuring economic stability. On the trade side, improved trade competitiveness through export diversification and foreign direct investment attraction can further strengthen the currency. Structural economic reforms intended at improving fiscal discipline & efficient financial markets are imperative for ensuring exchange rate stability. The findings yield valuable perspectives

for policymakers in managing India's exchange rate dynamics effectively.

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