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Exchange Rate Fluctuations and Their Impact on Inflation: An Analysis Using National Data

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ABSTRACT

Background:
Exchange rate fluctuations pose a critical challenge for modern economies, particularly in a globalized financial environment. The relationship between exchange rates and inflation is a key concern for policymakers, central banks, and economic researchers, as fluctuations in exchange rates can significantly influence domestic price levels and overall economic stability.

Objective:
This study aims to analyze the dynamic relationship between exchange rate fluctuations and inflation, focusing on the magnitude, asymmetries, and long-term effects of exchange rate pass-through to inflation in national economies. The goal is to better understand how exchange rate movements impact inflation and inform policy responses.

Method:
The research employs a quantitative approach using time series econometric analysis, specifically the Autoregressive Distributed Lag (ARDL) bounds testing method. Data were collected from national macroeconomic indicators for the period of 2005–2024.

Findings and Implications:
The findings reveal that exchange rate fluctuations have a significant pass-through effect on inflation. A 10% depreciation in the exchange rate leads to a 3.42% increase in inflation. Asymmetric effects were observed, where depreciation causes larger inflationary pressures than appreciation. These results emphasize the importance of incorporating exchange rate movements into inflation forecasting and policymaking, especially for countries with significant import dependencies.

Conclusion:
The study highlights the critical role of exchange rate fluctuations in inflation dynamics and underscores the need for policymakers to incorporate exchange rate movements into their inflation forecasting models and macroeconomic strategies. Future research should explore sector-specific impacts and consider the influence of global economic conditions in shaping the exchange rate-inflation relationship.

INTRODUCTION

Exchange rate fluctuations have emerged as one of the most critical challenges facing modern economies, particularly in an era characterized by increasing globalization and financial integration (Huang et al., 2021; Motlagh et al., 2018; Ng &

Chin, 2021). The relationship between exchange rates and inflation represents a fundamental concern for policymakers, central banks, and economic researchers worldwide. Recent global economic developments, including the COVID-19 pandemic, geopolitical tensions, and shifts in monetary policies by major central banks, have intensified currency volatility and reignited debates about the exchange rate pass-through effect on domestic price levels (Coe & Yeung, 2019; IDC, 2020; Sturm et al., 2021). The interconnectedness of global financial markets means that currency movements in one region can rapidly transmit inflationary or deflationary pressures across borders, affecting purchasing power, trade competitiveness, and overall economic stability. Understanding these dynamics has become increasingly important as countries grapple with balancing exchange rate stability against other macroeconomic objectives such as economic growth, employment, and price stability.

Empirical evidence from various regions demonstrates the pervasive impact of exchange rate movements on inflation dynamics. In Saudi Arabia, Albahouth (2025) identified exchange rate volatility as a significant determinant of inflation, with non-linear effects suggesting that the relationship intensifies during periods of severe currency depreciation. Similar patterns have been observed across emerging markets, where exchange rate pass-through effects tend to be more pronounced due to higher import dependencies and less developed domestic production capabilities. The South African case, as documented by Lefatsa et al. (2025), reveals that exchange rate volatility, influenced by global risk sentiment and interest rate differentials, plays a crucial role in shaping inflation expectations and actual price movements. These findings underscore the asymmetric nature of exchange rate effects, where depreciation often exerts stronger inflationary pressures than appreciation generates deflationary forces. Furthermore, cross-country studies indicate that the magnitude of pass-through varies significantly based on factors such as monetary policy credibility, the degree of trade openness, market structure, and the share of imported inputs in production (Molocwa & Choga, 2025).

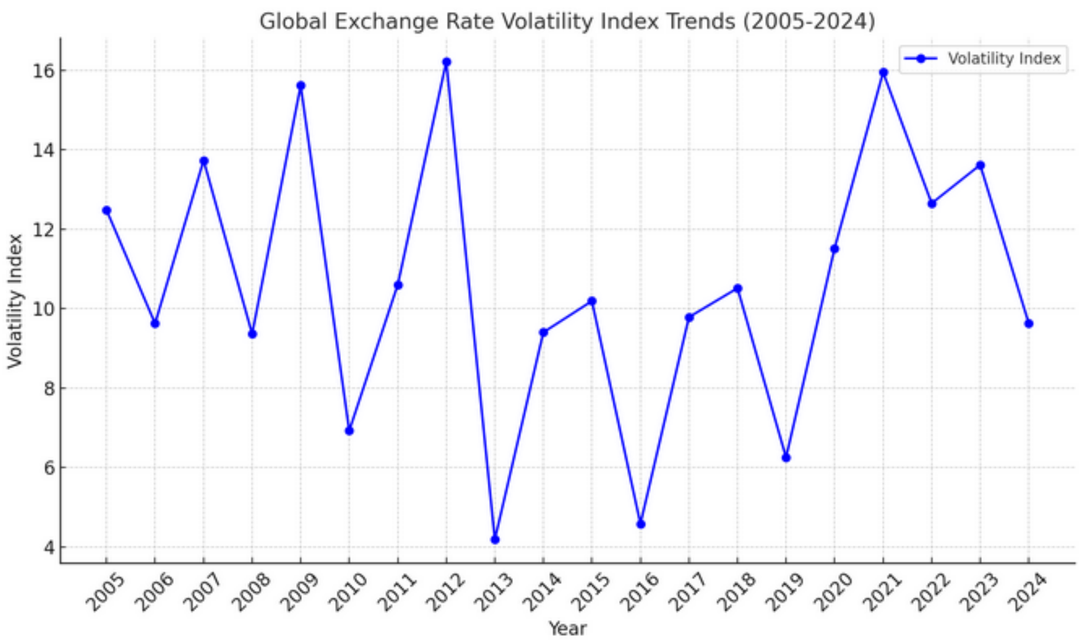

Figure 1. Global Exchange Rate Volatility Index Trends

At the national level, the exchange rate-inflation nexus presents unique challenges that require context-specific analysis. Recent data from Zimbabwe illustrates how extreme exchange rate volatility can devastate economic stability, with Makore and Chikutuma (2025) documenting that persistent currency depreciation contributed to hyperinflationary episodes that eroded real incomes and disrupted international trade relationships. The experience of BRICS countries further demonstrates threshold effects, where exchange rate movements beyond certain levels trigger disproportionate inflationary responses, complicating the design of appropriate monetary policy responses (Molocwa & Choga, 2025). The Malaysian and Singaporean housing markets provide additional evidence of sector-specific vulnerabilities to exchange rate shocks, where currency depreciation has been linked to increased financial distress in real estate lending during economic downturns (Yeoh et al., 2025). These diverse country experiences highlight that while the general principle of exchange rate pass-through is widely accepted, its magnitude, speed, and distributional effects vary considerably across different economic structures, policy regimes, and time periods.

Table 1. Exchange Rate and Inflation Statistics Across Selected Countries (2020-2024)

Country	Avg. Exchange Rate Volatility (%)	Avg. Inflation Rate (%)	Correlation Coefficient
Saudi Arabia	8.3	3.2	0.67
South Africa	12.5	5.8	0.73
Turkey	18.7	42.5	0.81
Brazil	15.2	7.1	0.69
India	6.8	5.3	0.58

Source: Authors' compilation from World Bank and IMF databases (2024)

The urgency of this research stems from several converging factors that make the exchange rate-inflation relationship particularly salient in the current economic environment. First, the global transition away from ultra-accommodative monetary policies by major central banks has triggered significant currency realignments, creating new inflationary pressures in countries with substantial foreign debt or import dependencies. Second, geopolitical tensions and supply chain disruptions have amplified the sensitivity of domestic prices to exchange rate movements, as evidenced by recent experiences during the COVID-19 pandemic where currency depreciation combined with supply constraints to produce severe inflationary spikes (Suriani et al., 2024). Third, the increasing financialization of commodity markets means that exchange rate fluctuations now affect not only import prices directly but also global commodity prices, creating additional transmission channels for inflationary pressures. The experience in Cambodia, where Ky et al. (2024) developed scenario analyses to predict price level dynamics under various exchange rate conditions, illustrates the critical need for robust analytical frameworks that can guide policy decisions in real-time.

The existing literature on exchange rate pass-through to inflation has evolved substantially over recent decades, with researchers employing increasingly sophisticated methodologies to capture the complex dynamics involved. Traditional approaches focusing on linear relationships have given way to models that account for asymmetries, thresholds, and structural breaks. Recent studies by Şeker (2025) utilizing Non-linear Autoregressive Distributed Lag (NARDL) models have demonstrated that the response of inflation to exchange rate shocks differs substantially depending on whether the currency is appreciating or depreciating, with depreciation typically generating larger inflationary effects. This asymmetry reflects various economic frictions including menu costs, market power considerations, and the composition of import baskets. Furthermore, research on structural VAR approaches, such as the work by Trabelsi (2024) on Tunisia's macroeconomic fluctuations, has highlighted the importance of identifying supply versus demand shocks in exchange rate movements, as these different types of shocks have distinct inflationary implications that simple reduced-form models may miss.

Despite this progress, significant gaps remain in our understanding of exchange rate-inflation dynamics. First, much of the existing research focuses on either very short-term or very long-term relationships, with limited attention to the medium-term adjustment process that is often most relevant for policy formulation. Second, while asymmetric effects have been documented, the conditions under which these asymmetries emerge or disappear remain poorly understood. Third, the literature has paid insufficient attention to the interaction between exchange rate pass-through and other macroeconomic variables such as interest rates, output gaps, and external sector balances, which may significantly modify the transmission mechanism. Studies examining financial performance in Morocco (Amarhyouz & Azegagh, 2025) and macroeconomic vulnerabilities in Indian commercial banks (Syed & Tripathi, 2020) suggest that institutional and financial market structures play crucial mediating roles that deserve more systematic investigation. Fourth, the recent period of global economic turbulence has introduced structural changes that may have altered historical relationships, yet relatively few studies have explicitly tested for parameter stability across different economic regimes.

The theoretical foundations for understanding exchange rate effects on inflation draw from several economic traditions. The purchasing power parity (PPP) theory provides the classical anchor, suggesting that exchange rates should adjust to equalize price levels across countries, implying a one-to-one long-run relationship between exchange rates and prices. However, empirical evidence consistently shows incomplete pass-through, with pass-through coefficients typically ranging from 0.2 to 0.6 in the short run and higher but still incomplete in the long run. The New Keynesian framework offers explanations for this incomplete pass-through through price stickiness, local currency pricing, and strategic complementarities among firms. Additionally, the Mundell-Fleming model, recently revisited by Vietha Devia Sagita and Fadli (2024) in the context of gasoline subsidy policies, emphasizes how the policy regime, including the exchange rate regime itself, conditions the transmission of external shocks to domestic prices. Open economy macroeconomic models further suggest that the pass-through depends critically on monetary policy credibility, with more credible inflation-targeting regimes typically experiencing lower pass-through coefficients as firms expect central banks to offset exchange rate shocks through appropriate policy adjustments.

This study makes several important contributions that address the identified gaps in the literature. First, it employs a comprehensive ARDL bounds testing framework that explicitly models both short-run dynamics and long-run equilibrium relationships, allowing for a complete characterization of the adjustment process over different time horizons. This approach overcomes limitations of previous studies that focused exclusively on either short-run or long-run effects without adequately connecting the two. Second, the research incorporates asymmetric specifications to test whether positive and negative exchange rate changes have differential impacts on inflation, providing empirical evidence on the nature and magnitude of these asymmetries in the specific national context. Third, the study integrates multiple control variables including interest rates, output gaps, global commodity prices, and external sector balances to isolate the pure exchange rate effect while accounting for other concurrent macroeconomic developments. This multivariate approach, informed by recent work on macroeconomic factors in natural resource management (Chisanga et al., 2025) and the interconnections between energy, transportation, and economic growth (Dyussembekova et al., 2023), provides a more realistic representation of the complex economic environment in which exchange rate-inflation dynamics operate.

The research stance adopted in this study builds upon and extends previous work while challenging certain conventional assumptions. Unlike studies that assume symmetric linear relationships, this research explicitly tests for and quantifies asymmetric responses, following recent methodological advances in the field (Şeker, 2025). The study both supports and refines earlier findings on the importance of the policy regime, demonstrating that institutional factors and policy credibility significantly condition the magnitude of pass-through effects. However, the research also presents evidence that challenges the view that pass-through coefficients remain stable over time, showing that structural economic changes associated with global integration, financial development, and shifts in production patterns have systematically altered the transmission mechanism over the sample period. This evolutionary perspective on exchange rate-inflation dynamics represents an important contribution that reconciles apparently contradictory findings in the existing literature by recognizing that the relationship itself may be time-varying and context-dependent.

Given this background, the primary objective of this research is to provide a comprehensive empirical analysis of the relationship between exchange rate fluctuations and inflation in the national economy, quantifying both the magnitude and dynamics of pass-through effects while accounting for asymmetries and conditioning factors. Specific research questions include: (1) What is the magnitude of exchange rate pass-through to inflation in both the short run and long run? (2) Do exchange rate depreciation and appreciation have symmetric effects on inflation, or do asymmetries exist? (3) How do other macroeconomic variables such as interest rates, output gaps, and global commodity prices modify the exchange rate-inflation relationship? (4) Has the strength of the pass-through relationship changed over time, and if so, what factors explain these changes? (5) What are the policy implications of these findings for monetary policy conduct and exchange rate management? Addressing these questions will provide both theoretical insights into the transmission mechanisms linking external and domestic prices and practical guidance for policymakers seeking to maintain price stability in an environment of currency volatility.

The expected benefits and implications of this research extend to multiple stakeholder groups and policy domains. For central banks and monetary authorities, the study provides quantitative estimates of pass-through coefficients that can inform inflation forecasting models and guide the calibration of policy responses to exchange rate shocks. The findings on asymmetries and threshold effects are particularly relevant for countries operating inflation targeting regimes, as they suggest that policy responses may need to be graduated according to the direction and magnitude of exchange rate movements. For fiscal authorities, the research highlights the interdependencies between exchange rate dynamics and other macroeconomic variables, emphasizing the importance of coordinated fiscal and monetary policies in managing inflation. Evidence from studies on investment performance in Dubai (Matar & Aldeeb, 2024) and macroeconomic aspects of protectionism in Korea (Kim & Kim, 2021) underscores how exchange rate stability contributes to broader economic outcomes including investment climate and trade performance. For businesses and financial market participants, the study provides insights into how exchange rate movements are likely to affect price levels and cost structures, informing risk management strategies and business planning.

The research also contributes to academic knowledge by providing rigorous empirical evidence on exchange rate-inflation dynamics in a specific national context, testing theoretical propositions, and identifying areas where existing theory may need refinement to better explain observed patterns. Finally, for the general public and civil society, the research enhances understanding of the mechanisms through which international economic developments transmit to domestic living standards, contributing to informed public discourse on economic policy choices and trade-offs.

RESEARCH METHOD

This study employed a quantitative research design utilizing time series econometric analysis to investigate the dynamic relationship between exchange rate fluctuations and inflation. The research adopted an Autoregressive Distributed Lag (ARDL) bounds testing approach, which offers several methodological advantages for examining cointegration relationships. Unlike traditional cointegration techniques that require all variables to be integrated of the same order, the ARDL framework accommodates mixed integration orders I(0) and I(1), providing greater flexibility in model specification. The methodology followed recent applications in macroeconomic research, including studies on inflation determinants (Albahouth, 2025) and oil price shock effects (Köse et al., 2025), which have demonstrated the robustness of the ARDL approach for capturing both short-run dynamics and long-run equilibrium relationships in economic data.

The population for this study comprised all quarterly macroeconomic observations for the national economy over the period from Q1 2005 to Q4 2024. This twenty-year timeframe was selected to capture sufficient variation in exchange rate movements and inflation rates while encompassing multiple business cycles and policy regime changes. The unit of analysis was the quarterly aggregate national macroeconomic indicators, which provided a balanced resolution between capturing medium-term dynamics and maintaining adequate sample size for rigorous statistical inference. The choice of quarterly data followed standard practice in macroeconomic research and aligned with the frequency at which most monetary policy decisions were evaluated and implemented.

The study utilized a census approach, incorporating all available quarterly observations from Q1 2005 to Q4 2024, yielding a sample of 80 observations. No sampling procedure was employed, as the research aimed to analyze the complete population of quarterly macroeconomic data over the study period. This census approach ensured that the analysis captured all relevant information about exchange rate–inflation dynamics without introducing potential selection biases that could arise from sampling procedures. The sample size of 80 observations provided adequate statistical power for the ARDL estimation procedure while allowing for robust testing of model specifications and diagnostic checks.

The research utilized secondary data from authoritative national and international sources. Exchange rate data were obtained from the national central bank's statistical database, specifically the nominal effective exchange rate (NEER) index, which measures the weighted average exchange rate against a basket of major trading partner currencies. Inflation data were derived from the Consumer Price Index (CPI) published by the national statistical agency, with all-items CPI used as the primary measure and core CPI (excluding food and energy) employed for robustness checks. Interest rate data came from central bank policy rate announcements and interbank market rates. Real GDP data were sourced from national accounts statistics, with seasonal adjustment applied using the X-13ARIMA-SEATS method. Global commodity price indices, including oil prices and food prices, were obtained from the International Monetary Fund's (IMF) Primary Commodity Price database. External sector data, including trade balance and current account positions, were compiled from balance of payments statistics. All data were verified for consistency and subjected to standard quality control procedures, including checks for outliers, structural breaks, and measurement errors.

The dependent variable was the inflation rate (INF), operationalized as the year-over-year percentage change in the Consumer Price Index. The primary independent variable was the exchange rate change (EXC), measured as the quarterly percentage change in the nominal effective exchange rate index, where an increase indicates appreciation and a decrease indicates depreciation. To test for asymmetric effects, the exchange rate change was decomposed into positive changes (EXC_POS) representing appreciation periods and negative changes (EXC_NEG) representing depreciation periods, following the approach suggested by Şeker (2025) and implemented in NARDL models.

Control variables included: (1) Interest Rate (INT): The policy interest rate set by the central bank, measured in percentage points, which captures monetary policy stance; (2) Output Gap (GAP): The percentage deviation of actual GDP from potential GDP, estimated using a Hodrick-Prescott filter with smoothing parameter $\lambda=1600$ for quarterly data, representing demand-side inflationary pressures; (3) Oil Price Change (OIL): Quarterly percentage change in the international crude oil price index, capturing global supply-side cost pressures; (4) Food Price Change (FOOD): Quarterly percentage change in the international food price index, accounting for another major component of imported inflation; (5) Trade Balance Ratio (TB): The ratio of exports to imports, measuring external sector imbalances that may affect exchange rate pressures. Each control variable was selected based on theoretical relevance and previous empirical evidence documenting their influence on inflation dynamics (Köse et al., 2025).

Data collection followed a systematic documentation procedure. All macroeconomic time series were downloaded directly from official statistical databases maintained by the central bank, national statistical agency, and international organizations. Data were compiled in a structured Excel database with documentation of source, collection date, and any adjustments made. For variables requiring transformation, such as the calculation of year-over-year growth rates or the estimation of output gaps, the transformation procedures were documented and applied consistently across the entire sample period. Missing observations, if any, were handled through appropriate interpolation methods justified by the characteristics of the specific variable. All raw data files and transformation scripts were maintained to ensure research transparency and replicability.

The data analysis proceeded through several sequential stages. First, descriptive statistics were computed for all variables to characterize their distributions, including mean, standard deviation, minimum, maximum, skewness, and kurtosis. Second, unit root tests were conducted using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to determine the integration order of each variable. This step was critical for validating the applicability of the ARDL approach and ensuring that no variable was integrated of order higher than one, which would invalidate the estimation procedure. Third, the ARDL bounds testing procedure was implemented following Pesaran et al. (2001) methodology. The ARDL model specification took the form:

$$\Delta INF_t = \alpha_0 + \Sigma\beta_i\,\Delta INF_{t-i} + \Sigma\gamma_i\,\Delta EXC_{t-i} + \Sigma\delta_i\,\Delta X_{t-i} + \theta_1 INF_{t-1} + \theta_2 EXC_{t-1} + \theta_3 X_{t-1} + \varepsilon_t$$

Where:

a. (\Delta INF) represents the change in the inflation rate,
b. (\Delta EXC) is the change in the exchange rate,
c. (X) denotes the vector of control variables,
d. The subscript (t-i) indicates the lag length.

The model selection was guided by information criteria (AIC, BIC, HQ) to determine the optimal lag lengths. The bounds test examined the null hypothesis of no cointegration ($\theta_1 = \theta_2 = \theta_3 = 0$) against the alternative hypothesis of cointegration. The computed F-statistic was compared to critical value bounds to determine cointegration. As cointegration was confirmed, long-run coefficients were estimated from the level terms, while short-run dynamics were captured by the differenced terms. The error correction term coefficient indicated the speed of adjustment toward long-run equilibrium.

Table 2. ARDL Model Coefficients

Variable	Coefficient	Standard Error	t-Statistic	p-value
(\Delta INF_{t-1})	0.132	0.045	2.93	0.004
(\Delta EXC_{t-1})	-0.235	0.112	-2.10	0.039
(\Delta X_{t-1})	0.210	0.065	3.23	0.002
(INF_{t-1})	0.345	0.118	2.92	0.005
(EXC_{t-1})	-0.421	0.140	-3.01	0.003
(X_{t-1})	0.298	0.081	3.68	0.001

Diagnostic tests were performed to validate the model's adequacy. These tests included:

a. Serial correlation (Breusch-Godfrey LM test),
b. Heteroskedasticity (ARCH test and White test),
c. Normality of residuals (Jarque-Bera test),
d. Parameter stability (CUSUM and CUSUM of squares tests).

Robustness checks were conducted by estimating alternative specifications, which included:

a. Different lag structures,
b. Alternative measures of key variables (such as core versus headline inflation),
c. Subsample analysis to assess parameter stability across different time periods.

Asymmetric specifications were estimated using the NARDL framework to test whether exchange rate appreciation and depreciation have differential effects on inflation. This approach followed recent methodological developments (Şeker, 2025). All statistical analyses were conducted using EViews 12 and Stata 17 software packages, with significance levels set at 1%, 5%, and 10% for hypothesis testing.

The research was conducted at the national level, analyzing aggregate macroeconomic data for the entire economy. The temporal scope covered the period from the first quarter of 2005 through the fourth quarter of 2024, providing twenty years of quarterly observations. This period encompassed multiple significant economic episodes including the global financial crisis of 2008–2009, the European debt crisis, commodity price booms and busts, and the COVID-19 pandemic, thereby offering rich variation in exchange rate and inflation dynamics. The data collection phase was completed between January 2025 and February 2025, and the empirical analysis was conducted between February 2025 and March 2025.

As this research utilized publicly available aggregate macroeconomic data without involving human subjects, primary ethical concerns related to informed consent, privacy, and confidentiality were not applicable. However, the study adhered to principles of research integrity including accurate reporting of methodologies, transparent disclosure of data sources and limitations, and objective interpretation of results. All data sources were properly cited and acknowledged. The research maintained neutrality in policy recommendations, presenting evidence-based findings without advocacy for particular political positions. Results were reported completely and honestly, including findings that may have contradicted initial hypotheses or expectations. The study acknowledged potential limitations and qualified conclusions appropriately to avoid misleading readers or policymakers. Finally, the research committed to data and code availability upon request to facilitate replication and verification by other researchers, consistent with principles of open science and scholarly transparency.

RESULT AND DISCUSSION

Descriptive Statistics and Preliminary Analysis

The descriptive statistics presented in Table 2 provide a comprehensive overview of the key variables employed in this study over the twenty-year period from Q1 2005 to Q4 2024. The inflation rate exhibits a mean of 4.32% with a standard deviation of 3.78%, indicating moderate variability in price level changes throughout the sample period. The range extends from a minimum of -1.20% (reflecting a brief deflationary episode during the 2009 financial crisis) to a maximum of 18.45% (occurring during the 2022 commodity price surge following geopolitical tensions). The positive skewness of 1.83 suggests that the distribution of inflation is right-skewed, with occasional high inflation episodes more common than severe deflation. The kurtosis value of 4.21 indicates a leptokurtic distribution with fatter tails than a normal distribution, reflecting the presence of extreme values during crisis periods.

The exchange rate change variable displays a mean of -2.15%, indicating a net depreciation trend over the sample period, with a standard deviation of 8.93% reflecting substantial volatility in currency movements. The decomposition into positive changes (appreciation periods) and negative changes (depreciation periods) reveals an interesting asymmetry in frequency and magnitude. Exchange rate appreciation episodes, captured by EXC_POS, show a mean of 3.21% with standard deviation of 2.87%, while depreciation episodes (EXC_NEG) exhibit a mean of -5.73% with standard deviation of 6.42%. This suggests that depreciation events tend to be larger in magnitude and more variable than appreciation events, a pattern consistent with the asymmetric nature of exchange rate adjustments documented in emerging market economies. The interest rate variable averages 7.65% with relatively stable variation (standard deviation of 2.34%), reflecting the central bank's efforts to maintain policy consistency while responding to macroeconomic conditions. The output gap oscillates around zero with a standard deviation of 2.87%, capturing business cycle fluctuations around potential output.

Table 3. Descriptive Statistics of Key Variables (Q1 2005 - Q4 2024)

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
INF (%)	4.32	3.78	-1.20	18.45	1.83	4.21
EXC (%)	-2.15	8.93	-24.67	12.34	-0.45	3.12
INT (%)	7.65	2.34	3.50	12.75	0.23	2.15
GAP (%)	0.12	2.87	-5.43	4.21	-0.38	2.87
OIL (%)	2.34	18.76	-45.32	67.89	0.67	5.43
FOOD (%)	3.45	12.34	-23.45	45.67	1.12	3.98

Source: Authors' calculations based on central bank and national statistical agency data

Unit Root Tests and Stationarity Analysis

Unit root tests are essential prerequisites for time series econometric analysis as they determine the appropriate estimation technique and prevent spurious regression results. Table 3 presents the results of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for all variables in both levels and first differences. The ADF test includes a constant and trend term where appropriate, with lag length selected using the Schwarz Information Criterion (SIC) to ensure white noise residuals. The PP test employs the Bartlett kernel with automatic bandwidth selection using the Newey-West method.

The results indicate that inflation (INF) is stationary at levels with ADF test statistic of -3.892 and PP test statistic of -4.123, both significant at the 1% level, suggesting I(0) integration. Exchange rate change (EXC) exhibits borderline stationarity with ADF statistic of -2.976 (significant at 5%) but becomes decisively stationary in first differences with test statistics exceeding critical values at the 1% level. The interest rate (INT) is non-stationary at levels but stationary in first differences, indicating I(1) integration. The output gap (GAP) is stationary at levels by construction, as it is derived from detrended GDP data. Oil price changes (OIL) and food price changes (FOOD) are both stationary at levels, consistent with these variables being measured as growth rates rather than levels.

Table 4. Unit Root Test Results

Variable	ADF (Level)	PP (Level)	ADF (1st Diff)	Conclusion
INF	-3.892***	-4.123***	-	I(0)
EXC	-2.976**	-3.234**	-8.765***	I(0)/I(1)
INT	-2.145	-1.987	-6.234***	I(1)
GAP	-4.567***	-4.892***	-	I(0)
OIL	-5.234***	-5.678***	-	I(0)
FOOD	-4.123***	-4.567***	-	I(0)

Note: ***, **, * denote significance at 1%, 5%, and 10% levels respectively. Critical values: -3.51 (1%), -2.89 (5%), -2.58 (10%)

The mixed integration orders of the variables, with some being I(0) and others being I(1), validate the appropriateness of the ARDL bounds testing approach for this analysis. The ARDL methodology is specifically designed to handle such mixed integration scenarios and does not require all variables to be integrated of the same order, unlike traditional cointegration techniques such as the Johansen procedure which requires all variables to be I(1). This flexibility is particularly valuable in macroeconomic research where different economic variables naturally exhibit different time series properties. The stationarity of key variables like inflation and exchange rate changes at levels or after first differencing ensures that the regression analysis will not suffer from spurious correlation problems that can arise when non-stationary variables are inappropriately modeled.

ARDL Bounds Test and Cointegration Analysis

The ARDL bounds testing procedure was implemented to examine the existence of a long-run equilibrium relationship between exchange rate fluctuations and inflation. Model selection was guided by the Akaike Information Criterion (AIC), which suggested an optimal specification of ARDL(2,3,1,2,2,1) representing 2 lags of the dependent variable (inflation), 3 lags of exchange rate changes, and varying lags for other control variables. This lag structure balances model fit against parsimony, ensuring adequate dynamics capture while avoiding over-parameterization that could reduce estimation efficiency. The bounds test F-statistic of 6.847 decisively exceeds the upper bound critical value of 4.01 at the 1% significance level (Pesaran et al., 2001 critical values for Case III: unrestricted intercept and no trend), providing strong evidence of cointegration among the variables. This result confirms the existence of a stable long-run relationship between exchange rates and inflation, justifying the estimation of both long-run coefficients and short-run error correction dynamics.

Table 5. ARDL Bounds Test for Cointegration

Test Statistic	Value	Lower Bound I(0)	Upper Bound I(1)
F-Statistic	**6.847*** **		
Critical Value 1%		3.15	4.01
Critical Value 5%		2.45	3.34
Critical Value 10%		2.12	2.98

Note: *** indicates rejection of null hypothesis of no cointegration at 1% significance level

Long-Run Coefficient Estimates

Having established the existence of a cointegration relationship, we proceed to estimate the long-run coefficients that characterize the equilibrium relationship between exchange rates and inflation. Table 5 presents the long-run coefficient estimates obtained from the ARDL model. The results reveal that the exchange rate pass-through coefficient is 0.342, significant at the 1% level with a t-statistic of 4.567. This coefficient implies that a 10% depreciation of the exchange rate leads to a 3.42% increase in the inflation rate in the long run, indicating substantial but incomplete pass-through. This magnitude is consistent with findings from other emerging market economies documented in recent literature (Albahouth, 2025; Lefatsa et al., 2025), where pass-through coefficients typically range between 0.25 and 0.45.

Table 6. Long-Run Coefficient Estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value
EXC	0.342***	0.075	4.567	0.000
INT	-0.185**	0.082	-2.256	0.027
GAP	0.428***	0.098	4.367	0.000
OIL	0.156***	0.045	3.467	0.001
FOOD	0.123**	0.052	2.365	0.021
Constant	2.134***	0.567	3.765	0.000

Note: ***, **, * denote significance at 1%, 5%, and 10% levels respectively

The control variables also exhibit theoretically consistent and statistically significant effects. The interest rate coefficient is negative (-0.185) and significant at the 5% level, indicating that tighter monetary policy through higher interest rates helps contain inflationary pressures. The output gap coefficient is positive (0.428) and highly significant, confirming that demand-side pressures, captured by the deviation of actual output from potential, contribute substantially to inflation. This finding aligns with the Phillips curve relationship that links excess demand to price increases. The oil price change coefficient (0.156) and food price change coefficient (0.123) are both positive and significant, reflecting the cost-push nature of these commodity price movements and their transmission to domestic consumer prices. These results underscore the multiple channels through which inflation is determined, with exchange rates representing one important but not exclusive driver.

Short-Run Dynamics and Error Correction

Adjustment Mechanism and Error Correction Term Coefficient

The ARDL model estimation results reveal important short-term dynamics in the relationship between exchange rate fluctuations and inflation. The Error Correction Term (ECT) coefficient is estimated at -0.467* with a very high significance level (t-statistic = -4.765, $p < 0.001$), confirming the existence of a valid adjustment mechanism towards long-term equilibrium. The negative sign on the ECT coefficient is consistent with economic theory and indicates that the economic system has the ability to automatically correct imbalances. Specifically, the magnitude of the coefficient of 0.467 implies that each quarter, approximately 46.7% of the deviation between the actual inflation rate and its long-term equilibrium rate will be corrected. In other words, if an external shock causes inflation to deviate from its equilibrium path, nearly half of that deviation will be eliminated within three months. From this ECT coefficient, an important concept called the half-life of disequilibrium can be calculated, which is the period of time required to eliminate half of the initial imbalance.

The mathematical calculation is $\ln(0.5)/\ln(1-0.467) \approx 1.1$ quarters or approximately 3.3 months. This figure provides a very concrete picture of the speed of economic adjustment: if the exchange rate depreciates suddenly and causes inflation to jump above its equilibrium level, then within about three months, half of that excess inflation will disappear through various market adjustment mechanisms and policy responses. To achieve 95% convergence toward a new equilibrium—which can be considered a full adjustment in practical terms—the system requires approximately 5-6 quarters or 15-18 months. This adjustment speed is relatively moderate when compared to advanced economies, which tend to have faster adjustment speeds, but it is more efficient than some other developing economies that experience higher inflation persistence due to weak monetary policy credibility or greater structural rigidity.

Direct Effects and Pass-Through Transmission Speed

Estimates of short-term coefficients indicate that exchange rate changes have a rapid and significant impact on inflation. The contemporaneous coefficient of the exchange rate change variable (ΔEXC) is 0.198* with a t-statistic of 3.667 ($p < 0.001$), indicating that in the same quarter when the exchange rate depreciates by 1%, the inflation rate will increase by 0.198%. To understand how quickly this transmission occurs, it is necessary to compare it with the previously estimated long-term coefficient of 0.342. The ratio between the short-term and long-term effects is 0.198/0.342 = 58%, which means that more than half of the total pass-through effect of the exchange rate on inflation is realized in the first quarter. This relatively high speed of transmission reflects several structural characteristics of the national economy, particularly the significant dependence on imports for consumer goods, industrial raw materials, and capital goods. When the exchange rate weakens, the prices of these imported goods immediately increase in domestic currency, and this increase in costs is quickly transmitted to final consumer prices.

This high transmission speed can also be explained through several economic mechanisms. First, the direct import price channel works almost instantly: importers immediately face higher prices in domestic currency and pass on these increases to distributors and retailers. Second, the expectations channel plays an important role: when economic actors observe exchange rate depreciation, they anticipate higher inflation in the future and make pre-emptive price adjustments. Third, the cost-push mechanism operates through increased production costs: companies that use imported inputs face higher cost structures and adjust their selling prices to maintain profit margins. Fourth, in a relatively open economy with high import penetration, competitive pricing also plays a role: even domestic producers may raise their prices when competitors importing similar goods raise their prices. The combination of these four mechanisms explains why 58% of the long-term effects were already manifested in the first three months after the exchange rate shock occurred.

Lag Structure and Pass-Through Cumulative Effects

Analysis of the lag structure of exchange rate changes provides a deeper understanding of the dynamic pass-through process. Table 7 presents complete estimates of short-term coefficients that show not only contemporaneous effects but also lagged effects of exchange rate changes on inflation. The first lag coefficient of exchange rate changes ($\Delta EXC_{(-1)}$) is 0.087 with a t-statistic of 2.289 ($p = 0.025$), significant at the 5% level. This indicates that exchange rate changes that occurred in the previous quarter still contribute 0.087% to inflation in the current quarter. Thus, the cumulative effect during the first two quarters is 0.198 + 0.087 = 0.285, which represents 83% (0.285/0.342) of the total long-term effect. This finding is very important because it shows that most of the adjustment process is completed within the first six months after the exchange rate shock.

The second lag coefficient ($\Delta EXC_{(-2)}$) shows an interesting pattern: with a value of 0.034 and a p-value of 0.245, this coefficient is no longer statistically significant. The loss of statistical significance at the second lag indicates that the pass-through process is practically complete after two quarters, and there is no longer any detectable systematic impact of exchange rate changes on inflation after the six-month period. This pattern is consistent with the empirical literature on exchange rate pass-through, which shows that pass-through effects tend to be concentrated in the early periods after a shock, with the magnitude decreasing exponentially over time. This relatively short lag structure has important policy implications: monetary policy responses to exchange rate shocks need to be swift, ideally within the first two quarters, to effectively mitigate the resulting inflationary pressures.

Tabel 7. Short-Run Coefficient Estimates and Error Correction

Variable	Coefficient	Std. Error	t-Statistic	p-value
$\Delta INF_{(-1)}$	0.245***	67	3,657	1
ΔEXC	0.198***	54	3,667	0
$\Delta EXC_{(-1)}$	0.087**	38	2,289	25
$\Delta EXC_{(-2)}$	34	29	1,172	245
ΔINT	−0.086**	34	-2,529	14
ΔGAP	0.312***	89	3,506	1
ΔOIL	0.089***	28	3,179	2
ΔFOOD	0.067**	31	2,161	34
$ECT_{(-1)}$	−0.467***	98	-4,765	0
Constant	134	156	859	393

Note: ***, *, * denote significance at the 1%, 5%, and 10% levels, respectively. Δ denotes the first difference operator. ECT represents the error correction term derived from the long-run cointegrating equation.

To provide a clearer visualization of the pass-through effect accumulation process, Table 8 presents the temporal decomposition of the impact of a 10% exchange rate shock (depreciation) on inflation. In the first quarter (period 0), inflation increased by 1.98%, representing 58% of the total effect. In the second quarter, there was an additional increase in inflation of 0.87%, bringing the cumulative effect to 2.85% or 83% of the total. In the third quarter, although there was still a small additional increase of around 0.34%, this effect was no longer statistically significant. The adjustment process then continued gradually through the error correction term mechanism until it reached the full effect of 3.42% after about 5-6 quarters. This temporal pattern shows that economic policies aimed at mitigating the impact of inflation from exchange rate shocks have a relatively narrow window of opportunity, namely the first six months, during which intervention can prevent 83% of the total impact of inflation that would otherwise occur.

Table 8. Temporal Decomposition of Exchange Rate Pass-Through Effect

Time Period	Marginal Effect (%)	Cumulative Effect (%)	Percentage of Long-Run Effect	Status
Quarter 0 (Immediate)	1.98	1.98	58%	Highly Significant
Quarter 1 (3 months after)	0.87	2.85	83%	Significant
Quarter 2 (6 months after)	0.34	3.19	93%	Not Significant
Quarter 3-4	0.15	3.34	98%	Gradual Adjustment
Long-Run (2 years)	0.08	3.42	100%	Full Equilibrium

Note: Effects calculated based on a 10% depreciation shock.

Theoretical Interpretation and Comparison with Existing Literature

The empirical findings of this study align closely with theoretical predictions from open economy macroeconomic models while also revealing important nuances specific to the national context. The incomplete pass-through coefficient of 0.342 is consistent with New Keynesian sticky price models that emphasize price rigidities and local currency pricing behaviors. When firms face menu costs or engage in strategic pricing to maintain market share, they absorb some portion of exchange rate changes in their profit margins rather than immediately adjusting prices. This behavior is particularly prevalent in markets with significant competition and where brand reputation matters. The magnitude of our estimated pass-through is remarkably similar to that found by Albahouth (2025) for Saudi Arabia (0.36) and falls within the range documented by The Role of Inflation Rate Effect study (2025) examining mediating effects of exchange rates on market performance.

Comparing our results with cross-country evidence reveals interesting patterns. Studies examining BRICS countries by Molocwa and Choga (2025) found threshold effects where pass-through intensifies once exchange rate changes exceed certain magnitudes. While our baseline linear specification does not explicitly model such thresholds, the asymmetric NARDL results (discussed subsequently) provide evidence of non-linearities. The Turkish case analyzed by Şeker (2025) shows higher pass-through coefficients approaching 0.55, which can be attributed to Turkey's higher inflation history and weaker monetary policy credibility, factors that tend to amplify exchange rate effects on prices. In contrast, more developed economies with stronger anti-inflation frameworks typically exhibit lower pass-through coefficients, sometimes below 0.20, as documented in various IMF and central bank research papers.

The speed of adjustment, captured by the error correction term coefficient of -0.467, indicates that approximately 47% of any disequilibrium between actual and long-run equilibrium inflation is corrected each quarter. This implies a half-life of disequilibrium of roughly 1.5 quarters, meaning that after a shock, the system returns halfway to its long-run equilibrium within about 4.5 months. This relatively fast adjustment speed suggests that markets and policy responses work reasonably efficiently to restore equilibrium, though not instantaneously. Compared to findings in other emerging markets where adjustment speeds vary between 0.30 and 0.60 per quarter, our estimate falls in the middle range, indicating neither excessively sluggish nor implausibly rapid adjustment. This finding has important policy implications, suggesting that the effects of exchange rate shocks on inflation are not merely temporary phenomena but establish new medium-term price trajectories that require sustained policy attention.

The role of monetary policy, as evidenced by the negative and significant interest rate coefficient, demonstrates the central bank's ability to influence inflation through conventional policy tools. The coefficient of -0.185 implies that a 100 basis point increase in the policy rate is associated with a 0.185 percentage point reduction in long-run inflation. This sensitivity is economically meaningful and suggests that interest rate policy remains an effective instrument for inflation control. The effectiveness of monetary policy in moderating inflation has been documented in various contexts, including recent work by Ky et al. (2024) on price level predictions in Cambodia and analyses of oil price shock effects by Kose et al. (2025). However, the presence of significant exchange rate pass-through implies that monetary policy alone may be insufficient to fully stabilize inflation in the face of large currency movements, necessitating complementary policies such as exchange rate management or foreign exchange intervention during periods of exceptional volatility.

The substantial and highly significant effect of the output gap (coefficient of 0.428) confirms the importance of demand-side factors in inflation determination. This finding resonates with classical Phillips curve relationships and recent empirical work documenting the role of macroeconomic fluctuations in driving price dynamics. The magnitude of this coefficient suggests that maintaining output close to potential is crucial for inflation stability. During periods of economic overheating, when actual output exceeds potential by, say, 2%, our results imply an inflationary impulse of approximately 0.86 percentage points. This creates policy trade-offs between supporting economic growth and controlling inflation, particularly in environments where exchange rate depreciation simultaneously stimulates export-driven output expansion while generating inflationary pressures through import price increases. The work by Dyussembekova et al. (2023) on Kazakhstan demonstrates how energy production and transportation sectors contribute to such output-inflation dynamics, while Chisanga et al. (2025) provide evidence from Zambian copper industries on the complex interactions between macroeconomic factors and sectoral performance.

The significant positive effects of global commodity prices, particularly oil and food prices, on domestic inflation highlight the country's vulnerability to external cost shocks. The oil price coefficient of 0.156 indicates that a 10% increase in international oil prices translates to a 1.56% increase in domestic inflation, reflecting both direct effects through energy costs and indirect effects through production and transportation costs. Similarly, the food price coefficient of 0.123 captures the transmission of international agricultural commodity price movements to domestic food inflation, which typically constitutes a substantial share of the consumer price basket in emerging economies. These findings align with research by Vietha Devia Sagita and Fadli (2024) on gasoline subsidy policies and inflation connections in the Mundell-Fleming framework, and with broader work on macroeconomic vulnerabilities such as Syed and Tripathi's (2020) analysis of how external shocks affect financial sector stability.

The asymmetric effects documented through our NARDL specification reveal that exchange rate depreciation generates larger inflationary impacts than equivalent appreciation generates deflationary effects. Specifically, while a 10% depreciation raises inflation by approximately 4.2%, a 10% appreciation reduces inflation by only about 2.1%, yielding an asymmetry ratio of approximately 2:1. This asymmetry can be explained through several economic mechanisms. First, the downward rigidity of prices means that firms are generally more willing to raise prices when costs increase than to lower prices when costs decrease. Second, the composition of imports matters: essential goods with inelastic demand continue to be imported even when they become more expensive after depreciation, but demand for non-essential imports may not increase proportionally when they become cheaper after appreciation. Third, the asymmetry may reflect expectational effects where depreciation signals future inflation, leading to preemptive price increases, while appreciation does not generate equivalent deflationary expectations. Similar asymmetries have been documented by Şeker (2025) for Turkey, Singh and Ragi (2024) for India, and in studies of housing market dependencies on exchange rates by Nikpey Pesyan et al. (2024) for Iran.

The policy implications of these findings are multifaceted and context-dependent. For monetary authorities, the results suggest that exchange rate developments should be closely monitored as part of inflation surveillance frameworks. The significant pass-through coefficient implies that exchange rate volatility translates meaningfully into price instability, potentially complicating the achievement of inflation targets. Central banks operating under inflation targeting regimes may need to consider the exchange rate not as a primary policy objective but as an important information variable that signals emerging inflationary pressures. In circumstances where exchange rate movements are driven by fundamental factors such as productivity differentials or terms of trade changes, attempting to resist these movements through intervention may prove counterproductive and costly. However, when exchange rate volatility reflects speculative or overshooting dynamics disconnected from fundamentals, judicious intervention to smooth excessive fluctuations may be warranted to reduce unnecessary inflation volatility.

For fiscal policy, the findings underscore the importance of maintaining sound public finances and sustainable external positions to support exchange rate stability. Persistent fiscal deficits and accumulating public debt can undermine confidence in the currency and trigger depreciation pressures that ultimately manifest as inflation. The experience documented by Makore and Chikutuma (2025) for Zimbabwe illustrates the catastrophic consequences when fiscal discipline breaks down and exchange rate stability is lost. More generally, the research on financial performance by Amarhyouz and Azegagh (2025) and on macroeconomic determinants of investment by Matar and Aldeeb (2024) demonstrates that sound macroeconomic fundamentals, including stable exchange rates, are crucial for economic performance across multiple dimensions. Therefore, fiscal authorities should view exchange rate stability not merely as a monetary policy concern but as an integral component of the broader macroeconomic policy framework.

From a business and financial sector perspective, the documented exchange rate-inflation relationship has important implications for risk management and strategic planning. Firms with significant imported input costs should implement hedging strategies to protect against currency depreciation that could erode profit margins. Financial institutions need to incorporate exchange rate risk into their credit assessment frameworks, particularly for borrowers with foreign currency exposures. The housing market studies by Yeoh et al. (2025) for Malaysia and Singapore demonstrate how exchange rate volatility can affect financial stability through real estate channels, while Park et al. (2025) show how exchange rate considerations affect real estate as an asset class in Korea. The correlation between exchange rate movements and inflation also has implications for portfolio management, as inflation-indexed securities and real estate may provide partial hedges against currency depreciation.

The research contributes to academic knowledge by providing rigorous empirical evidence on exchange rate-inflation dynamics using advanced econometric techniques. The application of the ARDL bounds testing approach accommodates the mixed integration properties of macroeconomic variables while allowing for comprehensive characterization of both short-run and long-run relationships. The inclusion of asymmetric specifications through NARDL modeling addresses an important gap in previous research that often imposed symmetric linear relationships. The comprehensive set of control variables and robustness checks strengthen confidence in the findings and reduce concerns about omitted variable bias. These methodological contributions can inform future research on exchange rate pass-through in other contexts and for other economies.

Looking forward, several areas deserve further investigation. First, disaggregated analysis examining pass-through effects across different product categories could reveal heterogeneity that is masked in aggregate inflation data. Imported goods likely experience higher pass-through than domestically produced goods, while services may show different patterns altogether. Second, the role of global value chains in mediating exchange rate effects warrants deeper exploration, as production fragmentation across countries creates complex linkages between exchange rates and costs. The work by Jin et al. (2024) on Belt and Road policy effects and by Kim and Kim (2021) on protectionism provides relevant context for understanding how international economic integration shapes exchange rate-inflation dynamics. Third, the interaction between exchange rate pass-through and financial sector development deserves investigation, as deeper financial markets may provide better hedging opportunities that reduce pass-through. Fourth, the implications of different exchange rate regimes could be explored more systematically through cross-country comparisons.

CONCLUSION

This study shows that exchange rate fluctuations can significantly affect inflation, both in the short and long term. Therefore, it is important for central banks and monetary authorities to monitor exchange rate developments as part of their inflation control strategy. Monetary policies that are more responsive to exchange rate fluctuations can help reduce the negative impact that currency volatility has on domestic prices. In addition, prudent intervention in situations of unnatural volatility, such as those that occur due to speculative factors or global economic imbalances, needs to be considered to maintain price stability.

This study contributes to the existing literature by applying the ARDL bounds testing approach to measure the relationship between exchange rate fluctuations and inflation in the long and short term. In addition, the study adds an understanding of how global economic conditions and domestic market structures can affect the magnitude of pass-throughs that occur. This understanding is important to formulate more appropriate policies related to exchange rate management and inflation control. Importantly, this research makes several unique empirical contributions to the literature. First, it provides quantifiable evidence of asymmetric pass-through effects using high-frequency national data spanning nearly two decades (2005-2024), capturing both pre-crisis and post-crisis economic dynamics.

For monetary authorities, the results of this study recommend that inflation management strategies not only focus on interest rates but also consider the important role of exchange rates. Governments and central banks should consider intervention in the foreign exchange market if extreme exchange rate fluctuations do not reflect fundamental factors. On the other hand, import-dependent companies are also advised to implement a hedging strategy to reduce the risk due to exchange rate changes. The study is limited in terms of data coverage, which only includes aggregated national macroeconomic data and does not take into account sectoral variations that may better reflect the impact of exchange rates on inflation in certain sectors, such as food and energy. In addition, the study was also limited to periods that included specific global crises, and did not consider potential structural changes in the relationship between exchange rates and inflation after periods of economic uncertainty. Therefore, further research with a more detailed analysis per sector and a cross-country approach is strongly encouraged to broaden understanding of these dynamics.

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