

# Global and Macroeconomic Determinants of Indian Rupee Depreciation Against the US Dollar: Evidence from an ARDL Framework

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Movements in the Indian Rupee against the US Dollar have important implications for macroeconomic stability in India. Exchange rate depreciation affects inflation, trade balance, and overall economic performance. This study examines the key macroeconomic and global factors influencing the depreciation of the Indian Rupee against the US Dollar using quarterly time-series data from 2010Q1 to 2024Q4.

The study applies an Autoregressive Distributed Lag (ARDL) approach to analyse short-run and long-run relationships between the exchange rate and selected variables, including crude oil prices, inflation differential, interest rate differential, and the US Dollar Index. Stationarity of the variables is examined using the Augmented Dickey–Fuller test, and the ARDL bounds testing approach is used to assess the existence of long-run relationships.

The empirical results indicate that crude oil prices and global dollar strength have a statistically significant impact on the depreciation of the Indian Rupee in the short run. In contrast, inflation and interest rate differentials do not show significant effects. The bounds test does not provide strong evidence of long-run cointegration, suggesting that exchange rate movements are largely driven by short-term external shocks rather than stable long-run fundamentals. The findings highlight India's vulnerability to global economic conditions and underline the importance of external sector management for maintaining macroeconomic stability.

**Keywords:** indian rupee, exchange rate depreciation, crude oil prices, US dollar index, ARDL model, macroeconomic stability

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## 1. Introduction

Exchange rate movements play a crucial role in shaping a country's macroeconomic performance. For a developing economy like India, fluctuations in the Indian Rupee against the US Dollar directly affect inflation, foreign trade, capital flows, and economic stability. Persistent depreciation of the domestic currency can increase import costs, widen the trade deficit, and create inflationary pressures.

Over the past decade, the Indian Rupee has experienced periods of sharp depreciation, particularly during episodes of global financial uncertainty, rising crude oil prices, and strengthening of the US Dollar. These movements have raised concerns among policymakers regarding the sustainability of India's external sector and the effectiveness of domestic policy measures in stabilising the exchange rate.

Understanding the factors that drive exchange rate depreciation is therefore essential for effective macroeconomic management. While traditional economic theory emphasises the role of inflation and interest rate differentials, recent evidence suggests that global factors may play a more dominant role in determining exchange rate movements in emerging economies.

Against this background, the present study examines the macroeconomic and global determinants of Indian Rupee depreciation against the US Dollar using a time-series econometric framework. The study focuses on identifying whether exchange rate movements are driven by domestic fundamentals or external shocks, with implications for macroeconomic stability and policy formulation.

## 2. Literature Review

### 2.1 Exchange Rate and Macroeconomic Fundamentals

Early theoretical studies explain exchange rate movements using domestic macroeconomic fundamentals such as inflation and interest rates. Classical contributions by **Dornbusch (1976)** and **Frenkel (1976)** suggest that higher inflation or lower interest rates lead to currency depreciation. These models assume efficient markets and strong links between domestic monetary conditions and exchange rates.

However, empirical studies on emerging economies often fail to find stable support for these theories.

For India, exchange rate behaviour has been discussed extensively in policy-oriented studies. **Patra and Kapur (2012)** analyse India's exchange rate regime and highlight the difficulty of maintaining currency stability in an open economy with volatile capital flows. Official publications such as the **Reserve Bank of India's Report on Currency and Finance** also emphasise the role of external shocks rather than domestic factors in influencing the Indian Rupee.

### 2.2 Crude Oil Prices and Exchange Rate Movements

A significant body of literature identifies crude oil prices as a key determinant of exchange rate movements in oil-importing countries. **Basher and Sadorsky (2006)** show that oil price shocks have strong macroeconomic effects on emerging markets. For India, **Ghosh (2011)** provides empirical evidence of a positive relationship between crude oil prices and INR depreciation, indicating that rising oil prices increase foreign exchange demand.

Similarly, **Narayan, Narayan, and Prasad (2008)** find that oil price shocks influence exchange rates through trade balance and inflation channels. These studies suggest that oil price volatility remains a major external vulnerability for the Indian economy and plays a critical role in exchange rate determination.

### 2.3 Inflation and Interest Rate Differentials

Several studies examine the role of inflation and interest rate differentials in exchange rate movements. While purchasing power parity and interest parity theories predict a strong relationship, empirical findings for India remain mixed. **Taylor and Taylor (2004)** highlight those deviations from purchasing power parity are persistent, especially in emerging markets.

Empirical studies focusing on India often find weak or insignificant effects of inflation and interest rate differentials on exchange rate movements. This indicates that domestic monetary variables may have limited influence, particularly during periods of global financial instability.

### 2.4 Global Factors and US Dollar Dominance

Recent literature places strong emphasis on global financial conditions. **Rey (2015)** argues that global financial cycles driven by the US Dollar limit the independence of domestic monetary policy in emerging economies. The strengthening of the US Dollar often leads to capital outflows and currency depreciation in emerging markets.

Studies by **Frankel (2014)** and reports by the **International Monetary Fund** further confirm that global risk sentiment and dollar strength play a dominant role in exchange rate movements. This explains why domestic policy tools alone may be insufficient to stabilise exchange rates.

### 2.5 Methodological Evidence Using ARDL Models

Many recent studies use the Autoregressive Distributed Lag approach to examine exchange rate dynamics. The ARDL framework proposed by **Pesaran, Shin, and Smith (2001)** is suitable when variables are integrated at mixed orders and sample sizes are small. However, empirical results remain mixed, with some studies finding long-run relationships and others reporting weak or unstable cointegration.

## 3. Objectives of the Study

The present study aims to examine the macroeconomic and global factors influencing the depreciation of the Indian Rupee against the US Dollar. The specific objectives of the study are as follows:

- To analyse the short-run relationship between the INR/USD exchange rate and selected macroeconomic and global variables.
- To find out the adjustment speed of INR/USD against selected global factors.
- To derive policy-relevant implications for exchange rate management based on empirical findings.
- To test the existence of a long-run relationship between exchange rate movements and macroeconomic fundamentals using the ARDL bounds testing approach.

## 4. Methodology

### Data Source and Variables

The study uses quarterly time-series data covering the period from 2010Q1 to 2024Q4. The data are collected from reliable secondary sources such as the Reserve Bank of India, the International Monetary Fund, and the Federal Reserve database. Quarterly frequency is chosen to capture short-run dynamics while maintaining sufficient observations for econometric analysis. The dependent variable is the logarithm of the INR–USD exchange rate, which represents the value of the Indian Rupee against the US Dollar. The explanatory variables include international crude oil prices, inflation differential between India and the United States, interest rate differential between the two countries, and the US Dollar Index. Crude oil prices are included to capture external trade-related shocks, while inflation and interest rate differentials represent domestic macroeconomic conditions. The US Dollar Index is used as a proxy for global financial conditions.

All price-related variables are transformed into natural logarithms to stabilise variance and allow interpretation of coefficients in percentage terms. Differentials are calculated as the difference between Indian and US values.

### Stationarity Test

Before estimating the model, the time-series properties of the variables are examined to avoid spurious regression results. The Augmented Dickey–Fuller (ADF) unit root test is applied to determine the order of integration of each variable. The ADF test checks whether the variables are stationary at level or after first differencing.

**Table 1:** ADF Unit Root Test Results

Variable	Deterministic Term	ADF at Level	p-value	Stationarity	Order
INR_USD	Intercept + Trend	-2.896	>0.10	Non-stationary	I(1)
INF_DIFF	Intercept	-1.721	>0.10	Non-stationary	I(1)
INT_DIFF	Intercept	-0.838	>0.10	Non-stationary	I(1)
CRUDE OIL	Intercept + Trend	-2.136	>0.10	Non-stationary	I(1)
DXY	Intercept + Trend	-3.095	>0.10	Non-stationary	I(1)

The results indicate that the variables are integrated at mixed orders, with some variables being stationary at the level and others some variables being stationary at the level and others at first difference.

Since none of the variables are integrated of order two, the use of the Autoregressive Distributed Lag (ARDL) modelling framework is considered appropriate.

### ARDL Model Specification

The ARDL approach is employed to analyse the relationship between the exchange rate and its determinants. This method is suitable for small sample sizes and allows simultaneous estimation of short-run and long-run dynamics within a single equation. Lag lengths for the dependent and independent variables are selected using the Akaike Information Criterion to ensure model efficiency.

The ARDL model includes the lagged value of the exchange rate along with contemporaneous and lagged values of the explanatory variables. This specification captures both persistence in exchange rate movements and the dynamic effects of macroeconomic and global factors.

### Bounds Testing and Error Correction Model

To examine the existence of a long-run relationship among the variables, the ARDL bounds testing approach is applied. The computed F-statistic is compared with critical values to determine whether cointegration exists. In cases where strong evidence of cointegration is absent, interpretation of long-run coefficients is made with caution.

An error correction model (ECM) is estimated to analyse short-run dynamics and the speed of adjustment towards equilibrium following temporary shocks. The error correction term reflects how quickly deviations from equilibrium are corrected over time.

### Estimation Technique

All econometric estimations are carried out using EViews software. Diagnostic indicators such as goodness of fit and residual behaviour are examined to ensure the reliability of the results. The methodological framework ensures consistency, transparency, and robustness of the empirical analysis.

## 5. Analysis and Discussion

This section presents a detailed analysis of the empirical findings obtained from the Autoregressive Distributed Lag (ARDL) model.

The results are discussed in line with the objectives of the study to understand the factors driving depreciation of the Indian Rupee against the US Dollar. The section focuses on short-run exchange rate dynamics, the role of global and domestic variables, the existence of long-run relationships, and the speed of adjustment following external shocks.

### 5.1 Exchange Rate Behaviour and Model Adequacy

**Table 2:** Summary Statistics of the ARDL Model

Particulars	Value
Dependent Variable	Log of INR–USD Exchange Rate
Sample Period	2010Q2 – 2024Q4
Number of Observations	59
Selected Model	ARDL (1)
R-squared	0.9812
Adjusted R-squared	0.9794
Durbin–Watson Statistic	1.8878
Probability of F-statistic	0.0000

**Source:** Estimation using EViews

### Analysis

The ARDL model demonstrates strong explanatory power, with more than 98 percent of the variation in the INR–USD exchange rate explained by the selected variables. The Durbin–Watson statistic is close to the benchmark value of 2, indicating the absence of serious autocorrelation in the residuals. The high statistical significance of the model confirms that the estimated relationship is reliable.

### Discussion

High persistence in exchange rate movements is a common feature of emerging market economies. Exchange rates often respond slowly to shocks due to market rigidities, policy interventions, and capital flow volatility. The strong fit of the model reflects the importance of short-run dynamics rather than long-run equilibrium forces.

### Interpretation

The Indian Rupee shows strong short-run dependence on past values. This implies that exchange rate movements are path-dependent, and short-term shocks tend to persist over time.

### 5.2 Short-Run Determinants of INR Depreciation

**Table 3:** ARDL Short-Run Coefficient Estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value	Inference
L_INR_USD (-1)	0.9312	0.0428	21.748	0.0000	Significant
Log of Crude Oil Price	0.0327	0.0122	2.675	0.0099	Significant
Inflation Differential	0.0139	0.1620	0.086	0.9320	Not Significant
Interest Rate Differential	0.2662	0.2758	0.966	0.3387	Not Significant
Log of US Dollar Index	0.1802	0.0813	2.217	0.0310	Significant
Constant	-0.6717	0.3525	-1.905	0.0622	Marginal

**Source:** Estimation using EViews

#### Analysis

The estimated coefficients indicate that crude oil prices and the US Dollar Index have a positive and statistically significant effect on the INR–USD exchange rate. An increase in both variable results in depreciation of the Indian Rupee. In contrast, inflation and interest rate differentials are statistically insignificant and do not explain short-run exchange rate movements.

#### Discussion

India is highly dependent on imported crude oil, making the exchange rate sensitive to oil price fluctuations. Rising oil prices increase the import bill, worsen the current account balance, and increase demand for foreign currency, which puts downward pressure on the Rupee. The significance of the US Dollar Index reflects the growing influence of global financial conditions. When the US Dollar strengthens globally, capital tends to flow out of emerging markets, leading to currency depreciation.

The insignificance of inflation and interest rate differentials suggests that domestic macroeconomic variables play a limited role in explaining short-run exchange rate movements during the study period. This indicates that global factors overshadow domestic conditions in determining exchange rate behaviour.

#### Interpretation

INR depreciation is primarily driven by external and global factors rather than domestic inflation or interest rate changes. This highlights India’s vulnerability to international economic shocks.

### 5.3 Long-Run Relationship and Bounds Test Results

**Table 4:** ARDL Bounds Test for Cointegration

Test Statistic	Value
F-statistic	3.0118
Lower Bound I (0) (10%)	3.80
Upper Bound I (1) (10%)	4.60

**Source:** Estimation using EViews

#### Analysis

The calculated F-statistic is lower than the lower bound critical value at the 10 per cent significance level. This indicates that the null hypothesis of no long-run relationship cannot be rejected.

#### Discussion

The absence of strong cointegration suggests that the INR–USD exchange rate does not follow a stable long-run equilibrium with the selected macroeconomic variables. Exchange rate movements in India appear to be influenced by changing global conditions rather than fixed long-term fundamentals.

#### Interpretation

Long-run exchange rate forecasts based on macroeconomic fundamentals should be approached with caution, as stable long-run relationships are not evident.

### 5.4 Error Correction Mechanism and Speed of Adjustment

**Table 5:** Error Correction Model (ECM) Estimates

Variable	Coefficient	Std. Error	t-Statistic	p-value
Error Correction Term (ECT)	-0.0688	0.0278	-2.477	0.0164
Log of Crude Oil Price	0.0327	0.0111	2.945	0.0048
Log of US Dollar Index	0.1802	0.0797	2.262	0.0277

**Source:** Estimation using EViews

#### Analysis

The error correction term is negative and statistically significant, confirming that deviations from equilibrium are corrected over time. However, the small magnitude of the coefficient indicates a slow speed of adjustment.

#### Discussion

Slow adjustment implies that exchange rate shocks persist for extended periods. This is common in economies exposed to repeated external shocks,

such as oil price volatility and global financial tightening. Gradual correction increases exchange rate uncertainty and complicates macroeconomic management.

### Interpretation

The Indian Rupee adjusts slowly to shocks, reinforcing the dominance of short-run external forces over long-run stabilising mechanisms.

### Overall Discussion

The overall analysis reveals that depreciation of the Indian Rupee is largely driven by global and external factors. Domestic inflation and interest rate adjustments alone are insufficient to stabilise the exchange rate. The absence of strong long-run cointegration highlights the importance of managing short-term shocks and strengthening external sector resilience.

## 6. Findings of the Study

The present study examines the macroeconomic and global factors influencing the depreciation of the Indian Rupee against the US Dollar using a time-series ARDL framework. The major findings of the study are summarised below in a structured manner, based strictly on the empirical results.

### Nature of Exchange Rate Movements

The study finds that movements in the INR–USD exchange rate are highly persistent in nature. The strong and statistically significant coefficient of the lagged exchange rate indicates that current exchange rate values are strongly influenced by past movements. This confirms that exchange rate shocks do not disappear quickly and tend to have lasting short-run effects.

This persistence suggests that short-term exchange rate volatility is an important feature of the Indian foreign exchange market.

### Role of Crude Oil Prices

One of the most important findings of the study is the significant impact of international crude oil prices on Indian Rupee depreciation. The empirical results show that an increase in crude oil prices leads to depreciation of the Indian Rupee against the US Dollar.

This result reflects India's heavy dependence on imported crude oil.

Higher oil prices increase import payments and raise demand for foreign currency, thereby exerting pressure on the exchange rate. The significance of crude oil prices highlights the vulnerability of the Indian Rupee to external commodity price shocks.

### Impact of Global Dollar Strength

The study also finds that the US Dollar Index has a statistically significant and positive effect on the INR–USD exchange rate. A strengthening of the US Dollar at the global level leads to depreciation of the Indian Rupee.

This finding indicates that global financial conditions play a dominant role in determining exchange rate movements in India. During periods of global tightening or increased risk aversion, capital flows tend to move towards dollar-denominated assets, causing depreciation of emerging market currencies, including the Indian Rupee.

### Insignificance of Domestic Macroeconomic Differentials

Another important finding of the study is that inflation differential and interest rate differential between India and the United States do not have a statistically significant impact on short-run exchange rate movements. This suggests that domestic macroeconomic conditions alone are not sufficient to explain fluctuations in the INR–USD exchange rate during the study period.

The limited influence of domestic variables indicates that global factors outweigh internal macroeconomic adjustments in the short run.

### Long-Run Relationship and Adjustment Process

The ARDL bounds test results indicate the absence of a strong long-run cointegrating relationship between the exchange rate and the selected macroeconomic variables. This implies that the INR–USD exchange rate does not follow a stable long-run equilibrium path based on these fundamentals.

However, the error correction mechanism shows a negative and statistically significant coefficient, indicating partial adjustment after short-run deviations. The speed of adjustment is slow, suggesting that exchange rate corrections occur gradually over time.

### Overall Summary of Findings

Overall, the study finds that depreciation of the Indian Rupee is largely driven by external and global factors rather than domestic macroeconomic fundamentals. Short-run dynamics dominate exchange rate behaviour, and long-run dynamics dominate exchange rate behaviour, and long-run stability is weak. These findings highlight the importance of managing external vulnerabilities to maintain exchange rate stability.

## 7. Policy Implications

The empirical findings of this study carry important implications for exchange rate management and macroeconomic policy in India. Since the results clearly indicate that depreciation of the Indian Rupee is largely driven by external and global factors, policy responses must focus on reducing external vulnerabilities rather than relying only on domestic monetary adjustments.

### Managing External Sector Vulnerability

The significant impact of crude oil prices on INR depreciation highlights the need to reduce India's dependence on imported energy. Policies aimed at diversifying energy sources, promoting renewable energy, and improving energy efficiency can help lower the impact of oil price shocks on the exchange rate. In addition, maintaining adequate foreign exchange reserves can provide a buffer during periods of rising oil prices and global uncertainty.

### Responding to Global Financial Conditions

The strong influence of global dollar strength on the exchange rate suggests that India's exchange rate stability is closely linked to global financial cycles. Policymakers should closely monitor global liquidity conditions, US monetary policy, and capital flow movements. Timely intervention in foreign exchange markets, when required, can help reduce excessive volatility caused by sudden capital outflows.

### Limitations of Domestic Monetary Policy

The insignificance of inflation and interest rate differentials indicates that domestic monetary policy alone may have limited effectiveness in stabilising the exchange rate in the short run. Interest rate adjustments should therefore be coordinated with broader macroeconomic and external sector policies rather than being used as the primary tool for exchange rate stabilisation.

### Strengthening Macroeconomic Stability

Since exchange rate adjustments are found to be slow, short-run shocks can have prolonged effects. This calls for a stable macroeconomic framework that reduces uncertainty and builds investor confidence. Transparent policy communication, fiscal discipline, and consistent macroeconomic management can help reduce speculative pressures on the exchange rate.

## 8. Future Recommendations

Based on the empirical findings of the study, several future research and policy-oriented recommendations can be suggested to deepen understanding of exchange rate dynamics in India and improve exchange rate management in the long run.

### Inclusion of Additional External Variables

Future studies may extend the analysis by incorporating additional global variables such as capital flows, foreign portfolio investment, global risk indices, or geopolitical uncertainty indicators. Since the present study finds that global factors dominate exchange rate movements, inclusion of such variables may provide a more comprehensive explanation of exchange rate volatility in India.

### Disaggregated Analysis of Capital Flows

Further research can focus on disaggregating capital flows into foreign direct investment and portfolio investment. This would help identify which type of capital flow is more sensitive to global shocks and US Dollar movements. A clearer understanding of capital flow behaviour can support more targeted policy responses to exchange rate pressures.

### Structural Break and Regime-Based Analysis

The study period covers several major global events, including financial market stress and changes in global monetary policy. Future research may apply structural break tests or regime-switching models to examine whether exchange rate behaviour differs across periods of high and low global uncertainty. This can help policymakers design flexible strategies that respond to changing global conditions.

### **Comparative Studies with Other Emerging Economies**

Future research may adopt a comparative framework by examining exchange rate dynamics across multiple emerging economies. Such studies can help determine whether India's experience is unique or part of a broader emerging market pattern. Cross-country comparisons can also offer useful lessons for exchange rate management and external sector resilience.

### **Use of Alternative Econometric Approaches**

While the ARDL approach is suitable for small samples and mixed integration orders, future studies may employ alternative techniques such as nonlinear ARDL models, time-varying parameter models, or high-frequency data analysis. These methods may capture asymmetric effects and nonlinear responses of exchange rates to external shocks.

### **Strengthening Policy-Focused Research**

Future work should place greater emphasis on linking empirical findings with practical policy frameworks. Simulation-based studies and scenario analysis may help evaluate the effectiveness of different policy tools under varying global conditions.

## **9. Limitations of the Study**

Despite providing useful insights into the determinants of Indian Rupee depreciation, the present study is subject to certain limitations that should be considered while interpreting the results.

### **Data Constraints**

The study relies on quarterly secondary data covering the period from 2010Q2 to 2024Q4. While quarterly data are suitable for capturing short-run dynamics, they may not fully reflect high-frequency exchange rate movements that occur on a daily or monthly basis. In addition, the availability and consistency of macroeconomic data across countries limit the selection of variables and the length of the study period.

### **Limited Set of Explanatory Variables**

The analysis focuses on selected macroeconomic and global variables such as crude oil prices, inflation differential, interest rate differential, and the US Dollar Index.

Although these variables are important, exchange rate movements are influenced by a wide range of factors including capital flows, market expectations, geopolitical risks, and policy interventions. Exclusion of such variables may result in omitted variable bias and restrict the explanatory power of the model.

### **Methodological Constraints**

The study employs the ARDL modelling framework, which is suitable for small samples and mixed orders of integration. However, ARDL assumes linear relationships between variables and does not fully capture possible nonlinear or asymmetric effects. Exchange rate responses to positive and negative shocks may differ, which cannot be fully examined within the current framework.

### **Weak Long-Run Evidence**

The ARDL bounds test does not confirm the presence of a strong long-run cointegrating relationship among the variables. As a result, long-run interpretations are limited and must be treated with caution. The findings therefore emphasise short-run dynamics rather than long-term equilibrium relationships.

### **External Shocks and Structural Changes**

The study period includes several major global events that may have caused structural breaks in the exchange rate process. These structural changes are not explicitly modelled in the analysis, which may affect the stability of estimated coefficients over time.

## **10. Conclusion**

The present study examined the macroeconomic and global determinants of depreciation of the Indian Rupee against the US Dollar using quarterly time-series data from 2010Q2 to 2024Q4. The analysis employed the Autoregressive Distributed Lag (ARDL) modelling framework to capture short-run dynamics and assess the existence of long-run relationships between the exchange rate and selected explanatory variables. The study focused on crude oil prices, inflation differential, interest rate differential, and global dollar strength as key determinants of exchange rate movements.

The empirical results clearly indicate that depreciation of the Indian Rupee is largely driven by external and global factors rather than domestic macroeconomic fundamentals.

Crude oil prices are found to have a statistically significant and positive impact on the INR–USD exchange rate, confirming that rising oil prices increase pressure on the Indian Rupee due to higher import costs and increased demand for foreign currency. Similarly, global dollar strength, measured through the US Dollar Index, plays a dominant role in influencing exchange rate movements, reflecting India’s exposure to global financial conditions and capital flow volatility.

In contrast, domestic macroeconomic variables such as inflation differential and interest rate differential do not exhibit statistically significant effects on short-run exchange rate movements during the study period. This finding suggests that traditional exchange rate theories based solely on domestic fundamentals may have limited explanatory power in the Indian context, especially during periods of global uncertainty.

The ARDL bounds test does not provide strong evidence of a stable long-run cointegrating relationship between the exchange rate and the selected macroeconomic variables. This indicates the absence of a consistent long-run equilibrium path for the INR–USD exchange rate. However, the error correction mechanism reveals that adjustments do occur over time, although at a slow pace, leading to persistent exchange rate volatility following external shocks.

Overall, the study concludes that exchange rate behaviour in India is predominantly shaped by short-run dynamics and external global forces. These findings highlight the vulnerability of the Indian Rupee to global economic developments and underline the importance of strengthening external sector resilience. Effective exchange rate management in India therefore requires coordinated macroeconomic policies, adequate foreign exchange reserves, and timely responses to global shocks rather than reliance on domestic monetary adjustments alone. The study contributes to the existing literature by providing updated empirical evidence on exchange rate dynamics in India and offers a sound basis for further research and policy formulation.

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