KMC Journal
[A Peer-Reviewed, Open-Access Multidisciplinary Journal]
ISSN 2961-1709 (Print)
Published by the Research Management Cell
Kailali Multiple Campus, Dhangadhi
Far Western University, Nepal
DOI: https://doi.org/10.3126/kmcj.v7i2.83459

Impact of Exchange Rate on Nepal's Balance of Payment: An ARDL Approach

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Abstract

This study examines Nepal's Balance of Payments (BOP) from 1998/99 to 2022/23 under its fixed exchange rate regime with the Indian Rupee (INR). Using the ARDL model, well suited for small samples and mixed-integration data along with an ECM, this study investigates the casual impact of the INR/USD exchange rate, remittance inflows, and import levels on Nepal's BOP. The results reveal a significant long-run cointegration among variables. Findings show long-run cointegration: a 1% INR depreciation versus the USD boosts BOP by NPR 6.32 billion, enhancing export competitiveness. A 1% rise in imports cuts BOP by NPR 27.47 billion, reflecting trade deficits and remittances increase BOP by NPR 15.22 billion, stabilizing it. The study highlights Nepal's vulnerability to INR fluctuations and import dependency, advocating for export diversification, remittance-driven investments, and strategic import controls. Policy recommendations emphasize enhancing forex reserves, diversifying trade partners, and strengthening monetary coordination with India to mitigate external vulnerabilities. These insights offer practical guidance for sustaining BOP stability in economies with pegged exchange rate regimes.

Keywords: Bound's test, Currency Peg, devaluation, Error Correction Model, remittance

Introduction

Balance of Payments (BOP) comprises the systematic recording of all economic transactions between the residents of the country and the rest of the world over a period

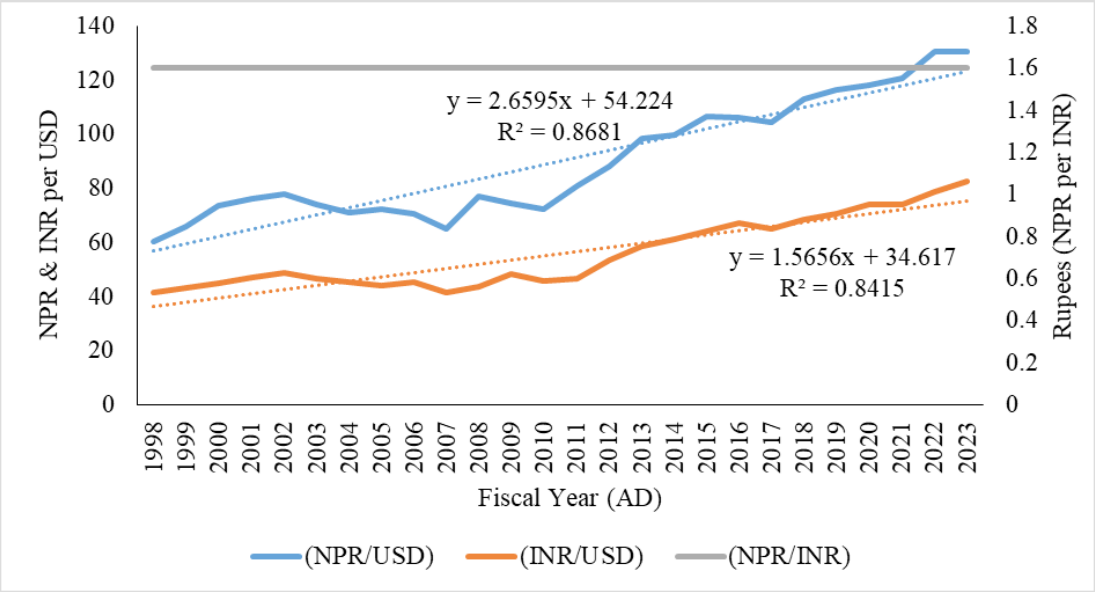
(IMF, 2009). It has three accounts: current, capital, and financial. Trade in goods and services, income, and current transfers are accounted for under the current account, where the capital account records financial transactions, including foreign direct investments, loans, and reserve assets (Ojha, 2013). The Balance of Payments is one of the crucial statistical statements reflecting a country's position on global trade, net foreign assets, economic relations with other countries, and financial capital (Ahmad et al., 2014). Information from the balance of payments reveals whether a country can cover its imports and other financial obligations through its savings (Afolabi & Kolawale, 2020). The Balance of Payments enables a country to manage and adjust its exchange rate effectively (Sangeetha & Patni, 2018). Exchange rate fluctuations influence the instabilities in the current and financial accounts of the balance of payment in the context of developing countries (Kandil, 2009).

The exchange rate is a key macroeconomic determinant of a country's economic growth, referring to the rate at which one country's currency is exchanged for another's (Ghimire et al., 2020). The US dollar (USD) is widely recognized as an international reserve currency and is commonly used as a benchmark for cross-exchange rates across global economies (Dahal & Raju, 2022). The growing emphasis on export-led growth and the dismantling of tariff and non-tariff barriers has made the exchange rate increasingly important. The effect of exchange rate fluctuations on economic activity has changed fundamentally. Nepal has pegged its exchange rate with the Indian Rupee (INR) at a rate of 1.6 Nepalese Rupees (NPR) to 1 INR since Nepal Rastra Bank to stabilize the economy, control inflation, and enhance international currency stability (Nepal & Pokharel, 2016). The objective in doing so is to balance the fluctuations between the supply and demand for foreign exchange (Adhikari et al., 2017). The exchange rate is officially determined, and the Nepalese Rupee value is influenced by changes in the Indian Rupee exchange rate (Koirala, 2018). This rate has remained unchanged since 1993 despite the growing economic disparity with India, which appears puzzling. This overvalued rate has led to a decline in export competitiveness, creating a persistent economic challenge (Paudel & Burke, 2015).

Nepal has a floating exchange rate system with other foreign currencies. The foreign exchange rate positively impacts BOP, but its volatility has inverse effects (Afolabi & Kolawale, 2020; Tijani, 2014). Also, studies (Gatawa et al., 2018; Sujianto, 2020) revealed a negative effect of the exchange rate on the balance of payments. The exchange rate of NPR/USD and INR/USD is depicted in Figure (1) along with the pegged exchange rate of NPR/INR.

Figure 1

Exchange Rate NPR/USD, INR/USD, and Pegged NPR/INR



NPR and INR have weakened significantly against the USD, with NPR facing sharper depreciation. The NPR/INR rate may deviate slightly from its peg due to asymmetrical USD trends. The fixed NPR/INR exchange rate ensures stability in Nepal-India trade, but also makes Nepal vulnerable to INR fluctuations against the USD. The high R^2 values suggest that exchange rate depreciation follows a predictable trend over time.

From mid-July 2023 to mid-July 2024, the Nepalese Rupee depreciated by 1.64% against the US dollar, following a 2.79% depreciation the previous year. The buying exchange rate was NPR 133.36 per US dollar in mid-July 2024. Nepal's gross foreign exchange reserves increased 30.4 % to USD 15.27 billion in mid-July 2024, which is sufficient to cover 13 months of imports for merchandise and services. In mid-July 2024, Nepal's imports decreased by 1.2%. Balance of Payments (BOP) recorded a surplus of NPR 502.49 billion ($ 3.77 billion) in the fiscal year 2023/24, up from NPR 285.82 billion ($ 2.17 billion) the previous year (NRB, 2024).

The trade deficit of Nepal has widened due to the larger volume of imports despite faster export growth (MoF, 2021). High imports and low exports have been leading to a persistent deficit balance of payments throughout Nepal's history (Acharya, 2013). Balance of Payments faces significant negative effects because of overvalued exchange rates, as it makes exports uncompetitive (Sultani & Faisal, 2022). Inflationary pressure caused by exchange rate volatility has become a significant concern for economists and policymakers (Musa, 2021). Trade and BOP deficits can

be mitigated by maintaining an optimal exchange rate, which in turn contributes to Nepal's economic stability. Several studies indicate that exchange rate devaluation improves the BOP in developing economies (Osman, 2016) and that stable exchange rates foster investment and economic growth (Ahmad et al., 2014; Koirala, 2018). Although global research has widely explored the influence of exchange rates and other macroeconomic variables on the BOP, there is a significant research gap in the Nepalese context. To address this gap, this this study investigates the long and short-run causal impacts of three key macroeconomic variables: exchange rate (NPR/USD, INR/USD, NPR/INR), remittances (as % of GDP), and imports (as % of GDP) on Nepal's balance of payments.

Methods and Procedures

This study employs methodologies based on established econometric techniques (Breusch & Pagan, 1979; Nepal, 2020; Pesaran et al., 2001).

Data Sources

Secondary data on these variables for the past 25 years were sourced from the web portals of the Nepal Rastra Bank (NRB) and the Ministry of Finance (MoF), Government of Nepal, covering the period from 1998/1999 to 2022/2023 AD. The INR/USD exchange rate data for the same period was collected from the Handbook of Statistics published by the Reserve Bank of India. The dataset has not been seasonally adjusted, and all figures are reported in their original form as published by the respective institutions.

Research Design and Analysis

Descriptive statistics and Empirical analysis are employed as the research design for this study. An augmented Dickey-Fuller (ADF) unit root test is done to assess the stationarity of the variables (Dickey & Fuller, 1979). Autoregressive Distributed Lag Model (ARDL) was employed for the time series data with the ARDL bound test of co-integration (Pesaran et al., 2001). The ARDL model was chosen over other time-series models because it is suitable when the variables are integrated of mixed order, i.e., I(0) and I(1), but not I(2), and it provides robust results in small sample sizes. The Error Correction Model (ECM) was further run to find out the short-run and long-run relationship among the variables (Engle & Granger, 1987). Normality, serial correlation, and heteroscedasticity were further assessed for diagnosing the model using the Jarque-Bera test (Jarque & Bera, 1987), Lagrange Multiplier (LM) test (Breusch & Pagan, 1980) and the Breusch-Pagan test (Breusch & Pagan, 1979) respectively. The stability of the model's parameter was assessed using the CUSUM

and CUSUM of Squares test (Kim et al., 2000). Stata (v.17.0) was used for all the analyses.

Model Specification

Given that there is an established relationship between the exchange rate and the Balance of Payments (BOP) from previous studies, this study treats the BOP as the endogenous variable with the exchange rate, remittance (% of GDP), and imports (% of GDP) as exogenous variables. INR/USD is used as the exchange rate in this model, as the Nepalese currency is pegged to the Indian Rupee at a fixed rate. The functional relationship between the variables is as follows:

$BOP_t = f(ER_t, REM_t, IMP_t)$

where,

BOP_t = Balance of Payments

ER_t = Exchange Rate (INR/USD)

REM_t = Remittance (% of GDP)

IMP_t = Imports (% of GDP)

ARDL Model

Since these variables are time series data, the Autoregressive Distributed Lag Model (ARDL) is employed to incorporate both I (0) and I (1) variables after conducting the unit root test. This model captures both short-term and long-term dynamics between BOP and its determinants. ARDL model is expressed as follows, where both the lagged values of the dependent variable (BOP) and the independent variables (exchange rate, remittance, and imports) are included as regressors:

$$BOP_t = \alpha + \sum_{i=1}^{p} \beta_i BOP_{t-i} + \sum_{j=0}^{q1} \beta_j \ln(ER_{t-j}) + \sum_{k=0}^{q2} \beta_k \ln(REM_{t-k}) + \sum_{l=0}^{q3} \beta_l \ln(IMP_{t-l}) + \varepsilon_t$$

where,

($BoPt_t$) is the current value of the Balance of Payments.

(BoP_{t-i}) represents the lagged values of the Balance of Payments.

(ER_{t-j}) is the lagged value of the Exchange Rate (INR/USD)

(REM_{t-k}) is the lagged value of the Remittance (% of GDP)

(IMP_{t-l}) is the lagged value of the Imports (% of GDP)

ε_t is the error term

β_i, β_j, β_k, and β_l are the coefficients to be estimated

The ARDL bound test is carried out to determine the presence of co-integration among the studied variables.

Results and Discussion

Summary of the Variables Included in the Study

Data analysis was conducted using Stata (v 17.0) software following data collection and inspection. Table 1 presents the descriptive summary statistics of the variables selected for the study. The Balance of Payments (BOP) has a mean value of 44.27 billion NPR, with a wide variation as indicated by the standard deviation of 110.07 billion NPR. The Exchange Rate (NPR/USD and INR/USD) has a mean of NPR 88.50 of INR 56.33 per USD, respectively with moderate variability and a slight tendency toward higher values. Consumer Price Inflation averages a 6.69% change, with a relatively stable range and a distribution close to normal. Imports and remittances as a percentage of GDP have an average of 29.36% and 17.56 %, respectively. While the p-values from normality tests do not indicate significant departures from normality. The skewness and kurtosis statistics further suggest that most variables have distributions close to symmetric with moderate tails, implying no extreme outliers or distortions in the data, making them suitable for regression-based econometric analysis.

Table 1

Descriptive Summary Statistics of the Variables Used

Variables	Mean (S.D)	Min.	Max.	Skewness	Kurtosis	p-value
Balance of Payments (NPR in billions)	44.27 (110.07)	-255.25	290.51	0.14	4.66	0.11
Exchange Rate (NPR/USD)	88.50 (20.62)	60.48	130.58	0.51	1.89	0.10
Exchange Rate (INR/USD)	56.33 (12.97)	41.34	82.59	0.55	1.87	0.09
Consumer Price Inflation (% change)	6.69 (2.83)	2.42	12.62	0.33	2.04	0.30
Imports (% of GDP	29.36 (4.10)	23.37	38.58	0.69	2.53	0.23
Remittance (% of GDP)	17.56 (6.57)	3.02	25.5	0.76	2.57	0.15

Note: Figures in the parentheses denote the standard deviation

Trend Analysis of the Variables Used in the Study

These graphs depict the trend of macroeconomic variables selected here from 1998/99 to 2022/23. The Balance of Payments (BOP) exhibited significant volatility over the years with notable peaks and troughs (Figure 2). It shows substantial deficits in the early and late years (like in 2010/11, 2018/19, and 2021/22) and surpluses in between. The trend line has a slight negative slope with low R^2 value suggesting no significant correlation with time. The exchange rate shows a clear upward trend indicating that the NPR has depreciated against the USD over time. Periods of BOP deficit coincide with years of higher exchange rates where the cost of imports increases negatively impacting the BOP. The consistent depreciation of the NPR against the

USD likely reflects underlying structural trade imbalances and growing dependence on imports.

Figure 2

Growing Trend of Balance of Payments and Exchange Rate from 1998/99 to 2022/23

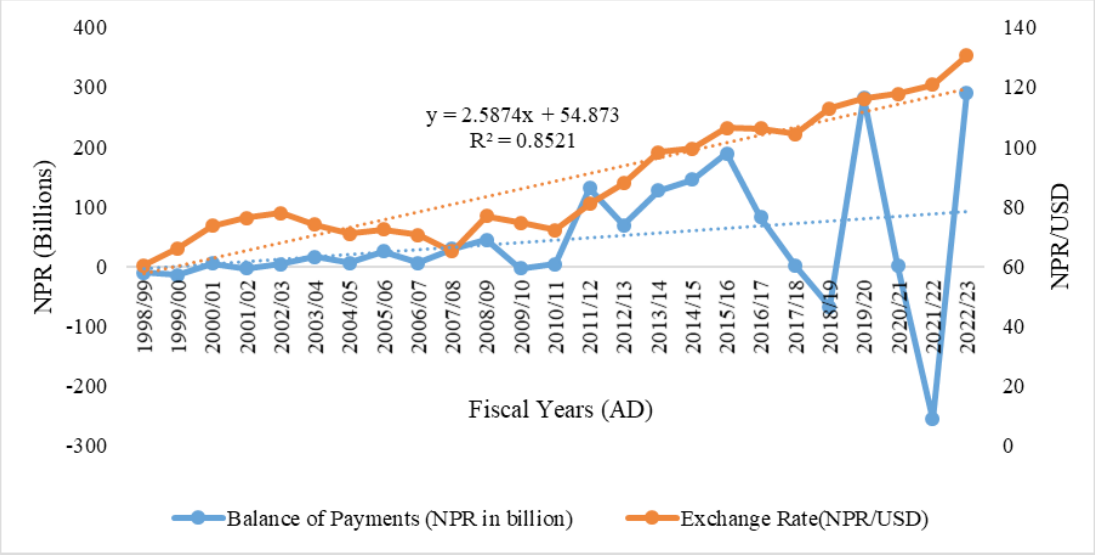
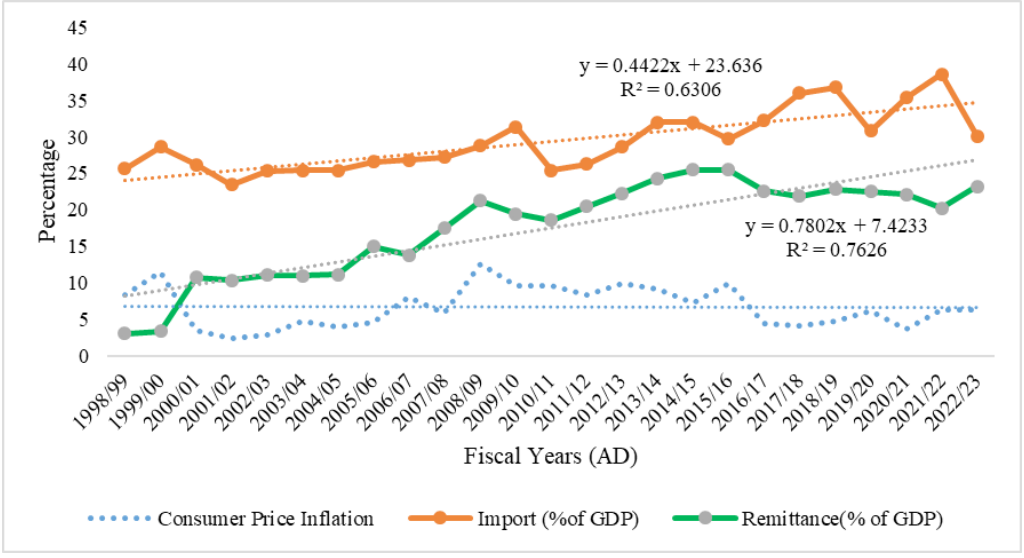


Figure 3

Growing Trend of Consumer Price Inflation, Remittance and Imports from 1998/99 to 2022/23



Inflation is highly variable with sharp peaks around the early 2000s and late 2000s, followed by fluctuations in the subsequent years (Figure 3). The overall trend shows a slight upward pressure on prices but with considerable short-term volatility. Imports as a percentage of GDP show a generally increasing trend ($R^2 = 0.63$) over the years, although the growth is moderate. Similarly, Remittance as a percentage of GDP shows a stronger upward trajectory with an R^2 value of 0.76, possibly driven by increased reliance on foreign income source. The increasing share of imports and remittances in GDP reflects Nepal's growing integration with the global economy. While remittances have helped cushion the economy and support household consumption, the rising import-dependence may undermine domestic production and widen trade deficits.

Unit Root Test

The Augmented Dickey-Fuller (ADF) or unit root test results are reported in Table 2. It reveals that the Balance of Payment and Import (% of GDP) series is stationary at a level with an order of integration I(0). In contrast, the Exchange Rate, Consumer Price Inflation, and Remittance series are non-stationary at their levels but become stationary after first differencing with order of integration I(1). This combination of I(0) and I(1) variables confirms the suitability of the ARDL model which is specifically designed to handle regressors with mixed integration orders, provided none are integrated of order two [I(2)].

Table 2

Augmented Dickey-Fuller (Unit Root) Test at Level and First Difference

	Level		First Difference		Order of Integration
Variables	Test Statistic	p-value	Test Statistic	p-value	
Balance of Payment (NPR in billions)	-4.57	0.000			I (0)
Exchange Rate (INR/USD)	-1.34	0.876	-3.93	0.001	I (1)
Consumer Price Inflation (%)	-2.29	0.441	-3.84	0.001	I (1)
Import (% of GDP)	-4.81	0.000			I (0)
Remittance (% of GDP)	-2.11	0.541	-4.50	0.000	I (1)

ARDL Model Estimation Results

To address multicollinearity concerns in the model, the Exchange Rate (NPR/USD) and Consumer Price Inflation (%) variables were excluded. This decision stems from the NPR's exchange rate pegging to the Indian Rupee (INR), which inherently ties its valuation to the INR/USD exchange rate rather than independent economic factors. Given the near-perfect positive correlation between NPR/USD and INR/USD

(r = 0.988), retaining both would introduce redundancy and distort model accuracy. Consequently, INR/USD was prioritized as the explanatory variable. Table 3 reports the results of ARDL with an R-squared value of 0.93, meaning the model explains approximately 93 % of the variation in the dependent variable. The adjusted R-squared value of 0.84 reflects a good explanatory power of predictor variables. The model is significant at a 1 % level as indicated by an F-statistic of 10 and a p-value of 0.0003. ARDL results reliability is further validated by the Durbin-Watson (Durbin & Watson, 1992) statistic of 2.18 suggesting no significant autocorrelation in the residuals of the model.

Table 3
Results of ARDL

Statistics	Values
R-squared	0.93
Adjusted R-squared	0.84
F-statistics	10.00
p-value	0.000
Durbin-Watson statistics	2.18

The ARDL (2 2 3 2) bounds test is used to determine the existence of a long-run relationship among variables with mixed integration orders, where the Balance of Payments (BOP) and Import series is I(0) and the other variables are I(1). This test has the null hypothesis (H_0) of no co-integration or long-run relationship between the variables. The F-statistic of 9.48 (Table 4) exceeds the critical value of 5.61 at the 1% significance level for I(1), leading to rejecting the null hypothesis and indicating a long-run relationship among the variables. Similarly, the t-statistic of -5.62 is more negative than the critical value of -4.37 at the 1% significance level for I(1), further supporting the conclusion of co-integration. Thus, the results confirm the existence of a significant long-run relationship between the variables.

Table 4
Bounds Test for Co-integration

Test Statistic	Value	Critical Values (1% Level)	Significance Level	Conclusion
F-statistic	9.48	I(0): 4.29, I(1): 5.61	1%	Reject H_0
t-statistic	-5.62	I(0): -3.43, I(1): -4.37	1%	Reject H_0

In the long run, estimated results (Table 5) revealed that the exchange rate, imports and remittance significantly impact the balance of payments. A sustained

depreciation of the Indian Rupee (INR) against the USD (e.g., INR weakening) is linked to a long-term improvement in Nepal's BOP by 6.32 billion NPR per unit increase in the exchange rate. Since the Nepalese Rupee (NPR) is pegged to the Indian Rupee (INR) at a fixed rate (1.6 NPR = 1 INR), Nepal's trade competitiveness is directly tied to INR fluctuations (Nepal & Pokharel, 2016). This likely reflects Nepal's currency peg to the INR: a weaker INR makes Nepalese exports cheaper globally boosting the trade surpluses (World Bank, 2022). However, Nepal's limited export diversification primarily agricultural and low-value manufactured goods restricts the full benefits of depreciation (ADB, 2020).

A unit increase in Imports (% of GDP) corresponds to a 27.47 billion NPR decrease in the BOP signifying higher imports could worsen BOP. Higher import dependency (as a % of GDP) reduces BOP in the long run. The adverse effect of rising imports (% of GDP) on BOP reflects Nepal's chronic trade deficit, which reached $10.80 billion in 2024 (NRB, 2024). Over 60% of Nepal's imports are from India, including essential goods like fuel and machinery, creating inelastic demand (Taneja et al., 2020). This dependency drains foreign reserves, worsening the BOP.

Remittances significantly strengthen BOP, adding 15.22 billion NPR for every unit percentage rise on GDP by remittance inflows. This underscores remittances' role in stabilizing Nepal's economy by injecting foreign currency. This aligns with the studies showing potential of remittance for sustainable economic development of Nepal. They are with short-run benefits and never be relied upon to solve economic challenges in the long run (Karki et al., 2024). The error correction term (-2.64, $p<0.001$) is negative and significant, confirming long-run equilibrium adjustment.

Table 5

Estimated Long-run and Short-run Coefficients of the ARDL Models

Variables	Coefficient	Standard Error	t-statistic	p-value
Long Run (LR)				
ECT_{t-1}	-2.64	0.47	-5.62	0.000
Exchange Rate (INR/USD)	6.32	1.14	5.56	0.000
Import (% of GDP)	- 27.47	4.32	-6.34	0.000
Remittance (% of GDP)	15.22	2.13	7.15	0.000
Short Run (SR)				
BOP_{t-1}	0.83	0.29	2.81	0.020
Exchange Rate (INR/USD)	-20.64	8.01	-2.58	0.030
Import (% of GDP)	51.31	15.30	3.35	0.008
Remittance (% of GDP)	-19.35	12.51	-1.55	0.156

Constant	589.95	192.89	3.06	0.014
R-squared	0.97			
Adjusted R-squared	0.93			
Log likelihood	- 105.97			

A notable difference was observed in short-run dynamics from the long-run trends. The lagged BOP is positive and significant (0.83, $p<0.05$) suggesting that past BOP trends influence current BOP movements. A unit change in Exchange rate (INR/USD) have a significant negative short-run impact on BOP as it is deducted by 20.64 billion NPR implying that sudden fluctuations in INR/USD can temporarily deteriorate the BOP before long-term adjustments occur. This could reflect immediate costs like pricier imported goods (e.g., fuel, machinery) before export benefits materialize (IMF, 2020). This short-term pain is common in pegged regimes with limited monetary autonomy (Bordo & Siklos, 2023). A spike in imports temporarily boosts BOP by 51.31 billion NPR which may reflect inventory buildup or speculative imports ahead of anticipated price hikes possibly (Chhetri, 2021). However, lagged effects are weak or unclear. Remittance inflows are often channeled into consumption (e.g., housing, education) rather than productive investments delaying their macroeconomic benefits due to which short-term remittance changes show no clear impact on BOP (Yin et al., 2022). These findings highlight the need for short-term buffer mechanisms like maintaining foreign exchange reserves and coordinated fiscal-monetary responses to manage exchange rate shocks. Long-term stability hinges on managing the INR/USD exchange rate, curbing excessive imports, and encouraging remittances.

Diagnostic Tests of the Model

The diagnostic tests for normality, autocorrelation, and heteroscedasticity of the model, as reported in Table 6 confirm the reliability of the ARDL model. This validation allows for meaningful interpretation as the residuals are normally distributed, free from autocorrelation, and homoscedastic. These results indicate that the model is statistically well-specified and robust for inference.

Table 6

Normality, Auto-correlation, and Heteroscedasticity Tests of Residuals

Test	Test Statistic	p-value
Jarque-Bera test (Normality)	JB = 3.18	0.203
Breusch-Godfrey LM Test (Auto-correlation)	$Chi^2(1) = 0.98$	0.322
Breusch-Pagan-Godfrey Test (Heteroscedasticity)	$Chi^2(1) = 1.10$	0.294

Stability tests

The cumulative sum (CUSUM) of recursive residuals and the CUSUM of Squares (CUSUMSQ) test were conducted to find out the model's parameter stability. Table 7 presents the test result and Figure 3 plots the CUSUM and CUSUMSQ square results. The test statistic value of 0.26 is lower than all the critical values at the 1%, 5%, and 10% significance levels indicating no evidence of structural instability in the model.

Table 7

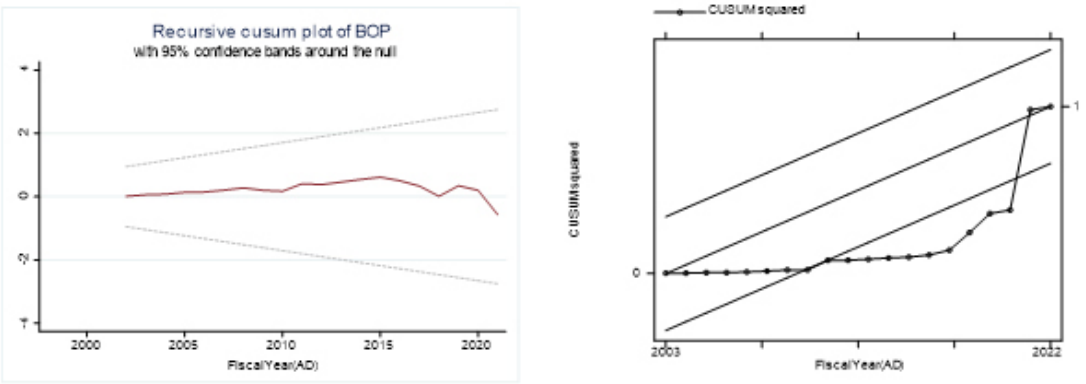
CUSUM Test for Recursive Residuals

Test Type	Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Recursive	0.26	1.14	0.948	0.850

The CUSUM test plots the cumulative sum of recursive residuals and compares them with critical bounds to assess the systematic changes in the regression coefficient whereas the CUSUM of Squares test detects the sudden shifts in residual variance. The CUSUM test shows stability throughout the entire period, but the CUSUM of Squares test indicates potential instability or a structural break in the model parameters in the final years (close to 2022). This suggests that the model's coefficients may have remained stable for most of the analyzed period but could have experienced changes more recently. This recent instability might be due to events like the COVID-19 pandemic, rising global inflation, or political and economic changes in Nepal. More study is needed to see if these changes have permanently affected the model's relationships.

Figure 4

CUSUM and CUSUMSQ Test for the Model's Parameter Stability



Conclusion

This study reveals that Nepal's Balance of Payments is shaped by long-term structural factors: depreciation of Indian Rupee improves competitiveness, high imports strain foreign reserves and remittance supports financial stability. While short term volatility stems from exchange rate shocks and temporary increase of import. The ARDL model highlights that Nepal's fixed exchange rate with Indian Rupee provides stability in the long run but expose the economy to immediate currency risks. Nepal's Balance of Payments improves over time with a weaker INR, controlled imports, and steady remittances but faces short-term pains from currency swings and import surges.

To enhance Balance of Payments resilience, Nepal should diversify exports beyond low-value goods, regulate non-essential imports, and channel remittances into productive investments. Strengthening forex reserves, diversifying trade partners to reduce INR dependency, and improving monetary policy coordination with India are critical. Addressing structural bottlenecks, such as political instability and landlocked geography will further mitigate external vulnerabilities.

However, this study has some limitations. The analysis excludes capital account variables which may also significantly impact the Balance of Payments. Potential structural breaks, especially in recent years were identified but not explicitly modeled. Future research could explore sectoral Balance of Payments dynamics or apply regime-switching models to better capture structural changes and policy shifts over time.

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