
Analyzing the Dynamics between Foreign Exchange Reserves, Trade Balance, Workers Remittances and Balance of Payments in Nepal

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Abstract: *This study explores the intricate dynamics among foreign exchange reserves, trade balance, workers' remittances, and the balance of payments (BOP) in Nepal, crucial for economic stability and policy formulation in a developing economy. Utilizing data from the Nepal Rastra Bank spanning from June 2017 to April 2024, the research employs statistical and econometric methods, including the Phillips-Perron test, ARDL model, Error Correction Model (ECM), and Granger causality analysis, to investigate the relationships and causal interactions among these variables. Key findings reveal significant long-term relationships, particularly highlighting how foreign exchange reserves are influenced by the trade balance and workers' remittances. The results suggest that maintaining optimal foreign exchange reserves is vital for mitigating trade and BOP deficits, which, in turn, impacts economic stability. The study's insights are crucial for policymakers aiming to develop strategies that enhance economic growth and resilience in Nepal.*

Keywords: *Foreign Exchange Reserves, Trade Balance, Workers' Remittances, Balance of Payments, ARDL Model, Granger Causality Analysis.*

1. INTRODUCTION

In the context of Nepal's developing economy, understanding the interplay between foreign exchange reserves [1], trade balance [16], workers' remittances [10], and the balance of payments (BOP) [15] is crucial for economic planning and policy formulation. Foreign exchange reserves are vital for stabilizing the national currency and facilitating international trade. The trade balance reflects the difference between a country's exports and imports, indicating its trade competitiveness. Workers' remittances, a significant source of foreign income for Nepal, play a crucial role in sustaining economic stability. The BOP highlights the country's financial health and its ability to meet international obligations.

This study investigates the relationships among these four key economic indicators using data from the Nepal Rastra Bank (NRB) spanning from June 2017 to April 2024. By employing statistical and econometric methods, this research aims to provide insights into their dynamics and causal interactions.

2. RELATED WORKS

The dynamics between foreign exchange reserves [1], trade balance [16], workers' remittances [10], and balance of payments (BOP) [15] have been thoroughly explored in economic literature due to their significant impact on a country's economic stability and policy formulation. In Nepal, these elements are crucial in shaping the macroeconomic environment.

Gross Foreign Exchange Reserves

Foreign exchange reserves are essential for maintaining economic stability, supporting the national currency, and providing a safeguard against economic crises. In Nepal, the fluctuations in foreign exchange reserves are influenced by various economic factors, including the trade balance [16], remittances [10], and the BOP [15]. An increase in foreign exchange reserves typically enhances investor confidence and protects the economy from external shocks.

Total Trade Balance

The trade balance, which measures the difference between exports and imports, is a critical factor affecting Nepal's foreign exchange reserves. A continuous trade deficit, where imports exceed exports, can significantly deplete foreign reserves. Nepal's dependency on imports, combined with limited export capacity, intensifies this trade imbalance [16]. Addressing the trade deficit is vital for improving the BOP and stabilizing foreign exchange reserves [12].

Workers' Remittances

Remittances from Nepalese workers abroad constitute a substantial portion of Nepal's foreign exchange earnings. These remittances are crucial for household incomes and national economic stability, significantly contributing to foreign exchange reserves [10]. The inflow of remittances helps offset the trade deficit, thereby playing a crucial role in managing the BOP deficit and maintaining economic balance [1].

Balance of Payments Deficit

The balance of payments accounts for all economic transactions between a country and the rest of the world. Nepal has been facing a persistent BOP deficit, mainly due to a significant trade deficit and slow export growth. This deficit indicates that the country is spending more on foreign transactions than it is earning, resulting in a depletion of foreign exchange reserves [1]. To address the BOP deficit, policy measures need to focus on boosting export performance, controlling import levels, and encouraging remittance inflows [15].

Dynamics and Interrelationships

The relationships between foreign exchange reserves [1], trade balance [16], workers' remittances [10], and the BOP [15] are complex and interrelated. Strong foreign exchange

reserves can help manage trade imbalances and mitigate BOP deficits. Conversely, a favorable trade balance and strong remittance inflows contribute to the accumulation of foreign reserves, enhancing economic stability [1]. Policymakers in Nepal must consider these dynamics to develop strategies that promote economic growth and stability.

Hypothesis

- **Long-Term Relationship:** There is a significant long-term relationship between foreign exchange reserves, trade balance, workers' remittances, and the BOP deficit in Nepal.
- **Influence on Foreign Exchange Reserves:** Changes in the trade balance, workers' remittances, and the BOP deficit significantly influence foreign exchange reserves.
- **Causal Relationships:** There are significant causal relationships among foreign exchange reserves, trade balance, workers' remittances, and the BOP deficit.

3. METHODOLOGY

The methodologies employed in this study draw from established econometric techniques [2], [3], [12], [13]. Data collection utilized information sourced from the Nepal Rastra Bank (NRB) [11], [16], covering the period from June 2017 to April 2024.

Data Collection

The data used in this study were collected from the Nepal Rastra Bank (NRB) website (Nepal Rastra Bank, 2020), covering a period from June 2017 to April 2024. The key variables analyzed include:

- Gross Foreign Exchange Reserves (Rs. in billion)
- Total Trade Balance
- Workers' Remittances
- BOP Deficit

Statistical Analysis

To assess stationarity, the Phillips-Perron test as introduced by Phillips and Perron (1988) was employed. Following this, the ARDL (AutoRegressive Distributed Lag) model proposed by Pesaran et al. (2001) was utilized, along with the ARDL bound test and the Error Correction Model (ECM) developed by Engle and Granger (1987), to investigate the long-run and short-run relationships among the variables. Additionally, Granger causality analysis (Granger, 1969) was conducted to identify causal relationships between the variables. Model diagnostics included the Jarque-Bera test (Jarque & Bera, 1987), the Lagrange Multiplier test (Breusch & Pagan, 1980), and the Breusch-Pagan-Godfrey test (Godfrey, 1978; Breusch & Pagan, 1979) for assessing normality, serial correlation, and heteroskedasticity.

Summary Statistics

Descriptive statistics, encompassing measures such as mean, median, maximum, minimum, standard deviation, skewness, kurtosis, and coefficient of variation (CV), were computed to provide a comprehensive overview of the data distribution and variability.

ARDL Model

The ARDL model, introduced by Pesaran et al. (2001) to integrate I(0) and I(1) variables within the same estimation framework, utilizes standard least squares regression. This model incorporates lagged values of both the dependent and explanatory variables as regressors (Greene, 2008). The basic form of an ARDL regression model is represented as:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \dots + \beta_k y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \dots + \alpha_q x_{t-q} + \varepsilon_t$$

Where ε_t denotes a random disturbance term, α_i and β_j represent cointegrated coefficients (with $i=1,2,\dots,q; j=1,2,\dots,p$), and p and q denote the number of lags of dependent and explanatory variables, respectively. The model encompasses an autoregressive component, where y_t is partly explained by lagged values of itself, and a distributed lag component, represented by successive lags of the explanatory variable.

Error Correction Model (ECM)

The ARDL Bound Test is applied to ascertain the presence of cointegration. If cointegration is present, the ECM (Engle & Granger, 1987) is employed to analyze the long-run and short-run relationships among the variables.

4. RESULTS AND DISCUSSION

After collecting the data, an initial thorough inspection was conducted. The data was then cleaned and subsequently analyzed using the Eviews 12 Evaluation Version software.

Table 1. Summary Statistics

Statistic	Gross Foreign Exchange Reserves (Rs. in billion)	Total Trade Balance	Workers' Remittances	BOP
Mean	1252.960771	-680720.9481	497709.6	20615.06835
Median	1165.798	3666617	477964.5	14428.28
Maximum	1911.859101	-63764.8765	1220560	365163.7819
Minimum	1030.880257	-1720417.391	51940.2	-288501.7535
Standard Deviation	223.0054195	402443.4807	284929.9	129723.4271
Skewness	1.167415323	-0.353831558	0.332898	-0.010266045
Kurtosis	0.648943781	-0.657673012	2.292629	0.998364953
Jarque-Bera	21.62072	3.705314	3.656673	3.013723
Probability	0.00002	0.15682	0.160681	0.221604
CV	17.79827626	-59.12018454	57.24822266	629.2650835
Observations	93	93	93	93

Table 1 represents summary statistics of the key economic indicators: Gross Foreign Exchange Reserves, Total Trade Balance, Workers' Remittances, and BOP. On average, the Gross Foreign Exchange Reserves amount to approximately Rs. 1252.96 billion, with significant variability as evidenced by the standard deviation of Rs. 223.01 billion. The distribution of these reserves

is positively skewed, indicating that most values are lower than the mean, with a few high outliers. The Total Trade Balance presents a stark contrast, showing a persistent and significant trade deficit, averaging around -Rs. 680720.95, with a wide range and slight negative skewness. This suggests that the trade balance is generally negative, with some extreme . Workers' Remittances average Rs. 497709.6, also displaying considerable variability and a slightly positive skewness, which points to a distribution with some higher outliers. The BOP has an average of Rs. 20615.07 and high variability, with a near-symmetrical distribution.

Table 2. Unit Root Test (Phillips-Perron) at Level and First Difference

Variable	Level		First Difference	
	Test Statistic	p-Value	Test Statistic	p-Value
Gross Foreign Exchange Reserves (Rs. in billion)	-0.79391	0.9619	-9.174989	0.0000
Total Trade Balance	-5.118486	0.0003		
Workers' Remittances	-5.197539	0.0002		
BOP Deficit	-1.351795	0.8684	-9.579082	0.0000

Table 2 shows Phillips-Perron unit root test at level indicates that Gross Foreign Exchange Reserves and BOP Deficit are non-stationary, as their p-values exceed 0.05, suggesting the presence of unit roots. However, the Total Trade Balance and Workers' Remittances are stationary at level, with p-values below 0.05. When tested at first difference, both Gross Foreign Exchange Reserves and BOP Deficit become stationary, indicating that the non-stationarity is resolved upon differencing.

Table 3. Results of ARDL

R-squared	0.979218	F-statistic	810.4443
Adjusted R-squared	0.97801	P value	0
Durbin- Watson statistic	2.166336		
*Significant at 1%			

Table 3 represents the ARDL model results which show an exceptionally high R-squared value of 0.979218, indicating that approximately 97.9% of the variability in the dependent variable is explained by the independent variables included in the model. The adjusted R-squared is also high at 0.97801, confirming the model's robustness. The F-statistic of 810.4443, with a corresponding p-value of 0, indicates that the model is highly significant at the 1% level. Furthermore, the Durbin-Watson statistic of 2.166336 suggests that there is no significant autocorrelation in the residuals of the model, thereby validating the reliability of the ARDL results.

Table 4. Results of bound test.

Test Statistic	Value	K
F-statistic	8.22014	3

Critical value bounds		
Significance	I0 Bound	I1 Bound
10%	3.47	4.45
5%	4.01	5.07
2.50%	4.52	5.62
1%	5.17	6.36

Table 4 shows the bound test results are crucial for determining the existence of a long-run relationship between the variables in the ARDL model. The test statistic value of 8.22014 exceeds the upper bound critical values at all conventional significance levels (1%, 2.5%, 5%, and 10%). For instance, at the 5% significance level, the critical value bounds are 4.01 (I0 bound) and 5.07 (I1 bound). Since the test statistic is higher than these bounds, it confirms the presence of a long-run equilibrium relationship among the variables in the model. This result implies that the variables are co-integrated and move together in the long run, validating the use of the ARDL approach in this analysis.

Table 5. ARDL Estimate Test Results

A. Long-Run Coefficients				
Variable	Coefficient	Standard Error	t-Statistic	p-Value
Constant	115.7552	39.2141	2.951877	0.0041
Gross Foreign Exchange Reserves (Rs. in billion)	-0.121342	0.038451	-3155717	0.0022
Total Trade Balance	-0.000138	0.000106	-1.298754	0.1975
Workers' Remittances	-0.000203	0.000157	-1.292951	0.1995
BOP Deficit	0.00034	0.000109	3.118842	0.0025
Trend	0.961652	0.253325	3.796118	0.0003
ECT_{t-1}	-0.121342	0.020801	-5.833317	0.0000

Table 5 present long-run coefficients from the ARDL model reveal that Gross Foreign Exchange Reserves, BOP Deficit, and Trend are significant. Specifically, Gross Foreign Exchange Reserves have a negative coefficient, indicating an inverse relationship with the dependent variable. The BOP Deficit has a positive and significant coefficient, suggesting a direct relationship. The trend variable also shows a significant positive impact. The Error Correction Term (ECT) is negative and significant, confirming that any short-term deviations from the long-run equilibrium are corrected over time.

Table 6. Short-Run Coefficients (Dynamic Short-Run)

Variable	Coefficient	Standard Error	t-Statistic	p-Value
D(Gross Foreign Exchange Reserve)	0.045168	0.109523	0.412409	0.6811
D(Total Trade Balance)	-0.000301	0.000201	-1.497662	0.138
D(Workers' Remittances)	-0.000441	0.000297	-1.481615	0.1422



D(BOP Deficit)	-0.000144	0.000195	2.285192	0.0248
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The table 6 presents short-run coefficients from a dynamic model, examining the impact of various economic variables on a dependent variable. The Gross Foreign Exchange Reserve has a positive but statistically insignificant effect (coefficient: 0.045168, p-value: 0.6811). The Total Trade Balance and Workers' Remittances both show negative but statistically insignificant effects (coefficients: -0.000301 and -0.000441, p-values: 0.138 and 0.1422, respectively). The BOP Deficit, however, has a statistically significant negative impact (coefficient: -0.000144, p-value: 0.0248), indicating that an increase in the BOP deficit significantly decreases the dependent variable in the short run.

Table 7. Diagnostic Tests

	Statistic	p-Value
Jarque-Bera Test (Normality)	JB=369.2906	0.0000
Breusch-Godfrey LM Test (Auto-correlation)	F=0.376035	0.6877
Breusch-Pagan-Godfrey Test (Heteroscedasticity)	F=1.608381	0.1664

Table 7 shows the diagnostic tests validate the reliability of the ARDL model. The Jarque-Bera test indicates non-normality of the residuals, but this does not necessarily invalidate the model. The Breusch-Godfrey LM test shows no evidence of autocorrelation, and the Breusch-Pagan-Godfrey test indicates no significant heteroscedasticity issues.

Table 8. Causality Test (Granger Causality)

Null Hypothesis	F-Statistic	p-Value
Gross Foreign Exchange Reserves do not Granger-cause Total Trade Balance.	2.46531	0.8972
Total Trade Balance does not Granger-cause Gross Foreign Exchange Reserves.	0.1086	0.8972
Gross Foreign Exchange Reserves do not Granger-cause Workers' Remittances.	3.1493	0.0479
Workers' Remittances do not Granger-cause Gross Foreign Exchange Reserves.	0.42152	0.6574
Gross Foreign Exchange Reserves do not Granger-cause BOP Deficit.	1.05152	0.3539
BOP Deficit does not Granger-cause Gross Foreign Exchange Reserves.	3.96887	0.0225
Total Trade Balance does not Granger-cause Workers' Remittances.	0.80504	0.4504
Workers' Remittances do not Granger-cause Total Trade Balance.	0.16644	0.8469
Total Trade Balance does not Granger-cause BOP Deficit.	0.09561	0.9089
BOP Deficit does not Granger-cause Total Trade Balance.	0.97314	0.382
Workers' Remittances do not Granger-cause BOP Deficit.	0.09623	0.9084
BOP Deficit does not Granger-cause Workers' Remittances.	0.49704	0.6101

Table 8 shows the Granger causality test which indicate significant causality from Gross Foreign Exchange Reserves to Workers' Remittances and from BOP Deficit to Gross Foreign Exchange Reserves. This implies that changes in foreign exchange reserves can predict changes in workers' remittances and that the BOP deficit can predict changes in foreign exchange reserves. However, there is no significant Granger causality in the other pairwise relationships, suggesting that these variables do not predict each other in the short term.

Stability Test Graph

The CUSUM and CUSUM of Squares tests are essential for assessing the stability of a model's parameters over time. The CUSUM test detects systematic changes in regression coefficients by plotting the cumulative sum of residuals and comparing it to critical bounds. If the plot stays within these bounds, the model is stable; otherwise, it indicates structural changes. The CUSUM of Squares test, which focuses on the cumulative sum of squared residuals, helps identify shifts or volatility in residual variance. Stability in both plots suggests reliable model parameters, while crossing the bounds indicates instability, necessitating model reassessment or adjustment. These tests are crucial for ensuring the robustness and predictive accuracy of econometric models.

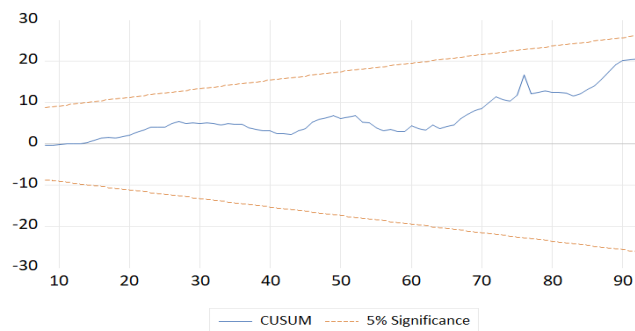


Fig 1. Cusum Test

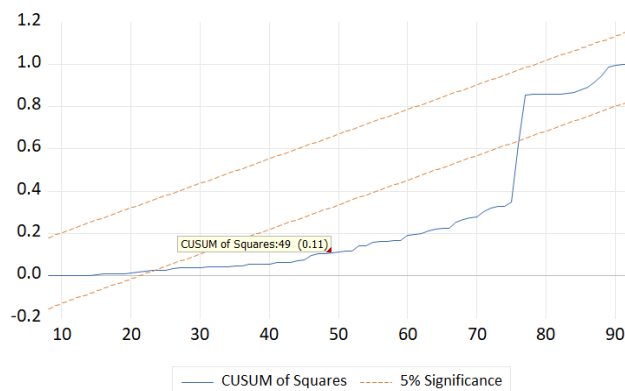


Fig 2. Cusum of Squares Test

Discussion

The analysis provides a comprehensive understanding of the interrelationships among gross foreign exchange reserves, total trade balance, workers' remittances, and BOP deficit. The significant long-term relationships identified through the ARDL model underscore the importance of these economic indicators in maintaining financial stability. Policymakers should note the inverse relationship between foreign exchange reserves and the dependent variable, and the direct relationship with the BOP deficit, as these insights are crucial for formulating effective economic strategies. The causality results suggest that monitoring foreign exchange reserves can provide predictive insights into workers' remittances and that the BOP deficit's trends can inform changes in foreign exchange reserves. Overall, this study highlights the intricate dynamics among key economic variables and their implications for economic policy and financial management.

5. CONCLUSION

This analysis elucidates the critical relationships among gross foreign exchange reserves, total trade balance, workers' remittances, and BOP, providing valuable insights for economic policy. The findings highlight the significance of maintaining optimal levels of foreign exchange reserves and understanding their interplay with remittances and the BOP deficit. The robust long-run relationships and the identified causal pathways suggest that policymakers should consider these dynamics when developing strategies to enhance economic stability and growth.

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