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Dynamic Interactions Between Real GDP and Macroeconomic Variables in Nepal

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Abstract

Background: This research explores the complex interplay between Nepal's real GDP and key economic variables including exports, imports, remittances, and gross fixed capital formation (GFCF) over the period from 1975 to 2023.

Methodology: Utilizing annual data, the study applies a Vector Autoregressive (VAR) modeling framework. Stationarity tests confirmed that all variables are integrated at first difference (I(1)), while the Johansen cointegration test showed no existence of long-term equilibrium relationships.

Findings: Results indicate that remittances have a strong and positive influence on Nepal's GDP, underscoring their vital role in the nation's economic growth. Conversely, exports and GFCF did not exhibit a statistically significant immediate impact on GDP. Imports demonstrated a weak two-way causal relationship with GDP, suggesting limited interaction between trade flows and economic expansion. The impulse response and variance decomposition analyses reveal a sustained effect of GDP shocks on imports, investments, and remittance inflows, whereas exports remain largely unaffected by such shocks.

Implications: The study suggests the necessity for policy measures focused on enhancing trade competitiveness, optimizing investment utilization, and leveraging remittances more effectively to support long-term economic sustainability.

Keywords: vector autoregressive model, remittances, gross fixed capital formation, Johansen cointegration, impulse response analysis

Introduction

Key macroeconomic factors such as trade, remittances, and investment shape Nepal's economic growth. Over the past decades, remittances have contributed to Nepal's GDP, accounting for nearly 25% of total economic output (World Bank, 2020). Theoretically, remittances serve as an essential source of household income, fostering consumption and poverty reduction (Adams & Page, 2005). However, there is growing concern about their long-term impact on economic growth, as they are often directed toward consumption rather than productive investments (Chami et al., 2003). While remittances provide financial stability, their role in

driving sustainable development remains uncertain (Acharya & Leon-Gonzalez, 2019).

Trade, particularly exports, is widely recognized as a key driver of economic growth under the export-led growth (ELG) hypothesis, which posits that increased exports enhance foreign exchange earnings, facilitate technology transfers, and improve productivity (Balassa, 1978; Feder, 1983). However, empirical studies show that Nepal's export sector contributes only marginally to economic growth due to its reliance on low-value-added products and trade imbalances (Karki, 2017). Imports, on the other hand, are essential for supplying raw materials and capital goods, but excessive dependence on imports has led to persistent trade deficits, raising concerns about economic sustainability (Mahat & Kunwar, 2021).

Investment, particularly gross fixed capital formation (GFCF), plays a fundamental role in economic growth by facilitating capital accumulation and productivity enhancement (Solow, 1956). However, Nepal faces structural inefficiencies in translating investments into economic growth due to policy instability, bureaucratic hurdles, and low project execution efficiency (Mahat & Kunwar, 2021). Despite government efforts to attract foreign direct investment (FDI) and improve domestic capital formation, the impact of investment on GDP remains limited (Majagaiya, 2009). FDI inflows positively induce more of domestic investment (Mishra & Fedorenko, 2019).

While previous studies have examined the individual roles of trade, remittances, and investment in Nepal's economy, there is limited research on their dynamic interrelationships using advanced econometric techniques. The existing literature lacks a comprehensive analysis of short-term and long-term interactions among these macroeconomic variables. Moreover, few studies employ modern time-series methodologies, such as Vector Autoregressive (VAR) models, impulse response functions, and variance decomposition analyses, to capture the intricate linkages between GDP, trade, remittances, and investment. Addressing these gaps is crucial for formulating effective policies that enhance economic resilience and sustainable growth.

The study aims to analyze the dynamic interactions between Nepal's GDP, trade, remittances, and investment, assessing their impact on economic growth using a VAR model, determining causal relationships using the Granger causality test, and evaluating their responsiveness to GDP fluctuations.

Research Objective

The purpose of this research is to analyze the dynamic relationships between Nepal's real GDP and key economic indicators—including exports, imports, remittances, and gross fixed capital formation (GFCF)—over the period from 1975 to 2023.

Literature Review

Economic growth is a fundamental objective for developing nations like Nepal, where macroeconomic variables such as trade, remittances, and investment play a crucial role. Numerous studies have investigated the relationship between these factors and real GDP, often employing econometric models like the Vector Autoregressive (VAR) approach. This review synthesizes existing literature on the interplay between GDP, exports, imports, remittances, and gross fixed capital formation (GFCF), focusing on their implications for Nepal's economic trajectory.

Economic growth in developing economies is influenced by key macroeconomic factors such as trade, remittances, and investment. These variables interact dynamically, shaping a country's long-term economic trajectory. In Nepal, remittances account for nearly 25% of GDP (World Bank, 2020), while exports and gross fixed capital formation (GFCF) have played a relatively minor role in driving economic expansion. The export-led growth (ELG) hypothesis suggests that increased exports lead to GDP growth through foreign exchange earnings,

productivity improvements, and technology diffusion (Balassa, 1978; Feder, 1983). Nepal needs to attract more foreign investment by sector (construction, energy, and manufacturing) and by scale (small, large, and medium); moreover, if Nepal develops its modern capital, it would benefit from maximum productivity and minimum labour cost, which creates a strong positive correlation with the overall effect of FDI in Nepal (Mishra et al., 2017). Likewise, Domar (1946) and Solow (1956) growth models emphasize investment-led growth, where increased capital formation fosters higher output (Harrod, 1939). However, empirical findings for Nepal show mixed results, with limited evidence supporting export- or investment-driven growth (Karki, 2017; Shrestha & Chaudhary, 2019).

While several studies have examined the individual effects of trade, remittances, and investment on Nepal's economy, few have investigated their dynamic interactions using modern time-series techniques. This study addresses this gap by applying a Vector Autoregressive (VAR) model to analyze short-term and long-term relationships between GDP, exports, imports, remittances, and investment.

The export-led growth (ELG) hypothesis has been widely studied in economic literature, with research showing that export expansion leads to higher economic growth by enhancing foreign exchange earnings and industrial development (Balassa, 1978; Feder, 1983). Empirical studies confirm that trade liberalization fosters economic growth in export-driven economies (Krueger, 1998). However, the extent of this effect varies across countries, depending on export composition, industrial competitiveness, and external trade barriers (Sharma & Panagiotidis, 2005).

For Nepal, empirical evidence on export-led growth is weak. Karki (2017) found that exports contribute marginally to GDP growth, primarily due to low-value-added products, trade imbalances, and structural inefficiencies. Similarly, (Mahat & Kunwar, 2021) argued that Nepal's export sector lacks competitiveness, with major exports (textiles, carpets, and agricultural goods) facing stiff international competition. Moreover, Nepal's persistent trade deficitdriven by high import dependencyraises concerns about its external sector's sustainability.

On the other hand, imports play a dual role in economic growth. While they provide essential inputs for domestic production, excessive dependence on imports worsens trade imbalances and limits industrial self-sufficiency (Frankel & Romer, 1999). In Nepal, imports primarily consist of fuel, machinery, and raw materials, which are crucial for industrial production but contribute to chronic current account deficits (Mahat & Kunwar, 2021). This study investigates the causal relationships between exports, imports, and GDP, assessing whether imports are growth-enabling or a constraint on Nepal's economic trajectory.

Remittances are a critical source of foreign income for Nepal, but their impact on long-term economic growth remains debated. On the positive side, remittances improve household income, boost consumption, and finance education and healthcare, thereby fostering human capital development (Adams & Page, 2005). (Acharya & Leon-Gonzalez, 2019) found that remittances positively impact Nepal's GDP, particularly by increasing household spending and small-scale investments.

However, remittance dependency has structural drawbacks. Chami et al. (2003) argue that remittance inflows discourage labour market participation, reducing productivity and creating a consumption-driven economy rather than an investment-led one. Pant (2008) found that in Nepal, remittances are largely used for consumption rather than productive investments, limiting their long-term contribution to GDP growth. Additionally, remittance inflows are highly vulnerable to external shocks, such as recessions in labour-exporting countries, making Nepal's economy externally

dependent and susceptible to fluctuations (World Bank, 2020).This study builds upon these findings by examining whether remittances Granger-cause GDP growth in Nepal. By using impulse response functions and variance decomposition analysis, the study assesses the short-term and long-term impact of remittance inflows on economic stability and capital formation.

Investment is a fundamental driver of economic growth, as emphasized by theories of capital accumulation (Harrod, 1939; Solow, 1956). Higher investment increases productivity, expands production capacity, and fosters innovation. However, in Nepal, empirical studies indicate inefficiencies in capital utilization, leading to a weak investment-growth relationship.

Dahal et al. (2024) found that Nepal's GFCF has not significantly contributed to GDP growth, largely due to policy instability, bureaucratic inefficiencies, and delays in project execution. (Majagaiya, 2009) similarly argued that foreign direct investment (FDI) inflows have remained low, limiting Nepal's ability to leverage capital for industrial expansion.

Empirical studies on Nepal highlight the challenges of translating investment into economic growth. While the government has made efforts to attract foreign direct investment (FDI) and enhance domestic capital formation, bureaucratic inefficiencies, policy instability, and infrastructure bottlenecks hinder investment effectiveness (Majagaiya, 2009). Financial development and trade openness are significant predictors of FDI in Nepal (Mishra & Paneru, 2021). Dahal et al. (2024) find that Nepal's GFCF has not translated into significant GDP growth due to delays in project execution and inefficiencies in public sector investments.While previous research has explored the relationships between GDP, trade, remittances, and investment in Nepal, several gaps remain. First, many studies focus on individual components rather than their combined effects on economic growth. Second, there is limited research using updated data spanning the past five decades, which is crucial for capturing Nepal's evolving economic structure. Third, most existing studies do not incorporate advanced econometric techniques like variance decomposition and impulse response functions to analyze the dynamic interactions among these variables.

The study uses a VAR model to analyse Nepal's economy from 1975 to 2023, revealing how GDP shocks affect trade, investment, and remittance flows. The findings suggest the need for structural reforms to improve trade competitiveness, investment efficiency, and remittance utilization for sustainable economic development. The study also highlights the need for capital efficiency and investment attraction. Despite exports and investment being key drivers of economic growth, their impact is limited due to structural inefficiencies and trade imbalances. Remittances sustain GDP but their long-term role in productive investment remains uncertain.

The literature suggests that while exports and investment are key drivers of economic growth in many countries, their impact in Nepal remains limited due to structural inefficiencies and trade imbalances. Remittances play a crucial role in sustaining GDP, but their long-term contribution to productive investment remains uncertain. This study contributes to the growing body of research on Nepal's economy by providing empirical evidence on the interdependencies among macroeconomic variables and proposing policy recommendations to enhance economic resilience.

Methodology

The study analyzed macroeconomic variables from the Ministry of Finance's annual data from 1975 to 2023, including Gross Domestic Product (RGDP), Exports, Imports, Remittances, and GFCF. The variables were calculated in real terms using the GDP deflator 2011(=100) and analyzed using various econometric parameters. The unit root test was used to integrate variables in a specific order and convert them into log format, reducing

heteroskedasticity and the natural logarithmic values of the variables were used for percentage interpretation.

All of the variables in this study are non-stationary at the data level but stationary at the first difference. So, we can run a cointegration test. The outcome demonstrates that cointegration is absent, which indicates that there isn't a long-run relationship.Therefore, we should use the Vector Autoregressive (VAR).

To evaluate causation in the Granger sense, VAR models are traditionally used. The first difference VAR framework's Granger causality test will be incorrect in the presence of cointegration (Engle and Granger, 1987). The study's entire set of data is in logarithmic form. As the log transformation shrinks the scale in which the variables are measured, it can lessen the problem of heteroscedasticity (Gujrati, 2004).

Results and Discussion

Vector Autoregressive (VAR)

The guideline suggests that if there is no cointegration after the Johansen test of cointegration among variables, an unrestricted VAR model must be run. In this method, all the variables are taken as dependent variables. Sims (1980) made VAR models in economics popular. One of the most effective, adaptable, and simple methods for the study of multivariate time series is the vector autoregression (VAR) model. The VAR model is particularly effective for forecasting and characterizing the dynamic behaviour of economic and financial time series. It frequently offers forecasts that are better than those from complex simultaneous equations models and univariate time series models. Typically, forecast error variance decompositions are used to summarize these causal effects. If three different time series variables denoted by Yt1, Yt2, and Yt3 are measured then the model will be like as shown below. VAR (1) denotes the vector autoregressive model of order 1

$$Y1,t = C1 + L1,1\ Y1,\ t-1 + L1,2\ Y2,t-1 + L1,3\ Y3,t-1 + e1,t$$

$$Y2,t = C2 + L2,1\ Y1,\ t-1 + L2,2\ Y2,t-1 + L2,3\ Y3,t-1 + e2,t$$

$$Y3,t = C3 + L3,1\ Y1,\ t-1 + L3,2\ Y2,t-1 + L3,3\ Y3,t-1 + e3,t$$

The general form of the VAR model is expressed as:

$$Y_t = C + \sum_{p=1}^{p-1} A_i Y_{t-i} + \epsilon_t$$

Where,

- Yt is the vector of endogenous variables at time t.
- C is a vector of constants.
- Ai are coefficient matrices for lag i.
- εt is an error term.
- p is the optimal lag length determined by lag selection criteria.

Granger causality based on the VAR model

Several tests related to the causality test approach were created later in the literature. One of the oldest techniques for measuring the causal effect from time series observations is Granger causality. Traditionally, calculating VAR models is used to assess causality in the Granger sense.

Several empirical researches have been carried out in the past to investigate the link between the three variables. However, there doesn't appear to be agreement on the relationship between imports and exports causative axes. There is a bi-directional causal relationship for some countries, but not for others. However, some countries have a one-way causality from imports to exports, while others experience the opposite causality from exports to imports.To examine the causal relationships among variables, the Granger causalitytest is performed using the following equation for each pair of variables (X and Y):

$$Y_t = \sum_{i=1}^{p} \lambda_i X_{t-i} + \sum_{j=1}^{p} \theta_j Y_{t-j} + \epsilon_t$$

If the coefficients λiare jointly significant, then X Granger causes Y.

Impulse Response Function (IRF) and Variance Decomposition (VD)

The Impulse Response Function (IRF) measures the impact of a shock on other variables over time, while the Variance Decomposition (VD) quantifies the proportion of forecast error variance in each variable due to shocks in itself and other variables.

Stationarity Test

The unit root test was used to test stationarity at a 1% level of significance. The Augmented Dickey-Fuller (ADF) and Phillip and Perron (PP) tests, two asymptotically comparable methods are used to find unit roots in the data (Dickey & Fuller, 1979) Phillips and Perron, 1988). Integration differed in the case of non-stationarity of the variables. Therefore, each variable is employed at its level of stationarity. Gujarati (2004) specifies the following for the unit root test:

$$\Delta Yt=\beta_1+\beta_{2t}+\delta Y_{t-1}+\sum\infty\, i\Delta Y_{t-i}+\varepsilon_t$$

Model Specification

GDPt= f (export, import,gfcf,remittance)

The function is transformed into a log-linear econometric format:

$$\log (RGDP)_t = \beta_0 + \beta_1 \log (export)_t + \beta_2 \log (import)_t + \beta_3 \log (gfcf)_t + \beta_4 \log (remittance) t + \varepsilon_t \ldots(i)$$

Where,

β_0: The constant term.

β_1: Coefficient of variable (log exports)

β_2: Coefficient of variables (log imports)

β_3: Coefficient of variables (log gfcf)

β_4: Coefficient of variables (log remittance)

t: The time trend.

ε: The random error term.

Unit Root Test

The summary output of the Augmented Dickey-Fuller (ADF) test for unit root is presented below:

Table 1

Augmented Dickey-Fuller (ADF) Test for Unit Root

Variables	Level		First Difference	
	t-stat	p-value	t-stat	p-value
LRGDP	0.2120	0.9707	-6.8414	0.000*
LEXP	-1.6366	0.4564	-6.0188	0.000*
LIMP	-1.4523	0.5489	-6.5240	0.000*
LGFCF	-1.0078	0.7433	-7.9911	0.000*
LREMIT	-0.3495	0.9093	-7.6736.	0.000*

Note. * indicates rejection of null hypothesis at a 1 per cent level of significance (Author's calculation)

The ADF test results indicate the presence of unit roots at the level form for all three variables: the logarithm of real GDP (lrgdp), the logarithm of exports (lexp), the logarithm of imports (limp), the logarithm of remittances (lremit), and the logarithm of gross fixed capital formation (lgfcf). The test statistics and p-values suggest non-stationarity in levels. However, after first differencing, all variables become stationary, as indicated by significant p-values and strongly negative t-statistics. This demonstrates the appropriateness of using a VAR model and suggests the data is integrated into order 1, i.e., I (1)

Table 2

Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	137.8853	NA	1.87e-09	-5.906013	-5.705273	-5.831179
1	360.4424	385.7656*	2.90e-13*	-14.68633*	-13.48189*	-14.23732*
2	372.2456	17.83604	5.45e-13	-14.09981	-11.89166	-13.27663
3	398.8826	34.33207	5.66e-13	-17.17256	-10.96072	-12.97522
4	429.2545	32.39671	5.61e-13	-14.41131	-10.19577	-12.83980

Note. Author's calculation

As shown in the above table, asterisk is marked on 1 lag of all criteria. It means that all lag selection criteria suggest to be selected one lag.

Johansen Cointegration Test

The unit root test shows that real GDP, Exports, Imports, Remittances, and GFCF are nonstationary at the level and stationary at the first difference. The Johansen cointegration test results, allowing for the deterministic trend in the cointegration equation with one lag ordering lrgdp, remit, and lgfcf, are presented in Tables 2 and 3.

Table 3

Cointegration Test Results (Unrestricted Cointegration Rank Test [Trace])

Hypothesised No.of CE(s)	Trace Statistic	0.05Critical Value	p-value
None	59.01801	69.81889	0.2668
At most 1	34.78652	47.85613	0.4593
At most 2	17.90178	29.79707	0.5734
At most 3	7.776328	15.49471	0.4896
At most 4	0.964970	3.841465	0.3259

Note. *Trace test test indicates no cointegration at the 0.05 level

Table 4

Cointegration Test Results (Unrestricted Cointegration Rank Test [Maximum Eigenvalue])

Hypothesised No.of CE(s)	Max-Eigen Statistic	0.05 Critical Value	p-value
None	24.23149	33.87687	0.4388
At most 1	16.88473	27.58434	0.5899
At most 2	10.12545	21.13162	0.7328
At most 3	6.811358	14.26460	0.5117
At most 4	0.964970	3.841465	0.3259

Note. *Max-eigenvalue test indicates no cointegration at the 0.05level (Author's calculation)

The Unrestricted Cointegration Rank Test (Trace) and Maximum Eigenvalue tests were used to test the cointegration of a model. The Trace test was used to determine the number of cointegrating equations, and the results were compared. For a model with no cointegrating equations, the Trace statistic was 59.01801, less than the critical value of 69.81889 at the 5% significance level. For other models, the Trace statistic was below the critical values, indicating no evidence of cointegration at

these levels. The Maximum Eigenvalue test was used to determine the number of cointegrating equations, and the results were also below the critical values, indicating no evidence of cointegration. In conclusion, both the Trace and Maximum Eigenvalue tests failed to reject the null hypothesis of no cointegration at the 5% significance level, suggesting that the variables in the model do not share a long-term equilibrium relationship.

Table 5

Standard Var

	LRGDP	LEXP	LIMP	LGFCF	LREMIT
LRGDP (-1)	0.741578	-0.015295	0,012852	0.090824	0.307255
	(0.10923)	(0.15621)	(0.08409)	(0.06026)	(0.17327)
	[6.78887]	[-0.09791]	[0.15284]	[1.50721]	[1.77322]
LEXP (-1)	-0.202829	0.932968	0.091564	-0.033408	0.241342
	(0.07087)	(0.10135)	(0.05456)	(0.03910)	(0.11242)
	[-2.86188]	[9.20508]	[1.67825]	[-0.85449]	[2.14673]
LIMP (-1)	0.416106	-0.020060	0.570876	0.234533	0.127489
	(0.22708)	(0.32475)	(0.17481)	(0.12527)	(0.36021)
	[1.83240]	[-0.06177]	[3.26565]	[1.87219]	[0.35393]
LGFCF (-1)	-0.234842	0.261446	0.466821	0.549771	-0.386060
	(0.31660)	(0.45276)	(0.24372)	(0.17465)	(0.50221)
	[-0.74177]	[0.57745]	[1.83333]	[3.14779]	[-0.76873]
LREMIT (-1)	0.089902	-0.101875	-0.022718	0.040636	0.885384
	(0.03729)	(0.05332)	(0.02870)	(0.02057)	(0.05915)
	[2.41113]	[-1.91056]	[-0.79148]	[1.97559]	[14.9695]
C	0.860880	-0.325797	-0.347388	0.489870	-0.762501
	(0.33341)	(0.47681)	(0.25667)	(0.18393)	(0.52888)
	[2.58202]	[-0.68329]	[-1.35345]	[2.66334]	[-1.44172]
R-squared	0.984199	0.919896	0.989143	0.992841	0.988056
Adj-R squared	0.982317	0.910359	0.987851	0.991989	0.986634

Note. Author's calculation

The analysis reveals significant persistence across all dependent variables, with their lagged values strongly influencing each other. Real GDP (LRGDP) is primarily driven by past values, with a 1% increase in past GDP leading to a 74.16% increase in current GDP. Lagged remittances (LREMIT) positively and significantly impact GDP, with a 1% increase in remittances leading to an 8.99% rise in GDP. Exports (LEXP) exhibit high autocorrelation, with a 1% increase in past exports resulting in a 93.29% increase in current exports. Imports (LIMP) display moderate persistence, with a 1% increase in past imports leading to a 57.08% increase in current imports. Gross Fixed Capital Formation (LGFCF) is strongly autocorrelated, with a 1% increase in past GFCF leading to a 54.97% rise in current GFCF. Remittances (LREMIT) remain stable over time, with a 1% increase in past remittances leading to a 76.25% rise in current remittances. GDP weakly influences remittances, indicating a potential link between economic growth and remittance inflows. Overall,

the results highlight the interconnectedness and persistence of key economic variables.

The study reveals that variables like GDP, exports, imports, capital formation, and remittances are strongly influenced by their lagged values, indicating autocorrelation and stability over time. Remittances significantly impact GDP, reaffirming their importance to Nepal's economic growth. GDP significantly influences exports and weakly influences imports, suggesting trade activities stimulated by economic growth. However, GDP has an insignificant effect on gross fixed capital formation, suggesting potential inefficiencies in translating growth into domestic investments. Remittances positively and significantly impact GDP, highlighting variables' persistence and importance in Nepal's economic growth.

Model Identification: VAR Model with substituted coefficients

lrgdp = 0.74 *lrgdp(-1)-0.20* lexp (-1)+ 0.41*limp(-1) - 0.23*lgfcf(-1) + 0.08*lremit(-1) + 0.86

lexp = -0.01*lrgdp(-1) + 0.93*lexp (-1) -0.02*limp(-1) + 0.26*lgfcf (-1) -0.10*lemit(-1) - 0.32

limp = 0.01*lrgdp(-1) + 0.09*lexp (-1) + 0.57*limp(-1) + 0.44*lgfcf (-1) - 0.02*lremit(-1) - 0.34

lgfcf = 0.09*lrgdp(-1) - 0.03*lexp (-1) + 0.23*limp(-1) + 0.54*lgfcf (-1) + 0.04*lremit(-1) + 0.48

lrremit = 0.30*lrgdp(-1)+ 0.24*lexp (-1)+ 0.12 * limp(-1) -0.38*lgfcf (-1) + 0.88*lremit(-1) - 0.76

Table 6

Causality Test Results

Null Hypothesis	Obs	F-Statistic	Prob.
LEXPdoes not Granger Cause LRGDP	48	0.08512	0.7718
LRGDP does not Granger Cause LEXP		0.04161	0.8393
LIMPdoes not Granger Cause LRGDP	48	3.09457	0.0854
LRGDP does not Granger Cause LIMP		1.81358	0.1848
LGFCFdoes not Granger Cause LRGDP	48	3.46763	0.0691
LRGDP does not Granger Cause LGFCF		1.34545	0.2522
LREMIT does not Granger Cause LRGDP	48	4.773069	0.0349
LRGDP does not Granger Cause LREMIT		0.29942	0.5869
LIMPdoes not Granger Cause LEXP	48	0.21035	0.6487
LEXP does not Granger Cause LIMP		0.03578	0.8508
LGFCFdoes not Granger Cause LEXP	48	0.14139	0.7087
LEXP does not Granger Cause LGFCF		0.00138	0.9705
LREMIT does not Granger Cause LEXP	48	0.25595	0.6154
LEXP does not Granger Cause LREMIT		7.47325	0.0089
LGFCF does not Granger Cause LIMP	48	3.36709	0.0731
LIMP does not Granger Cause LGFCF		0.28125	0.5985
LREMIT does not Granger Cause LIMP	48	0.43222	0.5143
LIMP does not Granger Cause LREMIT		3.41705	0.0711
LREMIT does not Granger Cause LGFCF	48	3.82234	0.0568
LGFCF does not Granger Cause LREMIT		1.20429	0.2763

Note. Author's calculation

The study found no significant causality between exports and GDP in either direction. Imports did not show a significant causality at a 10% level, but it was significant at a 10% level. Gross Fixed Capital Formation (LGFCF) did not show a significant causality at a 10% level, but no causality in reverse. Remittances did not show a significant causality at a 10% level, but GDP did not cause remittances. Other findings showed no significant causality between imports and exports, capital formation and exports, remittances and imports, and remittances and capital formation. The study concluded that remittances granger cause GDP, but GDP does not granger cause remittances. The study also found no significant causality between other variables at the 5% level. The findings suggest that remittances significantly affect GDP, while imports and capital formation do not.The study reveals that remittances significantly influence Nepal's economic growth, likely due to their impact on household consumption, investments, and government revenue. However, there is weak evidence that imports and gross fixed capital formation granger cause GDP, suggesting the need for further investigation or policy focus. There is no significant Granger causality in the reverse direction, suggesting that economic growth in Nepal does not directly drive increases in remittances, imports, or capital investment. Exports and GDP have no Granger causal relationship, suggesting that exports may not yet significantly drive Nepal's economic growth. The limited interdependence among these variables indicates that Nepal's economy might be segmented, with insufficient linkages between remittances, trade, and domestic investment. Overall, the study underscores the dominant role of remittances in driving Nepal's economic growth, the underutilised potential of trade and investment, and the need for structural reforms to make economic linkages more robust.

Table 7

Causality Test Results

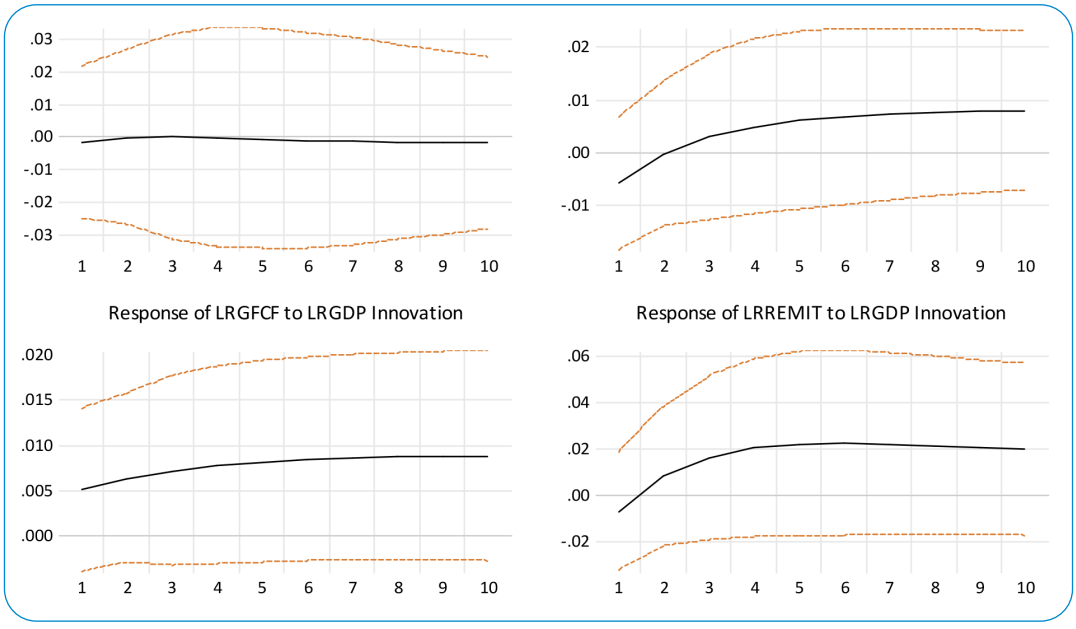
	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	3.659105	0.3735580	9.794700	0.0000
C(2)	0.860787	0.125495	6.859108	0.0000
C(3)	2.948880	0.306303	9.627316	0.0000
C(4)	2.775100	0.285330	9.725941	0.0000
C(5)	5.791097	0.599228	9.664260	0.0000
C(6)	0.620648	0.063345	9.797929	0.0000
C(7)	0.354639	0.043303	8.166664	0.0000
C(8)	0.206383	0.026378	7.812597	0.0000
C(9)	0.485206	0.083934	5.780798	0.0000
C(10)	0.165757	0.016918	9.797952	0.0000
C(11)	0.102693	0.011982	8.570910	0.0000
C(12)	-0.145168	0.066129	-2.195218	0.0281
C(13)	0.040223	0.004105	9.797957	0.0000
C(14)	0.232426	0.059923	3.878715	0.0001
C(15)	0.381246	0.038911	9.797957	0.0000

Note. Author's calculation

The analysis reveals that most coefficients in the model are highly significant, with p-values less than 0.01, indicating robust relationships between variables. Coefficients C(1) to C(10) exhibit extremely low p-values (p=0.0000), underscoring their statistical significance, while C(13), with a p-value of 0.0281, remains significant at the 5% level. Coefficients C(14) and C(15) are also important at the 1% level. None of the coefficients appears insignificant, although C (13) has a relatively higher p-value. Positive coefficients such as C(1) (3.659105) and C(5) (5.791097) indicate strong direct positive effects and structural impacts, whereas negative coefficients like C(12) (-0.145168) suggest inverse relationships. Larger coefficient magnitudes reflect stronger structural impacts. The model's robustness, evidenced by low p-values, highlights the interconnected dynamics of variables, offering policy insights into reinforcing effects, trade-offs, and constraints within the system.

Figure 1

IRF in Graph



Note. Author's calculation

The image depicts Impulse Response Functions (IRFs) from a Vector Autoregressive (VAR) model, which analyzes how a one-standard-deviation shock affects other variables in a system over time. The responses of exports (LOGEXP), imports (LOGIMP), gross fixed capital formation (LGFCF), and remittances (LREMIT) to innovations in real GDP (LRGDP) are shown.

Exports response to a GDP shock is initially negative but remains close to zero over the 10 periods, suggesting little to no significant impact on exports in the short or medium term. Imports respond positively and increase over time, indicating that a positive innovation in real GDP leads to higher imports. The response stabilizes after around 4 periods and remains within the confidence bands, indicating significance.

Gross fixed capital formation (LGFCF) responds positively to a GDP shock and grows steadily over time, suggesting that a higher GDP leads to increased investment. This highlights a feedback mechanism where economic growth

promotes further capital formation. The response stabilizes after around 6 periods and lies within the confidence bands, indicating a significant and persistent impact.

Key takeaways from the image are that imports and investment respond positively to GDP innovations, suggesting strong linkages between economic growth, investment, and external trade demand. Exports are unaffected by GDP innovations, indicating that GDP fluctuations might not directly influence export performance in the short or medium term. Remittances have a mixed response, with an initial decline in remittances following GDP growth, recovering and stabilizing positively over time. The impulse response function In Table 7.

Table 8

IRF in Table

Period	LEXP	LIMP	LGFCF	LREMIT
1	-0.001611	-0.005732	0.005129	-0.007071
	(0.01163)	(0.00623)	(0.00446)	(0.01288)
2	-0.000188	-0.000243	0.006360	0.007956
	(0.01345)	(0.00685)	(0.000462)	(0.01501)
3	0.000102	0.002992	0.007211	0.016155
	(0.01570)	(0.00784)	(0.00519)	(0.01770)
4	-0.000142	0.004923	0.007795	0.020301
	(0.01677)	(0.00831)	(0.00545)	(0.01922)
5	-0.000586	0.006091	0.008195	0.022071
	(0.01693)	(0.00843)	(0.00556)	(0.01986)
6	-0.001047	0.006813	0.008466	0.022480
	(0.01653)	(0.00834)	(0.00561)	(0.01993)
7	-0.001434	0.007270	0.008646	0.022138
	(0.01584)	(0.00815)	(0.00564)	(0.01970)
8	-0.001706	0.007570	0.008757	0.021415
	(0.01498)	(0.00792)	(0.00567)	(0.01932)
9	-0.001854	0.007776	0.008816	0.020529
	(0.01406)	(0.00768)	(0.00571)	(0.01891)
10	-0.001886	0.007922	0.008836	0.019610
	(0.01311)	(0.00747)	(0.00576)	(0.01851)

Note. Author's calculation

The study reveals a mixed short-term economic impact of a shock on exports, imports, and remittances. Exports show a mild negative response, with little variation over time. Imports initially respond negatively but rebound over time, showing a positive trend in the long term. Gross capital formation benefits from the shock, reflecting enhanced investment activity over time. Remittances initially decrease but recover quickly and show sustained positive growth over the long term. The shock has a small negative immediate effect on exports, with a small magnitude that stabilises over time. Imports show an initial negative response, followed by a rebound into positive territory, reflecting a recovery and growth in import activity in the long run. Remittances

show an initial decline, followed by a robust recovery and positive growth over time. The overall economic impact is a mixed situation, with some variables recovering and showing positive trends in the long term, while others, like exports, experience persistent negative impacts.

Table 9

Variance Decomposition Function of LEXP

Period	S.E.	LRGDP	LEXP	LIMP	LGFCF	LREMIT
1	0.056356	0.039938	99.96006	0.000000	0.000000	0.000000
2	0.070541	0.021450	98.68346	0.185659	0.456503	0.652924
3	0.079986	0.015257	96.30526	0.659471	1.184032	1.835979
4	0.087470	0.012271	93.25927	1.382491	2.047939	3.298024
5	0.093767	0.011803	89.87623	2.280600	2.972547	4.858824
6	0.099229	0.014301	86.41937	3.275640	3.900717	6.389972
7	0.104082	0.019602	83.08673	4.299528	4.788253	7.805884
8	0.108488	0.026908	80.01419	5.299276	5.603688	9.055935
9	0.112562	0.035143	77.28334	6.237357	6.327547	10.11661
10	0.116387	0.043267	74.93199	7.089915	6.950618	10.98421

Note. Author's calculation

The short-term impact of exports on the economy is primarily driven by their shocks, with a significant contribution from other variables. However, the influence of other variables such as LRGDP, LIMP, LGFCF, and LREMIT begins to grow over time. LIMP explains 7.09% of the variance by period 10, while LGFCF contributes 6.95%, indicating the link between investment and exports. LREMIT explains 10.98%, indicating remittances play an increasing role in influencing exports over time. Real GDP shocks account for a small but gradually increasing proportion of exports' variance, suggesting that GDP shocks do not significantly drive exports. The analysis indicates that exports are initially self-driven but become increasingly influenced by external trade, investment, and remittances in the medium to long term.

Table 10

Variance Decomposition Function of LIMP

Period	S.E.	LRGDP	LEXP	LIMP	LGFCF	LREMIT
1	0.080593	1.745846	9.799333	88.45482	0.000000	0.000000
2	0.110719	1.001346	13.47138	81.78572	3.620473	0.121078
3	0.131541	0.928430	15.67199	76.88931	6.330765	0.179504
4	0.147237	1.183001	16.95546	73.83379	7.847688	0.180065
5	0.159525	1.576899	17.67770	71.94727	8.639657	0.158465
6	0.169325	2.021220	18.05688	70.75037	9.029753	0.141774
7	0.177203	2.475886	18.22942	69.95354	9.193482	0.147675
8	0.183542	2.923641	18.28148	69.38390	9.223933	0.187045
9	0.188623	3.357563	18.26757	68.93686	9.172301	0.265708
10	0.192666	3.775194	18.22207	68.54872	9.068485	0.385536

Note. Author's calculation

In the first period, imports (LIMP) dominate the variance, accounting for 88.45% of the forecast error variance. Exports (LEXP) contribute to 9.80% of this variance, while real GDP (LRGDP), LGFCF, and LREMIT have negligible impacts. However, the influence of LIMP declines from 81.79% in period 2 to 71.95% in period 5. Other variables, such as LGFCF, increase, with LRGDP and LREMIT having minor but growing impacts.

In periods 6-10, LIMP's contribution stabilizes around 68-69%, indicating that imports retain a significant share of their variance over the long term. LGFCF contributes around 9%, reflecting the consistent role of investment in explaining imports. LRGDP continues to grow, contributing 3.77% by period 10, and LREMIT begins to show a notable contribution, increasing from 0.12% in period 2 to 0.38% in period 10.

In summary, imports are primarily self-driven in the short term, with minor contributions from exports. Over time, the influence of other variables, particularly exports and investment, grows, suggesting that imports are significantly influenced by external trade and investment in the medium to long term.

Table 11

Variance Decomposition Function of LGFCF

Period	S.E.	LRGDP	LEXP	LIMP	LGFCF	LREMIT
1	0.043384	2.721475	0.622960	38.11749	58.53808	0.000000
2	0.057336	4.230224	0.664634	48.42630	45.87184	0.807006
3	0.067155	5.672959	0.805520	53.89413	37.48344	2.143957
4	0.074751	6.995650	1.058769	56.52264	31.72156	3.701379
5	0.080901	8.178983	1.431755	57.54491	27.53030	5.314047
6	0.086037	9.218622	1.925289	57.64727	24.32818	6.880639
7	0.090431	10.11888	2.533794	57.22226	21.78995	8.335120
8	0.094263	10.88912	3.245977	56.50500	19.72312	9.636786
9	0.097663	11.54135	4.046021	55.64146	18.00635	10.76482
10	0.100723	12.08856	4.915123	54.72387	16.55881	11.71364

Note. Author's calculation

The short-term dynamics of LGFCF show that it is self-driven in the short term, with 58.54% of variance explained by its shocks. Imports (LIMP) are the second-largest contributor, accounting for 38.12% of the variance. Real GDP (LRGDP) initially plays a minor role, but grows consistently, indicating a stronger link between GDP and investment. Remittances (LREMIT) have almost no influence in the first period but start contributing from period 2. In the medium term, imports account for 57.65% of the variance, while LGFCF's share drops to 24.32%. Real GDP continues to grow, with remittances explaining 6.88% of LGFCF's variance. In the long term, imports maintain a strong influence, contributing around 54-56% of the variance. Real GDP explains 12.09% of the variance by period 10, emphasizing its critical long-term impact on investment. Remittances play a crucial role in the long term, underlining their importance as a source of funding for investment activities.

Table 12

Variance Decomposition Function of LREMIT

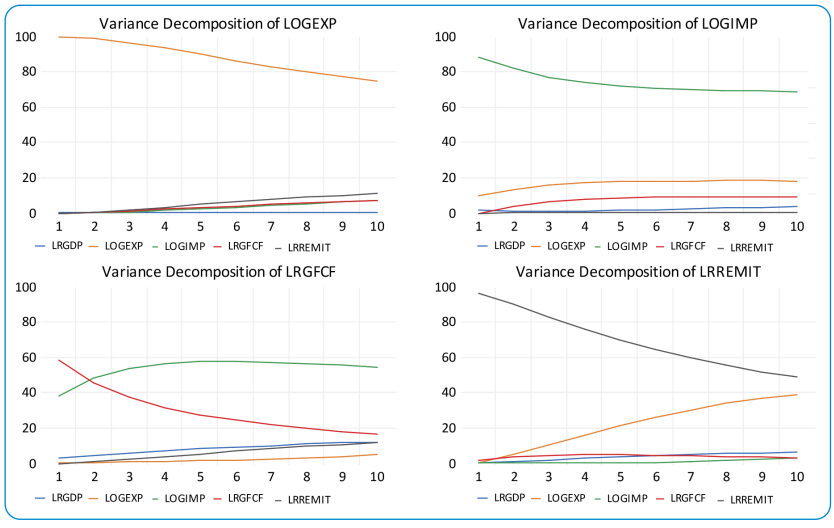
Period	S.E.	LRGDP	LEXP	LIMP	LGFCF	LREMIT
1	0.031089	0.625634	0.558022	0.392992	1.919867	96.50348
2	0.039725	0.743307	4.776910	0.543365	3.670573	90.26585
3	0.045752	1.695014	10.24604	0.493839	4.638191	82.92691
4	0.050656	2.763391	15.91669	0.387802	4.944133	75.98798
5	0.054917	3.709599	21.29328	0.361120	4.835117	69.80089
6	0.058765	4.478496	26.13111	0.504457	4.516907	64.36903
7	0.062328	5.077875	30.31107	0.863035	4.131093	59.61692
8	0.065682	5.534083	33.79153	1.445379	3.764453	55.46456
9	0.068876	5.876291	36.58537	2.233897	3.462941	51.84150
10	0.071938	6.131137	38.74352	3.195029	3.244364	48.68595

Note. Author's calculation

The short-term dynamics of remittances show that LREMIT dominates, explaining 96.50% of the variance in periods 1-3. However, this dominance declines over time, dropping to 82.93% in period 3. Investment has the second-largest influence, with LGFCF (investment) having a minor contribution. In the medium term, exports become more influential, explaining 26.13% of the variance in remittances by period 6. However, LREMIT's share drops and real GDP explains 4.47% of the variance in period 6. In the long term, exports dominate, explaining 38.74% of the variance, surpassing all other variables except LREMIT. LREMIT's self-dependence declines further, and GDP continues to play a role, accounting for 6.13% of the variance in period 10. LGFCF and LIMP remain minor contributors, while imports gradually gain significance. The analysis suggests that remittance flows are partly influenced by economic performance, with GDP playing a significant role in the long run.

Figure 2

IRF in Graph



Note. Author's calculation

The Cholesky variance decomposition analysis reveals that while each variable initially is influenced by its shocks, GDP (LRGDP) becomes a dominant factor over time in explaining the variance of exports, imports, capital formation, and remittances. This suggests that economic growth (captured by GDP) has a cascading impact on other macroeconomic indicators.

The initial observation shows that LOGEXP (logarithmic exports) is almost entirely explained by its shocks (close to 100%), with other variables (LRGDP, LRGCF, and LRREMIT) contributing negligibly. Over time, the share of variance explained by LOGEXP decreases, dropping from 100% to about 80% by period 10. The contribution of LRGDP gradually increases, rising to approximately 15–20% by period 10. Contributions from LRGCF and LRREMIT remain relatively low, with LRGCF contributing slightly more than LRREMIT by period 10.

Over the long term, shocks to GDP (LRGDP) become critical in explaining the variance in imports (LOGIMP), showing a strong economic relationship. Shocks to LRGCF (likely representing gross capital formation) explain about 70–80% of its variance, while LRGCF (green line) already plays a noticeable role, contributing around 15–20%.

The growing influence of GDP (LRGDP) on exports, imports, capital formation, and remittances highlights a tightly interconnected economic system where GDP shocks propagate through multiple channels. The analysis supports the idea that economic growth (captured by GDP) has a cascading impact on other macroeconomic indicators.

Table 13

Autocorrelation Test Results

Null hypothesis: No serial correlation at lag h				
Lag	LRE* Stat	Df	Rao F-stat	Prob.
1	18.83748	25	0.739792	0.8070
Null hypothesis: No serial correlation at lags 1 to h				
Lag	LRE* Stat	Df	Rao F-stat	Prob.
1	18.83748	25	0.739792	0.8070

Note. Author's calculation

The p-value of 0.8070 is higher than conventional significance levels, indicating no significant serial correlation in residuals at lag h or 1 to h. Thus, the model's validity is supported, and autocorrelation is prevented.

Table 14

Serial Correlation Test results

F-statistic	0.257914	Prob. F(1,41) 0.6143
Obs* R-squared	0.300061	Prob. Chi-square (1) 0.5838

Note. Author's calculation

The p-value of 0.6143 is higher than conventional significance levels, indicating no serial correlation.

Table 15

Heteroskedasticity Test Results

F-statistic	2.999263	Prob. F(5,42) 0.5621
Obs* R-squared	12.6929	Prob. Chi-square(1) 0.4638

Note. Author's calculation

The p-value of 0.5621 is higher than conventional significance levels, indicating no heteroskedasticity.

Table 16

Chow Test Results

F-statistic	1.3453	Prob. F (4,41)	0.2696
Log likelihood ratio	6.0426	Prob. Chi-Square (4)	0.1960
Wald Statistic	5.3810	Prob. Chi-Square (4)	0.2504

*Note.*Author's calculation

The p-value of the F-statistic is 0.2696, greater than the 5% significance level. Therefore, the null hypothesis was accepted,meaning there is no structural break in the series.

Discussions

Mishra and Aithal (2021a&b) emphasize the critical need for Nepal to adopt policy frameworks that simultaneously optimize the effectiveness of foreign aid and harness the considerable potential of remittances in driving sustainable economic development. Their work underscores that while foreign aid remains an important external funding source, its transformative impact is often constrained by structural and administrative inefficiencies. In contrast, remittances—largely autonomous and stable inflows—play a pivotal role in supporting household welfare, consumption, and investment, thus acting as a direct engine of economic growth.

The present analysis aligns closely with these insights by employing a Vector Autoregressive (VAR) model to empirically examine the interplay among Nepal's real GDP (RGDP), exports, imports, gross fixed capital formation (GFCF), and remittances. The model's high R-squared values and significant autocorrelation coefficients across all variables reveal strong persistence and inertia within Nepal's economic structure, particularly highlighting that past performance heavily influences current and future economic outcomes.

Most notably, the findings confirm that remittances have a significant and positive effect on GDP (coefficient = 0.0899, $p < 0.05$), validating Mishra and Aithal's claim that remittances are a vital driver of Nepal's economic growth. This effect likely reflects remittances' role in augmenting household income, stimulating consumption, and facilitating investment, particularly in sectors less dependent on formal financial channels. The unidirectional Granger causality from remittances to GDP further suggests that remittance inflows are predominantly shaped by external factors — such as migrant labor market dynamics — rather than domestic economic conditions, underscoring the importance of maintaining strong labor diaspora linkages and favorable foreign labor agreements.

In contrast, the analysis reveals a negligible direct role of exports in prompting economic growth, as indicated by no significant Granger causality between exports and GDP, and exports' relative insensitivity to GDP shocks. This highlights fundamental structural challenges in Nepal's export sector, including limited product diversification, low competitiveness, inadequate infrastructure, and restricted access to international markets. These findings suggest that without

deliberate policy interventions aimed at enhancing export capabilities and value addition, Nepal's economy remains vulnerable to external shocks and overly reliant on non-trade inflows.

Imports, meanwhile, show a weak but positive and bidirectional relationship with GDP, indicating that while imports – particularly of capital goods and raw materials – contribute to economic activity, the linkages within trade flows and growth remain limited. This partial interdependence points to opportunities for improving import utilization efficiency and linking imports more directly to productive investments.

Regarding domestic investment, GFCF exhibits strong persistence over time but an insignificant short-term effect on GDP, indicating inefficiencies in translating investments into immediate economic growth. Such inefficiencies could arise from delays in project implementation, misallocation of capital, underdeveloped financial sectors, or low absorptive capacity. The weak investment-growth linkage calls for structural reforms aimed at improving project execution, boosting institutional capacities, and ensuring that investments align better with growth-oriented sectors.

Further, the variance decomposition and impulse response analyses demonstrate that GDP shocks strongly influence imports, investments, and remittances over time, emphasizing the responsiveness of these components to economic performance fluctuations. However, exports remain largely unaffected by GDP shocks, reinforcing the notion of structural disconnect between export performance and overall economic dynamics.

Bringing these insights together, it becomes evident that Nepal's economic growth depends heavily on stable remittance inflows while suffering from structural limitations in both export and investment sectors. From a policy perspective, Mishra and Aithal's call for frameworks that optimize foreign aid efficacy should incorporate strategies to improve aid coordination, reduce administrative inefficiencies, and align aid more closely with developmental priorities such as infrastructure, human capital, and institutional strengthening. Simultaneously, maximizing the development impact of remittances requires innovative financial instruments and policies to channel remittance funds into productive investments—such as microfinance, entrepreneurship, and community development projects—which can stimulate broader economic diversification and sustainability.

Moreover, addressing the stagnation in exports calls for comprehensive trade reforms, improvement of export infrastructure, diversification into high-value sectors, and enhancing supply chain integration. Investment-related inefficiencies point towards the need for better governance, project management, and investment climate reforms to ensure that capital formation translates into tangible growth outcomes.

In sum, the symbiotic management of foreign aid, remittances, and domestic investment, combined with export sector revitalization, forms the cornerstone of sustainable economic development for Nepal. The empirical findings presented reinforce this holistic strategy by revealing where strengths lie (remittances) and where targeted interventions are most urgently needed (exports and investment). These multifaceted approaches are critical for strengthening Nepal's economic resilience and achieving inclusive and sustained growth.

Conclusion

This study provides robust empirical evidence highlighting the pivotal role of remittances in driving Nepal's economic growth, as reflected in their significant positive impact on GDP through enhanced household consumption and investment. The findings underscore remittances as the most stable and influential external financial inflow supporting economic activities in Nepal. Conversely, exports and gross fixed capital formation (GFCF) fail to demonstrate

a statistically significant direct effect on GDP, indicating persistent inefficiencies within Nepal's trade sector and investment productivity. The weak bidirectional causality identified between imports and GDP signifies imports' critical function in supplying the essential inputs required for domestic production but points to limited dynamic feedback effects.

Furthermore, impulse response and variance decomposition analyses reveal that shocks to GDP have enduring effects on imports, investments, and remittance flows, whereas exports remain largely insulated from these economic fluctuations. The absence of cointegration among key economic variables suggests that Nepal's economic interactions are predominantly driven by short-term dynamics rather than long-term equilibrium relationships, reflecting a structural dependence on remittance inflows and suboptimal integration of trade and investment processes within the economy.

Overall, these insights indicate that while remittances continue to bolster Nepal's economic resilience, the limited contributions from exports and domestic capital formation hinder the country's trajectory toward sustainable and self-reliant growth. Hence, systemic inefficiencies in trade competitiveness and investment efficiency represent key bottlenecks constraining broad-based economic development.

Policy Implications

The results of this study highlight several critical avenues for policy intervention to strengthen Nepal's economic growth foundations:

Enhancing Productive Utilization of Remittances

Policymakers should design targeted mechanisms to channel remittance inflows into productive investment sectors including infrastructure development, education, health, and entrepreneurship. Financial products such as incentive-linked savings, investment matching schemes, and diaspora bonds could mobilize remittance resources more effectively, thereby amplifying their long-term developmental impact.

Promoting Export Diversification and Competitiveness

Strategic efforts are needed to diversify Nepal's export base away from traditional commodities towards higher-value, export-oriented industries. This requires strengthening supply chains, investing in quality standards, adopting technology upgrades, and facilitating better market access through trade promotion and export facilitation centers.

Improving Trade Efficiency

Addressing non-tariff barriers, enhancing transport and logistics infrastructure, streamlining customs procedures, and actively participating in regional trade agreements can reduce trade costs and increase Nepal's integration with global and regional value chains. Such measures will help unlock the growth potential of exports and imports alike.

Optimizing Investment Productivity

To overcome the observed inefficiencies in capital formation, reforms are essential to streamline regulatory frameworks, fast-track project approvals, and improve coordination among stakeholders. Encouraging public-private partnerships and strengthening institutional capacities will be crucial to ensure that capital investments translate effectively into sustainable economic outputs.

Integrating Economic Linkages through Structural Reforms

A holistic approach is required to weave together remittance, trade, and investment flows into a coherent growth strategy. Structural reforms focusing on improving governance, enhancing financial inclusion, and fostering innovation ecosystems can create synergies that boost economic dynamism and resilience.

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