

Nepal's Trade Potential: An Empirical Assessment Using the Gravity Approach

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Abstract

The gravity framework has long served as a central tool in international trade analysis, linking bilateral trade volumes to the relative economic size of countries and the geographical distance separating them. Drawing on this theoretical foundation, the present study evaluates Nepal's potential trade performance with its major commercial partners. A modified gravity specification is applied to panel data covering 46 trading partners. The model incorporates eight key explanatory variables, while Nepal's own gross domestic product (GDP) and per capita income are also included to capture domestic economic capacity. The empirical investigation relies on annual data spanning 2001–2022, obtained from the International Monetary Fund's Direction of Trade Statistics (DOTS). The final dataset consists of 924 observations across ten variables. Estimation results indicate that the economic scale of partner countries exerts a positive and statistically meaningful influence on Nepal's bilateral trade flows. Conversely, physical distance between Nepal and its trading counterparts acts as a significant constraint, reducing trade intensity.

Keywords: Bilateral Trade, Exports, Imports, Gravity Model, Panel Analysis, Trade Partners

Introduction

Nepal occupies a distinctive geopolitical and economic position as a landlocked state located between two rapidly expanding Asian economies-India and China. This geographic setting offers both opportunity and structural constraint. On one hand, proximity to large markets creates the possibility of expanded cross-border trade. On the other hand, heavy dependence on a narrow set of partners has contributed to persistent external imbalances.

Recent fiscal statistics (F.Y. 2024/25) show that nearly three-fifths of Nepal's total imports are sourced from India, while China accounts for roughly one-fifth. Export patterns are even more

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concentrated: more than four-fifths of Nepal's total exports are directed toward the Indian market. The imbalance becomes clearer when examining trade ratios. The import-to-export ratio with India is approximately 4.8, whereas trade with China reflects a substantially wider disparity, with imports vastly exceeding exports.

These figures highlight a structural trade deficit not only with Nepal's two immediate neighbors but also with several other trading partners. The persistence of this imbalance raises important questions regarding Nepal's actual trade capacity relative to its potential, as determined by underlying economic fundamentals.

Theoretical Foundations

The basic gravity model in international trade was first introduced by Walter Isard in 1954. The model is inspired by Newton's law of universal gravitation, which states that the force between two objects is positively related to their masses and negatively related to the distance between them. Similarly, the trade gravity model is used to predict bilateral trade flows between two countries (i and j) based on their economic sizes and the geographical distance between them. The basic functional form of the model is expressed as follows:

$$F_{ij} = G \frac{M_i \times M_j}{D_{ij}}$$

Where, F_{ij} is the gravitational attraction for trade flow, G is constant, $M_i \times M_j$ denotes the economic dimension of the countries and D_{ij} is the distance between two trading countries.

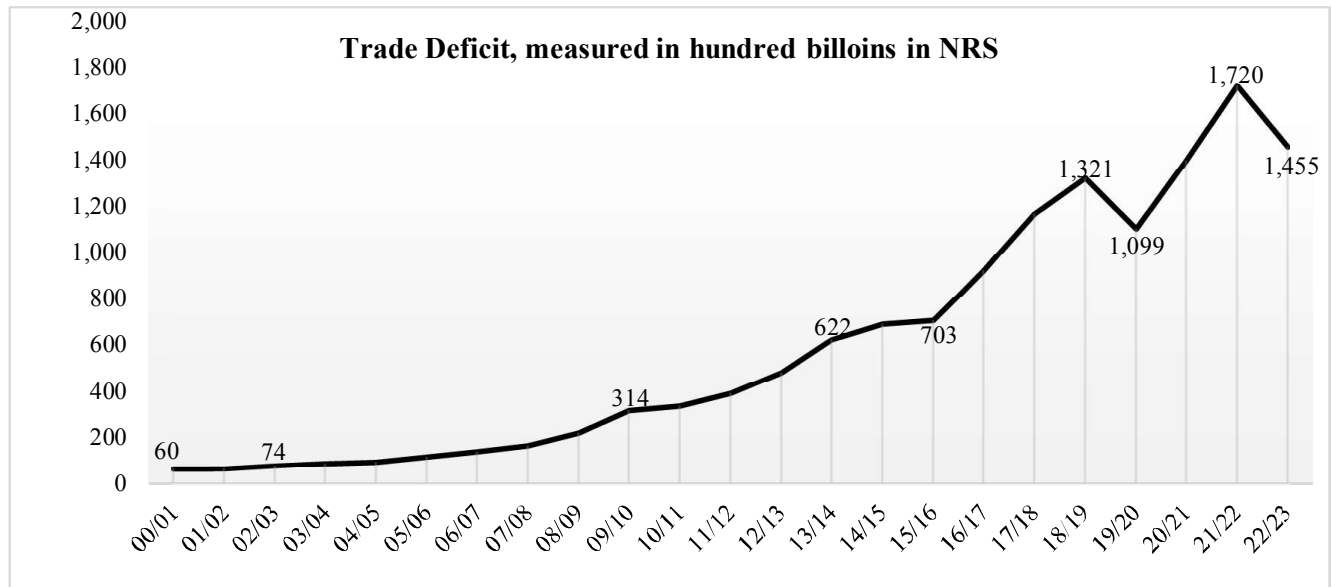
Overview of Nepal's international Trade

In macroeconomic analysis, the economy is commonly divided into four interacting spheres: households, firms, the government, and the external or foreign sector. Within this framework, international trade forms the core of the external sector, as it directly influences a nation's current account position and overall balance of payments stability. Nepal maintains trading relationships with numerous countries worldwide; however, its commercial exchanges are predominantly concentrated with India and China, which serve as its principal trading partners.

During the fiscal year 2022/23, Nepal's trade structure reflected a pronounced imbalance. The ratio of imports to exports reached 10.5, underscoring the magnitude of the country's external deficit. In monetary terms, the trade shortfall during this period accounted for roughly one-fourth of Nepal's total gross domestic product, which was approximately NPR 5.7 trillion.

The following figure illustrates Nepal's trade balance from fiscal year 2000/01 to 2022/23. Except for fiscal years 2019/20 and 2022/23, the trade deficit increased compared to the previous fiscal year, reflecting a persistent and widening imbalance in external trade.

Figure 1: Trade Deficit of Nepal



(Source: NRB, 2024)

Over the past two decades, Nepal's trade imbalance has widened markedly. At the start of the 2000s, the annual trade deficit stood at roughly NPR 60 billion (fiscal year 2000/01). By 2009/10, this figure had escalated to approximately NPR 314 billion, reflecting a dramatic expansion in external imbalance.

The deterioration became even more pronounced during the mid-to-late 2010s. Between fiscal years 2015/16 and 2018/19, the deficit surged sharply, with the latter year recording a trade gap nearly twice as large as that observed three years earlier. This rapid escalation underscores the structural nature of Nepal's external sector challenges.

Research Objective and Structure of the Study

This study investigates the structural factors shaping Nepal's international trade performance, with particular emphasis on identifying the determinants of bilateral trade flows. In addition to evaluating conventional gravity variables, the analysis considers the implications of Nepal's participation in regional and multilateral trade arrangements, specifically SAFTA and the WTO. The gravity framework serves as the principal analytical tool for isolating the drivers of trade intensity, and the resulting parameter estimates are subsequently used to gauge Nepal's unrealized trade potential with its partner economies.

At its core, the study seeks to determine whether Nepal's actual trade flows align with levels predicted by underlying economic fundamentals. To accomplish this, an adapted version of the gravity specification originally developed by Huot and Kakinaka (2007) is employed. While their framework was designed for Cambodia, several components have been recalibrated to better reflect Nepal's institutional and regional setting. Unlike Cambodia, Nepal participates in SAARC and is formally integrated into SAFTA. Accordingly, five SAARC member states that are also SAFTA signatories are incorporated into the sample covering the period 2000–2022.

Nepal offers a compelling case for gravity-based analysis due to its distinct structural profile. It is a small, open, landlocked, and least developed economy positioned between two major emerging markets—India and China. These characteristics simultaneously create opportunities for market access and constraints arising from limited domestic production capacity and transit dependence.

The remainder of the paper is organized as follows. The introductory section establishes the theoretical basis of the gravity model and outlines Nepal's trade landscape. A comprehensive review of empirical studies employing gravity specifications follows. The methodology section details the model formulation, data construction, and estimation strategy. Empirical findings are then discussed, and the paper concludes with policy-relevant observations.

Review of Literature

Empirical applications of the gravity model have consistently demonstrated its explanatory power in analyzing bilateral trade patterns across different regional contexts. Using cross-sectional data for the year 2000, Batra (2004) applied the ordinary least squares (OLS) technique and confirmed that traditional gravity variables—economic size and distance—carry both statistical and economic significance. By extending the conventional framework into an augmented gravity model, the study projected India's trade potential across global regions. The findings suggested particularly strong prospects within the Asia-Pacific region, followed by Western Europe and North America. Within regional blocs, Pakistan (SAARC) and the Philippines and Cambodia (ASEAN) emerged as promising trade partners for India.

Similarly, Boughanmi (2008) examined trade patterns between Middle East and North African (MENA) economies and their principal trading partners using pooled time-series cross-sectional data. Although intra-GCC trade volumes remained modest, the analysis indicated that newly established trade agreements possessed substantial capacity to stimulate regional trade integration.

Karagoz and Saray (2010) assessed Turkey's bilateral trade potential with 23 countries over the period 2001–2005. Their gravity-based panel estimates showed that larger economic size

significantly enhances trade flows, whereas geographical distance acts as a clear deterrent. The Asia-Pacific region was identified as a particularly dynamic trade partner group for Turkey.

In the case of Pakistan, Gul and Yasin (2011) utilized panel data for 42 countries spanning 1981–2005. Their results revealed that Pakistan's highest trade potential lay with ASEAN economies, exceeding prospects with the European Union, Middle Eastern nations, Latin America, and North America.

More recently, Masood et al. (2022) incorporated tariff variables into an augmented gravity specification to evaluate Pakistan's trade with South Asian countries. The study found that partner-country GDP and average tariff rates exerted positive effects on trade volume, whereas bilateral tariff barriers dampened trade intensity. Additional structural variables—including common language, landlocked status, and physical distance—were also shown to significantly shape trade outcomes.

Focusing on India's export dynamics, Jomit (2014) analyzed panel data covering 58 countries from 1991–2011. The results indicated that the importing country's GDP plays a decisive role in determining export performance. Furthermore, shared colonial history and participation in bilateral trade agreements were found to enhance trade flows.

With respect to Nepal, Oh and Prasai (2012) examined bilateral trade with 94 countries over a 29-year period (1981–2009). Their findings reinforced the central predictions of gravity theory: economic mass positively influences trade, while distance reduces it.

Bista and Adhikari (2021), using panel data on 21 trading partners between 2010 and 2019, demonstrated that differences in GDP and per capita income between Nepal and its partners stimulate both imports and exports. Consistent with gravity expectations, greater geographical distance was associated with lower export volumes.

Likewise, Prasai (2014) employed a 29-year panel dataset covering 94 partner countries and incorporated a one-year lag of GDP within an OLS framework. The empirical evidence aligned closely with gravity model predictions, highlighting the positive contribution of economic size and the constraining effect of distance on Nepal's trade flows.

Methodology

Data Description and Analysis Procedure

The empirical analysis relies on a panel dataset comprising 46 countries that engage in substantial bilateral trade with Nepal. These partner countries were selected on the basis of their relative importance in Nepal's overall trade structure. For each country pair, eight principal explanatory variables are included in the estimation framework. In addition, Nepal's own

macroeconomic indicators—gross domestic product (GDP) and per capita income—are incorporated to account for domestic economic capacity.

The dataset is constructed using annual observations spanning 2001 to 2022 and is drawn primarily from the International Monetary Fund's Direction of Trade Statistics (DOTS) database. The final sample contains 924 observations distributed across ten variables.

Core explanatory variables reflect the conventional gravity determinants of trade. Measures of economic size—GDP and per capita income (proxied alternatively by GNI per capita where appropriate) are included for both Nepal and its trading partners. Geographical distance between Nepal and each partner country serves as a proxy for transportation costs and other trade frictions.

To account for structural and institutional influences, several binary (dummy) variables are introduced. These include indicators for shared language, landlocked status of partner countries, participation in the South Asian Free Trade Area (SAFTA), and membership in the World Trade Organization (WTO). Collectively, these variables capture policy-related and structural conditions that may either facilitate or hinder bilateral trade flows.

The dependent variables consist of Nepal's bilateral export flows to partner countries and its corresponding import flows from those economies.

Model Identification and Specification

Within the gravity framework, bilateral trade flows—whether exports or imports—are interpreted as the economic equivalent of gravitational attraction between two countries. The “mass” component of this relationship is represented by the economic size of each country, typically measured through GDP and income per capita. In contrast, physical distance operates as a resistance factor, reflecting transportation expenses, information costs, and other barriers to trade interaction.

Guided by this theoretical structure, the selected economic and structural variables are incorporated into the empirical model. In addition to the standard gravity components, institutional and regional integration factors are controlled for through the inclusion of dummy variables. By extending the traditional gravity equation to include these broader determinants, the study adopts an augmented gravity specification capable of capturing both economic fundamentals and policy-driven influences on Nepal's bilateral trade performance.

Augmented Gravity Model

To estimate Nepal's trade potential, two different models are introduced and used. The first model examines the determinants of Nepal's exports to its trading partner countries. The second model analyzes the determinants of Nepal's imports from those countries.

$$\ln X_{it} = \alpha_0 + \beta_1 \ln(\text{GDP})_{it} + \beta_2 \ln(\text{GDP})_{jt} + \beta_3 \ln(\text{GDP per capita})_{it} + \beta_4 \ln(\text{GDP per capita})_{jt} + \beta_5 \ln(\text{Distance}_{ij}) + \beta_6 (\text{Language}_{ijt}) + \beta_7 (\text{SAFTA}_{jt}) + \beta_8 (\text{WTO}_{jt}) + \mu_{ijt}$$

and

$$\ln M_{jt} = \alpha_0 + \beta_1 \ln(\text{GDP})_{it} + \beta_2 \ln(\text{GDP})_{jt} + \beta_3 \ln(\text{GDP per capita})_{it} + \beta_4 \ln(\text{GDP per capita})_{jt} + \beta_5 \ln(\text{Distance}_{ij}) + \beta_6 (\text{Language}_{ijt}) + \beta_7 (\text{SAFTA}_{jt}) + \beta_8 (\text{WTO}_{jt}) + \mu_{ijt}$$

The variables are explained as follow:

X_{it} : the total exports volume from Nepal(i) to the partner country (j) for a year (t) in the U.S. dollar value (adjusted with the U.S. GDP deflator).

M_{jt} : the total imports volume to Nepal(i) from the partner country (j) for a year (t) in the U.S. dollar value (adjusted with the U.S. GDP deflator).

GDP_{it} : gross domestic product of Nepal(i) for a year(t) in millions of US dollars.

GDP_{jt} : gross domestic product of the partner country(j) for a year(t) in millions of US dollars.

$\text{GDP per capita}_{it}$: the gross domestic product per capita of Nepal(i) for a year(t) in US dollars.

$\text{GDP per capita}_{jt}$: the gross domestic product per capita of the partner country(j) for a year(t) in US dollars.

Distance_{ij} : the distance between the capital of Nepal (i) and the capital of the trading partner country(j), in kilometers.

Language_{ijt} : a dummy variable which takes the value '1' if the two countries share a common language, otherwise '0'.

Landlocked_j : the nature of the trading partner country (j) whether it is landlocked or not. Landlocked is a dummy variable. It is considered 1 if the country is landlocked and 0 otherwise.

SAFTA_{jt} : a dummy variable. It is considered '1' If the partner country is a member of SAFTA, otherwise '0'.

WTO_{jt} : a dummy variable. It is considered '1' If the partner country is a member of WTO, otherwise '0'.

μ_{ijt} : Residuals

Panel Estimation Strategy

The empirical analysis is conducted using panel data techniques, which allow for the simultaneous examination of cross-country and time-series variations. In panel econometrics, two principal estimation frameworks are generally considered: the Fixed Effects Model (FEM) and the Random Effects Model (REM), the latter often referred to as the Error Components Model.

The Fixed Effects approach accounts for unobservable country-specific characteristics by assigning each cross-sectional unit its own intercept. In doing so, it effectively controls for time-invariant heterogeneity across trading partners. However, when the number of cross-sectional units is relatively large, this method can significantly reduce degrees of freedom, potentially limiting estimation efficiency (Gul and Yasin, 2011).

By contrast, the Random Effects specification assumes that individual-specific effects are randomly distributed rather than fixed parameters. This framework preserves degrees of freedom and is statistically more efficient, provided that the explanatory variables are not systematically correlated with the composite error term (μ_{ijt}). Given this assumption and the structure of the dataset, the Random Effects Model is selected as the preferred estimation technique in this study.

Empirical Findings

The estimation results obtained from the gravity specification are summarized in Table 1. Under the ordinary least squares (OLS) estimation for the import equation, the model accounts for approximately 54.92 percent of the variation in bilateral trade flows. The explanatory power remains unchanged when robust standard errors (VCE robust) are applied, indicating stability in the results.

For the export equation, the model demonstrates slightly stronger explanatory capacity. Approximately 61.21 percent of the variation in export flows is explained under both the conventional OLS and the robust estimation frameworks.

Overall, these goodness-of-fit indicators suggest that the gravity model performs reasonably well in capturing the determinants of Nepal's trade flows, providing empirical support for its suitability in analyzing the country's bilateral trade structure.

Table 1: Results using by OLS and OLS with vce (robust)

Explanatory variables	OLS		OLS with vce (robust)	
	Ln(imports)	Ln (Exports)	Ln (imports)	Ln (Exports)
Ln(GDP)	1.227***	1.094 ***	1.227***	1.094 ***
Ln(GDP Per Capita)	0.057	0.294 ***	0.057	0.294 ***
Ln(GDP _i)	0.047	-0.126	0.047	-0.126
Ln(GDP Per Capita _i)	0.293	-0.510	0.293	-0.510
Ln(Distance)	-2.070***	-0.396 ***	-2.070***	-0.396 ***
Language	0.607	3.094 ***	0.607**	3.094 ***
Landlocked	-0.561**	0.165	-0.561**	0.165
SAFTA	-0.807**	2.509 ***	-0.807***	2.509 ***
WTO	-0.492	-0.597**	-0.492*	-0.597*
N	913	894	913	894
R ²	54.92%	61. 21%	54.92%	61. 21%
Adj. R ²	0.5447	0.6082	0.5447	0.6082
F	122.22 (9, 903)	155.02(9, 884)	711.46(9, 903)	208.88(9, 884)

(Source: Results of estimation in STATA)

***Significance at 10%, 5% and 1% level respectively.

**Significance at 10% and 5% level respectively.

*Significance at 10% level.

For both exports and imports, the fundamental properties of the gravity model hold well. The explanatory variables-GDP and GDP per capita of the trading partner countries-have positive coefficients, while distance has a negative coefficient. These three variables are statistically significant at the 10%, 5%, and 1% levels in both the basic OLS and robust (VCE robust) models, except in the case of imports, where the GDP per capita of the partner countries is not statistically significant at any of these levels.

The positive coefficients of GDP and GDP per capita indicate that as the economic size of the trading partner countries increases, bilateral trade volumes with Nepal also increase. Conversely, the negative coefficient for distance suggests that longer distances reduce the trade volume between Nepal and its partners.

In contrast, Nepal's own economic size (\$GDP_i) and GDP per capita (\$GDP_i per capita) have no significant positive effect on Nepal's exports, which may reflect limitations in domestic production capacity. SAFTA membership is statistically significant at the 10%, 5%, and 1% levels for both imports and exports in both OLS specifications. The results suggest that SAFTA membership positively influences Nepal's exports but negatively affects imports from

these member countries. On the other hand, WTO membership exhibits a different effect from SAFTA, indicating that broader multilateral agreements may have distinct trade impacts.

Table 2 presents the estimation results obtained using the Random Effects Model (REM) and REM with robust standard errors. These results differ noticeably from the OLS findings in Table 1. Notably, in the import estimation, the GDP per capita of trading partner countries has a negative coefficient, which contradicts the basic assumptions of the gravity model.

Table 2: Results using by REM only and REM with vce (robust)

Explanatory variables	With Random Effects Models (REM)		With Random Effects Models (REM) and vce (robust)	
	Ln(imports)	Ln(Exports)	Ln(imports)	Ln(Exports)
Ln(GDP)	1.065*	1.023*	1.065*	1.023*
Ln(GDP Per Capita)	-0.254	0.021	-0.254	0.021
Ln(GDP_i)	1.882	-1.737	1.882	-1.737
Ln(GDP Per Capita_i)	-1.449	1.639	-1.449	1.639
Ln(Distance)	-1.648*	-0.194	-1.648*	-0.194
Language	0.805	-0.029*	0.805	-0.029*
Landlocked	-0.395	5.062	-0.395	5.062
SAFTA	-0.212	-0.191	-0.212	-0.191
WTO	0.562	0.774*	0.562	0.774

(Source: Results of estimation in STATA)

*Significance at 10% level.

With the exception of the GDP per capita variable, the empirical findings largely align with the theoretical expectations of the gravity framework. Economic size, measured by GDP, remains statistically significant at the 10 percent level for both export and import equations. As anticipated, geographical distance consistently exerts a negative influence, confirming its role as a trade-impeding factor.

When comparing estimation techniques, the coefficient magnitudes obtained under the Random Effects specification are generally smaller than those derived from the baseline OLS model. For example, in the import equation, the GDP elasticity ranges between approximately 1.05 and 1.227 under the standard OLS framework. In the export equation estimated with robust standard errors, the GDP coefficient stands at 1.023. Although the strength of these effects varies slightly across specifications, their direction remains stable.

Structural characteristics also produce differentiated outcomes. The landlocked status of partner countries appears to constrain Nepal's imports, yet it does not exert a statistically meaningful effect on exports. Regional trade integration through SAFTA membership is associated with a negative relationship in the bilateral trade estimates, whereas WTO participation demonstrates a positive contribution to both export and import flows. These mixed effects suggest that

multilateral and regional trade arrangements may operate through distinct channels in shaping Nepal's trade dynamics.

Conclusion

This study explored the determinants of Nepal's bilateral trade with 46 partner countries using an augmented gravity modeling approach. The empirical evidence demonstrates that the gravity specification provides a strong explanatory framework for understanding Nepal's external trade patterns.

The analysis confirms that larger partner economies tend to generate greater trade flows with Nepal, reinforcing the central prediction of gravity theory. In contrast, physical distance continues to function as a structural barrier, reducing trade intensity between Nepal and geographically distant markets.

Taken together, the findings validate the relevance and applicability of the modified gravity model in explaining Nepal's trade behavior. They also underscore the importance of economic scale and trade costs in shaping the country's integration into the global trading system.

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