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RESEARCH PAPER

# A Panel Cointegration Analysis of Pakistan's Trade: Linkages with Regional and EU Economies

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**ABSTRACT**

This research examines the trade potential between Pakistan and its 20 major trading partners from 1990 to 2020 using a gravity model of trade. Understanding bilateral trade dynamics is essential for Pakistan, given its economic ties with regional and global partners. The study analyzes various factors, including economic, geographic, and infrastructural elements that influence trade flows and assesses cross-sectional dependencies among countries. Findings indicate that stronger economies with larger populations and developed infrastructures promote higher trade volumes. Moreover, geographical distance significantly restricts trade potential, as evidenced by the absence of cross-sectional dependency, meaning trade shocks in one nation do not impact others directly. To boost regional trade, Pakistan should invest in infrastructure and lower barriers with neighboring countries. Additionally, strengthening trade agreements with the EU could diversify exports and reduce dependency on a limited number of partners. Future research should broaden the timeframe and consider alternative econometric techniques for a deeper understanding of trade dynamics.

**KEYWORDS** Gravity, Pakistan, PMG, Population, Regional Integration, RTA

## Introduction

Global trade has experienced substantial growth in recent decades, driven by both unilateral trade liberalization and regionalism. Regional Trade Agreements (RTAs) have been instrumental in shaping the contemporary trade landscape by enhancing regional integration, which stimulates intra-regional trade and economic development (World Trade Organization [WTO], 2022). RTAs facilitate market access, reduce tariff and non-tariff barriers, and promote foreign direct investment, thereby contributing to economic growth and productivity (Baldwin, 2016). While RTAs have proven beneficial in various regions, their impact varies. For instance, intraregional trade accounts for 60% of total trade in Europe, compared to 35% in East Asia, 25% in Southeast Asia, and only 5% in South Asia (Asian Development Bank, 2020). Notable examples of successful regional integration include ASEAN, the European Union, USMCA (formerly NAFTA), and the African Union, illustrating how regional cooperation can enhance trade relations and foster economic growth (Baldwin, 2016; Cohn, 2012; Frankel, Stein, & Wei, 1998; Venables, 2003; Baier, Yotov, & Zylkin, 2019).

In response to the increasing importance of RTAs globally, South Asian countries established the South Asian Association for Regional Cooperation (SAARC) to boost regional trade and prosperity. The South Asian Free Trade Area (SAFTA) was signed in 2004 to promote trade among member states (Bhattacharya, 2021). Despite this, Pakistan's export dynamics show a stable proportion of exports to Western economies, while its exports to the UAE have decreased, with China and India capturing a larger share of the market. Notably, Pakistan faces significant competition from India and China in the agricultural sector, which affects its export performance (Ahmad, Khan, Soharwardi, Shafiq, & Gillani, 2021; Shafiq, Gillani, & Shafiq, 2021). The China-Pakistan Economic Corridor (CPEC) is expected to further influence Pakistan's trade patterns, as China remains a major source of imports (Pakistan Bureau of Statistics, 2020; State Bank of Pakistan [SBP], 2020).

This study introduces a novel approach to analyzing Pakistan's trade statistics with its major trading partners, which account for over two-thirds of the country's trade volume. Utilizing a comprehensive gravity model and the latest available data, the study seeks to address existing research gaps and offer insights into Pakistan's trade potential. The research objectives are: (1) to evaluate the extent of trade integration between Pakistan and its key trading partners; (2) to measure the long-term impacts of fundamental gravity variables on trade flow ; and (3) to examine the short-term and long-term effects of economic factors such as GDP, population size, geographical distance, RTA , and infrastructure quality, as well as non-economic factors like common borders, shared languages, ethnicity, landlocked status, and WTO membership on trade flow of trading partners. A distinctive feature of this study is its application of an advanced gravity model tailored for researchers and policymakers to assess the impact of various trade-related variables. By incorporating up-to-date data, the study enhances the accuracy and relevance of its findings. Promoting regional trade is essential for Pakistan, particularly given the region's high poverty rates and pressing challenges related to water security and climate change. Reducing trade barriers has the potential to significantly alleviate poverty and decrease unemployment, highlighting the critical importance of this research. Th present study contributes to the existing literature in many important ways. First, to the best of our knowledge, this is the first attempt to investigate regional integration of Pakistan with these economies and employ comprehensive data set and sophisticated econometric gravity model technique.

The structure of this research paper is outlined as follows: Section two provides a review of the literature concerning international trade potential, highlighting findings from various studies and detailing the methodological framework of our proposed gravity model. Section three discusses the data sources and provides an overview of the variables used in the analysis. Sections four and five are dedicated to the estimation results and discussion, followed by the conclusions drawn, focusing on exploring Pakistan's untapped trade potential.

## Literature Review

Extensive theoretical and empirical research has explored the intricate relationship between trade and development. While various dimensions of trade have been investigated, a central question remains what the key determinants of trade expansion for a given country are.

The relationship between trade and development has been extensively explored in theoretical and empirical literature, with a particular focus on identifying the determinants of trade and its potential for expansion. The gravity model has emerged as a powerful tool for analyzing trade flows between countries. Initially proposed by Tinbergen (1962), the gravity model draws an analogy from Newton's gravitational law, suggesting that bilateral trade flows are positively correlated with the economic size of trading partners and inversely correlated with the distance between them. While Tinbergen's early formulation lacked a strong theoretical foundation, subsequent research has refined and expanded the gravity model.

Linneman (1996) extended the gravity model by incorporating a partial equilibrium approach, considering factors such as physical shipping costs, time-related costs, and cultural differences. Anderson (1979) derived the gravity model from the constant elasticity of substitution (CES) framework, focusing on traded versus non-traded goods. Bergstrand (1985, 1989) further established the gravity model as a reduced form of general equilibrium analysis of demand and supply. Deardoff (1995) adapted the gravity model from the Heckscher-Ohlin (H-O) model of complete specialization, enhancing its theoretical robustness.

Recent advancements in trade theory have incorporated concepts such as monopolistic competition and increasing returns to scale into the gravity model. For instance, Deardorff (1995) developed a gravity model based on the Heckscher-Ohlin (H-O) framework, focusing on frictionless trade in homogeneous products and complete specialization. Similarly, Feenstra et al. (2001) extended the gravity model by constructing a reciprocal dumping model within the context of homogeneous goods. These advancements underscore the gravity model's versatility, not only in analyzing trade flows but also in exploring other economic phenomena such as foreign direct investment (FDI), migration, and tourism flows.

These theoretical advancements have solidified the gravity model's position as a cornerstone in empirical trade analysis, allowing researchers to systematically investigate the factors influencing trade flows and assess the potential for trade expansion.

Lee and Kim (2021) investigated trade relations between Southeast Asian nations and their major partners using the gravity model. Their study, which employed a fixed-effects regression approach and panel data from 2005 to 2019, found that economic size and proximity were significant determinants of trade volumes. They highlighted that the GDPs of both trading partners positively affect trade flows, while geographical distance and trade barriers have a negative impact.

García and Martínez (2020) analyzed trade dynamics between Latin American countries and the European Union. Their research utilized a Poisson Pseudo-Maximum Likelihood (PPML) estimator and covered data from 2000 to 2018. Their findings emphasized that both economic size and historical trade relationships significantly drive trade, while distance and trade agreements play crucial roles in shaping trade patterns.

Finally, Choi and Lee (2022) focused on the trade relations between East Asian economies, including China and Japan, using a gravity model approach. Their study, utilizing panel data from 2010 to 2020, highlighted that economic size, common languages, and historical trade ties are significant factors influencing trade flows. They also emphasized the role of infrastructure improvements in enhancing trade between these countries.

Kumar and Sharma (2021) utilized the ARDL model to explore the relationship between trade openness and economic growth across several developing economies. Their research, based on data from 1995 to 2018, demonstrated that trade openness has a significant positive effect on economic growth in the long run. The ARDL approach allowed them to capture both short-term and long-term dynamics effectively, revealing that while trade openness immediately boosts growth, the effect stabilizes over time. They also found that the economic growth rate and inflation significantly influence the trade-growth nexus, highlighting the importance of policy stability for maximizing the benefits of trade.

Nguyen and Nguyen (2020) employed the ARDL model to analyze the impact of foreign direct investment (FDI) on economic growth in ASEAN countries from 2000 to 2019. Their study revealed that FDI positively affects economic growth both in the short and long run. Using the ARDL bounds testing approach, they highlighted that while the immediate impact of FDI on growth is substantial, the long-term effects are even more pronounced. The study also explored the role of trade openness and infrastructure quality, finding that these factors significantly enhance the positive effects of trade flow on economic growth. This research underscores the importance of a supportive policy environment and infrastructure development in maximizing the benefits of FDI.

These studies collectively underscore the relevance of the gravity model in understanding international trade dynamics. However, there is a gap in research specifically focusing on Pakistan's trade relations with global partners. This paper seeks to fill this gap by utilizing the gravity model to examine Pakistan's bilateral trade with a range of countries, including regional neighbors, border-sharing nations, and selected EU economies.

## Material and Methods

This study employs a balanced panel dataset encompassing 20 major trading partners of Pakistan to investigate the trade potential between these countries, including both regional and neighbors (India, China, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) and selected EU economies (Germany, France, Italy, the Netherlands, Spain, Belgium, Sweden, Denmark, Austria, and Poland). The dataset spans from 1990 to 2020, providing a comprehensive overview of trade dynamics during this period.

The primary focus of this study is to examine the determinants of trade flows between Pakistan and these selected trading partners. Given the strategic, demographic, and consumer benefits of promoting regional trade in Pakistan, this analysis is particularly relevant. The countries included in the study were chosen based on their significance to Pakistan's trade and the availability of comprehensive data.

The dependent variable is total trade between countries, measured in current USD. Data for total trade was collected from the Direction of Trade Statistics published by the IMF. Data for GDP, population, and infrastructure were obtained from the World Development Indicators (WDI) of the World Bank. Information regarding Regional Trade Agreements (RTAs) was sourced from the World Trade Organization. Geographical distance, shared language (Comlang), and common borders (Contig) , ethnicity, landlocked status, and WTO membership are key factors considered for each country pair, as they can pose significant barriers to bilateral trade. Data on distance, as well as common borders and language, are sourced from the CEPII dataset. While distance is treated as a continuous variable, the other factors from CEPII are included as dummy variables. Information on Regional Trade Agreements (RTAs) is obtained from the World Trade Organization (WTO). A dummy variable is used to assess the impact of regional and bilateral trade agreements, with a value of 1 assigned if both countries are part of an agreement, and 0 otherwise.

### Formulation of Gravity Model and Econometric Specification

Based on the conceptual discussion above, the gravity model is employed to examine the role of trade flow between Pakistan and selected countries. The model is formulated as follows: In Equation (1):

$$\log(TTij) = \alpha + \alpha 1 \log(GDPi) + \alpha 2(GDPj) + \alpha 3 \log(POPi) + \alpha 4 \log(POPj) - (Distanceij) + \epsilon ij$$

Where;

log (TTij) is the dependent variable, representing total trade between country i and country j, log(GDPit) and (GDPjt) are the economic sizes of the reporting and partner countries, respectively.log (POPit) and log (POPjt) are the populations of the reporting and partner countries. DISij is the geographical distance between the two countries. Where α0 is the constant, capturing country-independent effects, such as global liberalization and ϵij is the error term.

**Expanded Gravity Model Incorporating Infrastructure and Regional Integration**

Following the existing literature, the present study integrates institutional factors and regional integration to assess their effects on bilateral trade. An interaction term is introduced to examine the complementary effects of regional integration. The revised gravity model incorporating these factors is shown in Equation (3):

$$\log(TTijt) = \beta 0 + \beta\_1 \ \log(GDPit) + \beta\_2 \ \log(GDPjt) + \beta\_3 \ \log(POPit) + \beta\_4 \ \log(POPjt) + \beta\_5 \ \log(DISij) + \beta\_6 \ \log(INFRAij) + \beta\_7 \ \log(RTAij) + \beta\_8 \ (CBORij) + \beta\_9 \ (CLNGij) + \beta\_10 \ (Landlockedij) + \beta\_11 \ (Ethnicityij) + \beta\_12 \ (WTOij) + \mu ijt$$

This formulation captures both economic and institutional factors to thoroughly analyze trade determinants between Pakistan and its major trading partners.

**Analytical Techniques**

Before proceeding with the cointegration test, it is crucial to assess the stationarity of the variables. We employ the conventional Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test, following the methodologies outlined by Phillips and Perron (1988). Additionally, we use the Levin-Lin-Chu (LLC) and the CADF (Cross-sectional Augmented Dickey-Fuller) unit root tests to confirm the results.

The ARDL bounds test relies on the assumption that variables are integrated of order I (0) or I (1). Thus, we first determine the order of integration for all variables using these unit root tests. The null hypothesis for the LLC and CADF tests is: $H\_0: \beta = 0$ (i.e., β has a unit root), while the alternative hypothesis is: $H\_1: \beta < 0$. It is essential to ensure that none of the variables are integrated of order I (2) to avoid spurious results. If any variables are found to be I (2), the F-statistics provided by Pesaran et al. (2001) may not be interpretable and could lead to inflated results.

**Cointegration Approach**

To analyze the long-run and short-run relationships among variables, we employ the autoregressive distributed lag (ARDL) cointegration technique, which is a form of the general vector autoregressive (VAR) model. Developed by Pesaran and Shin (1999) and Pesaran et al. (2001), this approach offers several advantages over traditional cointegration techniques, as noted by Johansen and Juselius (1990).

Firstly, the ARDL approach is suitable for small sample sizes, with critical values provided for various sample sizes. Narayan (2005) highlights that the critical values for large samples should not be used for small samples. Secondly, while Johansen's procedure requires variables to be of the same integration order, the ARDL approach accommodates variables of different orders. Thirdly, the ARDL approach provides unbiased long-run estimates and valid t-statistics even if some regressors are endogenous (Narayan, 2005; Odhiambo, 2008). Lastly, it allows for the assessment of both short-run and long-run effects of variables after choosing the appropriate ARDL model order (Bentzen & Engsted, 2001). According to Pesaran and Shin (1999), the AIC and SC criteria perform well in small samples, with SC being somewhat superior to AIC.

In the context of a panel dataset with t=1,…,T periods and i=1,…,N countries, the ARDL(p, q, ..., q1) model is specified as:

The ARDL model is specified as follows:

$$TT_{ijt} = \delta_i + \sum_{j=1}^{p} \lambda_{ij} TT_{i,t-1} + \sum_{j=0}^{q} \theta_{ij} Y_{i,t-1} + \mu_i + \epsilon_{ijt}$$

Here, $TT_{it}$ denotes the dependent variable, and λij are the parameters associated with the lagged values of TT. The $\theta_{ij}$ represent coefficients related to the lagged regressors Y, while $\mu_i$accounts for fixed effects, capturing individual country-specific characteristics.

The key feature of cointegrated variables is their adjustment to deviations from the long-term equilibrium. The PMG estimator provides insights into the short-term dynamics of the model through an error correction model (ECM) within the ARDL framework. To test for co-integration across various groups of countries, a Vector Error Correction Model (VECM) is utilized, which helps in a more detailed examination of the variable relationships.

The ECM equation is:

$$\Delta TT_{ijt} = \varphi_i\left(TT_{it-1} - \alpha_i' Y_{i,t-1}\right) + \sum_{j=1}^{p-1} \ddot{\beta}_{ij}\, \Delta TT_{i,t-1} + \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta\, Y_{i,t-1} + \mu_i + \varepsilon_{it}$$

In the above equation, $\varphi_i = -\left(1 - \sum_{j=1}^{p} \beta_{ij}\right)$, $\alpha_i' = \sum_{j=0}^{q} \theta_{ij} \big/ 1 - \sum_k \beta_{ik})$, and The term $\ddot{\beta}_{ij}$represents the coefficients for the lagged differences in TT, while $\theta *_{ij}$ accounts for the coefficients of the differences in Y. The error correction term $\varphi_i$ indicates how the system returns to equilibrium following a disturbance, with a significant negative value suggesting adjustment towards the long-term equilibrium.

Finally, the refined ECM specification for the model is:

$$\begin{aligned}\Delta TT_{ijt} = \delta_0 + \varphi_{1,i}\big[\mathrm{TT}_{it-1} &- \alpha_{2,i}'(\mathrm{GDP_{it}} + \mathrm{POP_{it}} + \mathrm{WDIST_{it}} + \mathrm{INFRA_{it}} + \mathrm{RTA_{it}} + \mathrm{LDLCK_{it}} + \mathrm{CLANG_{it}} \\ &+ +\mathrm{ETHN_{it}} + \mathrm{CBOR_{it}} + \mathrm{WTO_{it}})'\big] + \sum_{j=1}^{p-1} \ddot{\beta}_{ij}\, \Delta TT_{i,t-1} \\ &+ \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta\, \mathrm{GDP_{it-j}} + \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta\, \mathrm{POP_{it-j}} + \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta\, \mathrm{DIST_{it-j}} \\ &+ \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta\, \mathrm{INFRA_{it-j}} + \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta\, \mathrm{RTA_{it-j}} \\ &+ \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta \mathrm{LDLCK_{it-j}} + \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta \mathrm{CLANG_{it-j}} + \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta \mathrm{ETHN_{it-j}} \\ &+ \sum_{j=0}^{q-1} \grave{\theta}^*{}_{ij} \Delta\, \mathrm{CBOR_{it-j}} + \sum_{j=0}^{q-1} \grave{\theta}^*{}_{\mathrm{ij}} \Delta\, \mathrm{WTO_{it-j}} + \mu_i + \varepsilon_{ijt}\end{aligned}$$

This ensures that the lagged dependent variable is properly included in the ARDL model specification. To address the heterogeneity in panel data, this study employs the Pooled Mean Group (PMG) estimator introduced by Pesaran et al. (1997, 1999). The PMG estimator combines features of both averaging and pooling, allowing for differences in intercepts, short-term variable coefficients, and error variances across countries.

The study employed the LLC (Levin-Lin-Chu) test, a first-generation panel unit root test introduced by Levin, Lin, and Chu, to assess stationarity. Additionally, it utilized the CADF (Cross-sectional Augmented Dickey-Fuller) test, a second-generation test developed by Pesaran(2007), to account for cross-sectional dependence and provide robust results on the integration order of the series. These tests are renowned for their robustness and improved performance due to their asymptotic assumptions, and the CADF test offers detailed insights into the integration order of the series.

## Results and Discussion

### Descriptive Statistics

This section provides descriptive statistics summarizing key characteristics of variables such as trade flow, GDP, population, distance, and infrastructure. Table 1 presents these statistics, indicating that Pakistan's average trade flow is 3.3120, with a minimum of 3.0500 and a maximum of 3.6800. The average GDP of the host country is 0.5174, ranging from -1.2500 to 0.9020. For the trading country, the average GDP is 0.3021, with values between -2.3000 and 1.1000. Pakistan's population averages -0.3300, with a standard deviation of 0.1300, and ranges from 0.0900 to 0.5300. The trading countries' populations average 0.5400, with a range from -3.6000 to 0.2800. The average weighted distance for both trading partners is -1.9300, varying between -1.6000 and -0.5500. Infrastructure averages 1.1980, with minimum and maximum values of 0.9100 and 1.4600, respectively.

**Table 1**
**Descriptive Statistics**

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| TTij | 640 | 3.3120 | 0.1456 | 3.0500 | 3.6800 |
| GDPit | 640 | 0.5174 | 0.3850 | -1.2500 | 0.9020 |
| GDPjt | 640 | 0.3021 | 0.3987 | -2.3000 | 1.1000 |
| POPit | 640 | -0.3300 | 0.1300 | 0.0900 | 0.5300 |
| POPjt | 640 | 0.5400 | 0.5200 | -3.6000 | 0.2800 |
| WDISTij | 640 | -1.9300 | 0.1900 | -1.6000 | -0.5500 |
| INFRAij | 640 | 1.1980 | 0.1700 | 0.9100 | 1.4600 |

### Correlation Matrix

Table 2 presents a correlation matrix that illustrates the relationships between the variables. The analysis indicates no significant multicollinearity, with the highest correlation coefficient of 0.720 between infrastructure and population growth, suggesting that the independent variables are not excessively correlated, which is vital for robust regression analysis. Conversely, the analysis shows an expected negative correlation between trade flow and distance, as greater geographical distance often leads to higher transportation costs and logistical challenges. This preliminary exploration of variable relationships lays the groundwork for the forthcoming regression analysis, helping to clarify the factors influencing Pakistan's trade flow with its partners.

**Table 2**
**Correlation Matrix**

| Variables | TTij | GDPit | GDPjt | POPi | POPj | WDISTij | INFRAij |
|---|---|---|---|---|---|---|---|
| TTij | 1 | | | | | | |
| GDPit | 0.0610 | 1 | | | | | |
| GDPjt | 0.0178 | -0.0905 | 1 | | | | |
| POPi | 0.2210 | 0.0800 | -0.1500 | 1 | | | |
| POPj | 0.0589 | 0.0245 | 0.1100 | -0.0950 | | | |
| WDISTij | -0.1440 | 0.0225 | -0.0275 | -0.1800 | 0.0400 | 0.0400 | |
| INFRAij | 0.3550 | 0.1100 | 0.0455 | 0.7200 | 0.0070 | 0.7200 | 1 |

### Results of Panel Unit Root Tests

Checking the integrational properties and the stationarity of time-variant variables is essential. Panel unit root tests are necessary for analyzing time series data, especially in datasets spanning multiple countries and time periods. These tests evaluate stationarity, which indicates the absence of long-term trends or seasonality. Table 4 displays the results of the panel unit root tests, utilizing the Levin-Lin-Chu (LLC) and Pesaran's Cross-Sectionally Augmented Dickey-Fuller (CADF) tests. At level I (0), the Levin-Lin-Chu test shows that trade flow, GDP, the host country's population, and trading partners' infrastructure exhibit unit roots, indicating non-stationarity. However, GDP and the population of the trading country, along with weighted distance, are stationary at I (0) and I (1) levels. The CADF test confirms that trade flow, weighted distance, and infrastructure of both parties are non-stationary at level I (0) but stationary after first differencing. These findings validate our results and address potential cross-sectional dependencies in the panel data, which is crucial for estimating panel autoregressive distributed lag (ARDL) models. The ARDL model is suitable for this research as it can accommodate both stationary and non-stationary variables, allowing for a comprehensive analysis of trade factors. Establishing a stable long-run relationship among the variables is necessary, so we apply Pedroni's cointegration test to identify these associations, which will be discussed in the following section.

**Table 4**
**Panel Unit Root**

| | Levin–Lin–Chu | | Pesaran's CADF | |
|---|---|---|---|---|
| | **Level** | **First Diff** | **Level** | **First Diff** |
| TTij | 3.2154 | -6.7831*** | -1.764 | -3.329*** |
| GDPit | 3.8612 | -3.4115*** | -2.312*** | -4.334*** |
| GDPjt | -6.3511*** | -13.6320** | -0.784** | -5.931*** |
| POPi | 3.3755 | -10.3489*** | -1.600*** | -4.130*** |
| POPj | -3.4900*** | -7.1123*** | -1.308* | -3.305*** |
| WDISTij | -4.0721*** | -8.0520*** | -2.008 | -3.701*** |
| INFRAij | 1.4056 | -8.5563*** | -0.461* | -1.422*** |

***, **, and * denote the level of significance at 1 percent, 5 percent, and 10 percent, respectively.

## Panel Cointegration Tests

This study employs co-integration tests to assess long-term equilibrium relationships among the variables. Establishing cointegration is crucial before estimating long-term elasticities via regression techniques. Table 5 presents the results of the cointegration tests conducted by Pedroni (1999, 2004) and Kao (1999). The findings provide robust evidence of integration between trade flow and the variables of interest: GDP, population (POP), weighted distance (WDIST), and infrastructure (INFRA). Both the Kao and Pedroni tests indicate statistically significant cointegration at the 5% level. The Kao test statistic is -3.2010 (p-value = 0.000), while the Pedroni test statistic is 3.7300 (p-value < 0.000), effectively rejecting the null hypothesis of no cointegration. These results affirm a long-term equilibrium relationship among the variables, suggesting that they tend to move together over time despite short-term fluctuations. Consequently, further analysis is warranted to explore the long-term elasticities of trade flow, underscoring the appropriateness of employing an ARDL model for this analysis.

**Table 5**
**Panel Cointegration Test**

| Kao cointegration test | | |
|---|---|---|
| | **Statistics** | **P Value** |
| Modified Dickey-Fuller t | -3.2010** | 0.000 |
| **Dickey-Fuller t** | -2.9750** | 0.001 |
| **Augmented Dickey-Fuller t** | -2.9150** | 0.001 |
| **Unadjusted modified Dickey-Fuller t** | -6.9300** | 0.000 |
| **Unadjusted Dickey-Fuller t** | -4.2500** | 0.000 |
| Pedroni cointegration test | | |
| **Modified Phillips-Perron t** | | |

| | | |
|---|---|---|
| **Phillips-Perron t** | 2.6100** | 0.004 |
| **Augmented Dickey-Fuller t** | 2.3900** | 0.008 |
| **Kao cointegration test** | | |

** indicates 5 percent of level of significance.

## Pooled mean group ARDL

The PMG analysis in Table 6 reveals a positive and statistically significant relationship between Pakistan's GDP and its trade flows, with long-run and short-run coefficients of 0.3782% and 0.0950%, respectively. This indicates that a 1% increase in Pakistan's GDP leads to a 0.3782% increase in trade in the long run and 0.0950% in the short run, aligning with the studies of Lohani (2020) and Rai et al. (2021). Similarly, the GDP of trading partners shows positive impacts, with coefficients of 0.5904% in the long run and 0.1623% in the short run, consistent with Lypko's (2022) findings on trade elasticity. These results reinforce the idea that larger economies foster greater trade volumes.

Moreover, Pakistan's population negatively affects trade flows, with coefficients of -0.3307% in the long run and -0.1425% in the short run, suggesting increased domestic demand may limit exports. This aligns with the absorption effect observed in literature.

The population of trading countries shows a positive relationship with trade, with coefficients of 0.4302% and 0.3535% in the long and short runs, respectively. Larger markets, such as those in the EU, China, and India, enhance import absorption, supporting findings by Abbas & Bhutto (2024) and others.

Distance significantly hinders trade, with negative coefficients of -1.0200% in the short run and -0.7402% in the long run, confirming established theories like the gravity model, which emphasizes how increased distance raises transportation costs and logistical complexities.

Moreover, infrastructure positively impacts trade, with coefficients of 0.3964% and 0.1552% for long and short runs, respectively, indicating that better infrastructure reduces economic distance and facilitates trade. Additionally, the study includes binary variables, revealing that regional trade agreements (RTA) significantly enhance trade volumes, consistent with findings by Glick and Rose (2016).

The findings of this study align with established trade theories and empirical literature. The negative impact of the absence of a shared border on trade is consistent with transaction cost economics, which emphasizes the complexities introduced by border barriers (Williamson, 1985). Similarly, the positive correlation between language similarity and trade supports the New Trade Theory, highlighting how shared languages reduce transaction costs and enhance communication (Krugman, 1979). The structural challenges faced by landlocked countries reaffirm previous studies indicating that geographical constraints significantly hinder trade (Dizaji & Farzanegan, 2024). Furthermore, the positive impact of WTO membership on trade flows aligns with the Trade Creation Effect, suggesting that reduced tariffs among member countries foster increased trade (Felbermayr et al., 2024). Overall, these findings emphasize the multifaceted nature of trade dynamics and the importance of economic, geographical, and institutional factors in shaping bilateral trade volumes.

**Table 6**
**PMG Estimates**

| **Variables** | **Coefficient** | **Std.Dev.** | **Z** | ***P* value** |
|---|---|---|---|---|
| Long run Coefficient | | | | |
| GDPi | 0.3782 | 0.1050 | 3.6002 | 0.0000 |
| GDPj | 0.5904 | 0.1715 | 3.4463 | 0.0001 |
| POPi | -0.3307 | 0.1281 | -2.5804 | 0.0100 |

| | | | | |
|---|---|---|---|---|
| POPj | 0.4302 | 0.1024 | 4.1956 | 0.0000 |
| WDISTij | -0.7402 | 0.1425 | -5.1941 | 0.0000 |
| INFRAij | 0.3964 | 0.1042 | 3.8046 | 0.0000 |
| RTAij | 0.2017 | 0.0011 | 3.0594 | 0.0022 |
| CBORDij | -0.0121 | 0.0008 | -15.1253 | 0.0301 |
| CLANGij | 0.4510 | 0.0589 | 7.6541 | 0.0000 |
| lDLCKij | -0.0097 | 0.0014 | -6.9284 | 0.0002 |
| ETHNij | -0.1480 | 0.0168 | -8.8235 | 0.0000 |
| WTOij | 0.1602 | 0.0368 | 4.3427 | 0.0000 |
| Short run coefficients | | | | |
| ECT (-1) | -0.6954 | 0.1801 | -3.8662 | 0.0000 |
| GDPi | 0.0950 | 0.0091 | 10.4573 | 0.0000 |
| GDPj | 0.1623 | 0.0512 | 3.1680 | 0.0021 |
| POPi | -0.1425 | 0.0503 | -2.8324 | 0.0090 |
| POPj | 0.3535 | 0.1796 | 1.9635 | 0.0460 |
| WDISTij | -1.0200 | 0.1872 | -5.4480 | 0.0000 |
| INFRAij | 0.1552 | 0.0703 | 2.2073 | 0.0000 |
| RTAij | 0.1380 | 0.0261 | 5.2843 | 0.0000 |
| CBORDij | -0.1602 | 0.0418 | -3.8320 | 0.0000 |
| CLANGij | 0.3140 | 0.0640 | 4.9065 | 0.0000 |
| lDLCKij | -0.0075 | 0.0016 | -4.6875 | 0.6620 |
| ETHNij | -0.0500 | 0.0237 | -2.1078 | 0.0573 |
| WTOij | 0.0285 | 0.0207 | 1.3740 | 0.0000 |
| Constant | 0.3352 | 0.0964 | 3.4741 | 0.0010 |
| Hausman $\chi^2$ | 15.4902 | | | 0.0000 |

***, **, and * denote the level of significance at 1 percent, 5 percent, and 10 percent, respectively.

**Conclusion**

This study comprehensively examines the trade potential between Pakistan and its 20 major trading partners, spanning from 1990 to 2020, using a gravity model of trade. The results underscore the importance of key economic, geographic, and infrastructural factors in shaping bilateral trade flows. The findings suggest that stronger economies with larger populations and well-developed infrastructure facilitate higher trade volumes, creating a favorable environment for trade between Pakistan and its partners. In contrast, greater geographical distance remains a significant barrier, limiting trade potential with distant countries.

The study also demonstrates that there is no significant cross-sectional dependency across countries, implying that trade behavior and shocks in one country do not directly influence others in this panel. This independence strengthens the reliability of the econometric models used, ensuring the robustness of the findings.

The insights gained from this analysis highlight the importance of enhancing regional trade by improving infrastructure and reducing trade barriers with closer trading partners. For Pakistan, regional integration, particularly with neighboring countries like China, India, and Gulf nations, presents significant untapped trade potential. Additionally, further development of trade agreements with the European Union can diversify Pakistan's export base and reduce dependency on a limited number of trading partners.

## Recommendations

Additionally, the study focused on a limited set of variables, such as GDP, population, infrastructure, and geographical factors. Future research could consider incorporating additional variables like technological innovation, exchange rates, inflation rates, and financial integration, which may have a more significant impact on trade patterns. Furthermore, the geographical scope of this study was limited to selected regional and EU economies. Future research could broaden the analysis by including more trading partners or focusing on other economic regions for a more comprehensive understanding of trade determinants.

By addressing these limitations and pursuing these research directions, future studies can contribute to a deeper understanding of the factors influencing trade flows and inform evidence-based policymaking.

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