PAKISTAN'S TRADE INSIGHT IN TERMS OF GRAVITY MODEL: AN EMPIRICAL EVIDENCE

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ABSTRACT

This study intends to analyze the determinants of the trade potential of Pakistan. For the said purpose, the study employed an augmented gravity model over the data of 12 trading partner countries of Pakistan for the period of 20 years from 2002 to 2022. The dependent variable is merchandise trade, while the independent variables consist of core variables i.e., GDP & bilateral distance, and explanatory variables like population, common border, and preferential trade agreement. Breusch-Pegan and Hausman's tests were used for model selection, which proposes that the Random effect model is appropriate for estimation. The results confirm that distance among trading states hurts trade between them. Although the GDP of Pakistan shows a positive effect on trade the relation is inconsequential. However, the impact of GDP on trading associates of Pakistan is positive and highly substantial. The population of trading allies of Pakistan is showing a significant positive impact on trade. Common border and preferential trade agreements between the trading partners have a significant negative influence on trade. The study concludes that for Pakistan, the larger the distance with its trading associate country the smaller the trade among them and Pakistan has greater trading potential with larger economies as compared to smaller ones.

Keywords: *International Trade; Gravity Model; Trade Agreements; Panel Data Analysis.*

INTRODUCTION

Sir Isaac Newton was most likely unaware of how "universal" his law was when he first developed the Universal Law of Gravity in the 17th century (Wlazel, 2014). Tinbergen (1962) was the first to adapt the gravity equation for the description of global trade flows, although it required nearly three more centuries. Since then, a substantial amount of work has been published on the subject; it is divided into two categories: theoretical, which

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aims to explain the microeconomic underpinnings of the gravity equation of global trade, and the practical, which applies the model to actual statistics and concentrates on its accurate description and evaluation. According to the standard gravity equation in physics, the force attracting two objects is directly proportional to their masses and in reverse proportionate to their distance from one another. Translating this into an economic formula, the trade between two nations is inversely correlated with mutual distance, which takes into account all transaction costs. Bilateral trade is directly proportionate to GDPs. Surprisingly, steady results have been obtained with this model throughout time, across various country samples and methodologies. Chaney (2011) claimed that the gravity equation stands among the most robust and sF pragmatic uniformities in economics. The gravity model measures not only the economic components but also the effects of non-economic factors such as population, common border, trade agreements, distance, etc. on international trade (Metin & Tepe, 2021).

The gravity model is one of the few effective observed models in economics for ages. A deeper and more precise measurement and construal of the spatial interactions provided by gravity has resulted from the recent practice of incorporating the theoretical underpinnings of gravity (Anderson, 2010). While global value chains and product improvements are facilitated by free trade, free trade agreements must be carefully negotiated because they have a significant impact on bilateral CO2 emissions and pollution. Therefore, it is compulsory to explicitly define sanctions on the requisites of trade development for emerging countries. To maintain environmental standards and protections in low-income nations, the rules and regulations about free trade agreements need to be updated. (Khayat, 2019).

The most contested question in economics is determining what factors influence bilateral trade and how it affects economic growth. The gravity model is a popular tool for estimating trade potential. The lag between the estimated gravity model trade flow and the real trade flows (trade potential) is used in literature to predict the direction of future trade. However, the majority of the research is done to determine a nation's entire trade potential with its trading partners. Trade is not divided into its two constituent parts, import and export. Few studies are done, specifically for Pakistan, to determine the potential for export and overall trade with partner nations. (Sultan & Maryam, 2015) A nation's overall trade flow for a given market differs significantly from its export and import markets taken apart. The picture of the potential for trade as a whole may differ from that of imports and exports. Therefore, it is crucial to investigate this aspect of

commerce. Quantifying Pakistan's trade potentialities with its border-sharing allies and other trading associates is the aim of this paper. The study will offer an important context for understanding Pakistan's trade strategy with its neighbors and other trading partners. This study will offer a variety of policy recommendations to help Pakistan capitalize on its unrealized trade potential. Pakistan's trade potentiality with its neighboring allies and other trading associates is determined using the augmented gravity model.

Understanding Pakistan's trade patterns helps in assessing its relationships with neighboring countries and global partners. It provides insights into which countries Pakistan trades with the most, the nature of those trade relationships, and the potential for expansion or diversification. Analyzing Pakistan's exports and imports sheds light on its economic performance and competitiveness in various industries. It helps identify sectors where Pakistan has a comparative advantage and those where improvements are needed to compete more effectively in international markets. Pakistan's trade dynamics influence its economic growth and development. By examining trade patterns, policymakers can identify areas for policy intervention to promote growth, create jobs, and reduce poverty through trade-led development strategies. Understanding trade dynamics informs the formulation of trade policies aimed at enhancing Pakistan's competitiveness and integration into the global economy. It helps policymakers design strategies to address trade barriers, improve infrastructure, and attract foreign investment to stimulate trade. Analysis of trade patterns helps identify risks associated with dependence on specific trading partners or products. It enables policymakers and businesses to diversify their trade portfolio, mitigate risks, and build resilience against external shocks such as economic downturns or geopolitical tensions.

This research intends to examine the determining factor of the trade potential of Pakistan. The gravity equation is estimated over the data of 12 trading partner countries of Pakistan including UAE, USA, UK, Singapore, Indonesia, Germany, Australia, China, Sri Lanka, Malaysia, Japan, and India. Since the early 1990s, there has been a noteworthy upsurge in the number of preferential trading agreements, often known as regional trading arrangements (RTAs) (Ekanayake et al., 2010). Although the merchandise trade provisions of RTAs can increase commerce among member nations, trade among non-members will always suffer as a result, according to theoretical work on RTAs. As a result, the relative cost structures of partner and non-member nations determine whether or not a country benefits from joining an RTA (Viner, 1950). The primary benefit of the

gravity equation is its capability to include strategic influences in trade flow prediction (Gonzalez Esteban, 2021).

The remnants of the paper are organized subsequently. A review of previous studies is discussed in Section 2. Methodology is explained in section 3 along with data collection, data analysis, and empirical framework in the sub-sections 3.1, 3.2, and 3.3. The estimation results are analyzed in section 4. Section 5 contains concluding remarks and policy implications. Limitations and directions for other research are given in the concluding section 6.

LITERATURE REVIEW

The most commonly adopted model in the study of global trade is the gravity model, which was established after the groundbreaking research of Tinbergen (1962) and Pöyhönen (1963). Afterward, the model's quantitative structure was supplied by Linneman (1966). Tinbergen (1962) emphasized that the primary determining variables of the gravity model were the Gross National Product of the importing and exporting nations as well as the distance between the nations. In the past, economists frequently examined aggregated trade flows by applying the gravity model of trade (Ming et al., 2016). The gravity model measures not only the economic components but also the effects of non-economic factors such as population, common border, trade agreements, distance, etc. on international trade (Metin & Tepe, 2021).

Leitao (2023) in order to investigate the extent to which the cultural and linguistic problems contribute to Portuguese FDI, the gravity equation is employed. The study utilized panel data from 30 countries from 2005–2020. The panel quantile regressions, OLS, and Poisson Pseudo-Maximum-Likelihood estimator were used for estimation. The economic side of the Portuguese and stockholder economies were used in the regression model, along with the transport and transaction costs which were used to analyze the geographical distances. Results confirm that terrestrial proximity intensifies the possibility of attracting FDI, provided that the common dialect and social elements are positively associated with the Portuguese FDI. Whereas geographical distance negatively influences FDI.

To illustrate the practical capability of the gravity model to forecast mutual trade flows, Kulkarni (2013) used the GDP data of 177 trading partners of the United Kingdom in 2004. After controlling the gravity model's size and distance factors, the study discovered that two EC countries traded 11% less with non-European countries and an additional 68% more with each other in 1990. Regarding exchange rates, the results indicate that although the stabilization

of the ERM led to a rise in bilateral trade among its members, the gains were negligible in comparison to the trade union's influence.

In an attempt to investigate the export latent of Pakistan with its trading allies, Abbas (2015) employed the gravity equation on panel statistics of 40 trading associates of Pakistan from 1991 to 2011. The response variable is goods exports flow while, the independent variables are demand potentiality of trading allies, price level, and dichotomous variables for free trade contracts, similar language, and common borderline. The estimation shows that Pakistan's export is positively determined by its supply volume and partner country's demand latent as well as the magnitude of the market, whereas inversely determined by the geographical distance. The relative price shows substantial positive, but less flexible influence. The common dialect shows a substantial positive effect while the common border shows a negative impact. The free trade agreements of Pakistan show adverse but insignificant effects. Europe arose as the most potential export region for Pakistan's trade.

Ismaiel et al. (2023) aimed to examine the determining factor of Egyptian rice exports with 11 rice importing states using the gravity model on yearly data of Egypt's agricultural trade during 2001–2016. The study concluded that the Egyptian GDP had an undesirable effect on the full worth of Egyptian imports. Egyptian imports and exports were severely affected by its increasing population. The study also demonstrates that exports of Egyptian rice to partner nations increase by 3.97% for every 1% increase in export prices. The fluctuating distance between Egypt's capitals hurts the country's exports.

Theoretically elucidated the econophysical nature of the gravity model, Capoani (2023) presented a chronological bibliographic review of the past 30 years, to explain the usefulness of this model in international economics. In light of the ideas of "fat word" and "death of distance," he concluded that the concept of distance in the gravity model has become more significant. The study further asserted that, given its multilinearity, no gravity model evolution in the literature yet has been able to successfully combine economic geography and international trade.

Demidova et al. (2022) created a generalized gravity model that incorporates all of its standard micro foundations such as Armington and Melitz-Pareto, and also demonstrated how the resulting model of an SOE can be used to comprehend comparative statics and the optimal tariff in a way that is robust across the various micro foundations consistent with the gravity model. The comparative statistics results exhibited that the SOE's wage, trade flows, and

welfare are greatly influenced by foreign shocks, while the optimal tariff formula emphasized the relevance of the trade elasticities concerning wages and tariffs.

Pal and Karl (2021) investigated the evolution of the widely used gravity models in world trade by tracing back Newton's law of gravitation as well as Kirchhoff's and Ohm's laws of current electricity. The paper examined these theoretical parallels and provided numerical solutions for observable trade trends between India and other nations.

Jayasuriya (2021) conducted the Bayesian gravity model to determine the extent of influence of determinants on global trade. Annual data of 43 Asian countries from 1995 to 2018 were collected for this purpose. All these Asian states have mutual trade dealings within the area as well as around the globe. The gravity equation is evaluated for imports and annual values of real trade with each trading associate of the Asian states. The Bayesian gravity model confirms that GDP, populace, and area of the state are substantial predictors of the growth of imports. The distance between the countries and barriers in trade has a significant negative, while the exchange rate has a positive influence. The result shows that digitization of the areas has a robust influence on the trade.

With the intent of determining the latent Indonesian fruit trade, Sinaga et al. (2019) employed the classical gravity model. The OLS estimation is done by using 16 years data of from three core groups of Indonesian exported fruits. The sum of tariffs, the presence of free trade treaties, populace count, GNP of each state, distance, and trade were used as independent variables. The calculation of trade latent shows that the real value of trade is less than the forecasted value. This specifies that Indonesia has a trade potentiality that should be satisfied depending on its comparative advantage as well as its economic and geographical fundamentals.

Focusing on the elementary form of the gravity equation that consists of three response variables; mutual imports, exports, and trade, Khayat (2019) used panel data of 6 GCC countries for the period 2001–2012 to examine the trade pattern of GCCs. ordinary least squares and Random effects modeling techniques were employed for estimation. The findings confirmed that per capita GDP and population for source and destination states have a substantial effect, while distance amongst states has an adverse effect on trade flows. The research also proposed that both nations should address trade restrictions and endeavor its obliteration to enhance the trade flows.

Attempting to figure out the latent market for South Korean trade, Irshad et al. (2018) used an enhanced gravity approach in conjunction with pooled ordinary least squares to analyze South Korea's export flow while controlling for temporal fixed effects. The study examined a large

panel dataset that covered the 189 countries that South Korea imports from between 2001 and 2016. Since the conclusion reveals positive factors for economic mass, rate of exchange, trade contracts, and trade liberalization in associate countries and negative parameters for distance and noncoastal nations, the empirical values are determined consistently with the gravity method. The findings also show how the Heckscher-Ohlin theory affects South Korea's export trends. The analysis discovered that 94 states, including China, Japan, Hong Kong, Germany, India, the UK, and France, have enormous export potential.

Sultan and Munir (2015) targeting to figure out the trade determinants and latent trade of Pakistan applied an augmented gravity approach over the panel data of 38 countries from 2000 to 2013. The outcomes obtained from the gravity method prove that Pakistan has strong trade potentiality with Norway, Hungry, Switzerland, Philippines, Portugal, and Greece. Compared to non-border sharing states, border-sharing countries have cheaper transportation costs because of their shorter travel distances. China and India are two of the main nations that share borders with Pakistan, but Pakistan has exhausted its trade potential with China only.

Incorporating the impacts of incidental trade in the gravity approach for the Czech Republic, Wlazel (2014) used the OECD-WTO TiVA database to create data on 56 nations over five years, from 1995 to 2009. The PPML technique is utilized following current academic research, casting doubt on the conventional way of calculating the log-linear equation. The empirical research reveals that Czech exports are strongly determined by the need for German products and discovers that the stronger the share of services charge added, the more they increase. However, it does not clearly show the consequence of regulating the gross exports for their overseas satisfaction. Moreover, it is discovered that the target nation's involvement in international value chains has little bearing on where Czech exports end up.

METHODOLOGY

Data Collection

The statistics for this investigation are gathered from several domestic and foreign sources. The yearly statistics of Pakistan’s trade with its 12 trading associates, are gathered from several volumes of the Statistical Yearbook, issued by the Pakistan Bureau of Statistics. The statistics on GDP and populace count are compiled from the World Bank. The information on mutual distance in Km from the state capital of the trading associate nations is collected from www.indo.com/distance. The statistics on dichotomous variables for Free Trade Agreement among republics are generated marking 1 when Pakistan signed an unrestricted trade contract

with its trading allies and 0 if not. Similarly, the information on the common border is created by valuing 1 if trading allies share a common border and 0 otherwise.

Data Analysis

When modeling with panel data, the B-P test is used to determine whether the Common effect outperforms the Random effect after the model has been estimated using Partial Least Squares. In cases when the p-value exceeds 0.05, the PLS or Common effect model is employed. We run the equation exploiting the Random Effect technique if the probability value is less than 0.05, and we use the Hausman Test to select between the Fixed and Random Effect models. We use the Random Effect model if the probability of the Hausman test is more than 0.05; if not, we use the Fixed Effect approach to run the model.

Empirical Framework

Originating from Newton's principle of gravitation, the gravity approach for trade says that the trade force is directly proportionate to the economic mass of the states and in reverse proportionate to the geographical distance between the two trading nations.

$$\boldsymbol{Tij = (GDPi \text{ x } GDPj)/ Dij}$$

where,

Tij is the bilateral trade among state i and state j

$GDPi$ is the GDP of republic i (i.e., Pakistan)

$GDPj$ is the GDP of republic j

Dij is the distance between state i and state j

For empirical estimation, the above gravity model can be returned as:

$$\boldsymbol{Tij = \beta o + \beta 1\ GDPi + \beta 2\ GDPj + \beta 3\ Dij + eij}$$

The study used the augmented gravity model for analysis, which is an extension of the traditional gravity model used in economics to predict the flow of goods, services, people, and information between two states. It incorporates additional variables such as distance, economic size, population size, and other features that affect the trade between two states. In this study, the other explanatory variables include population, preferential trade agreements, and common border, as these variables tend to influence the bilateral trade between two states, and neglecting them might lead to underestimation or biased estimation of model parameters. Adding other explanatory variables, the equation will be:

$$Tij = \beta o + \beta 1\ GDPi + \beta 2\ GDPj + \beta 3\ Dij + \beta 4\ POPj + \beta 5\ BDR + \beta 6\ PTA + eij$$

where,

POPj is the population of republic j

BDR is the dummy variable for countries with common borders and

PTA is the dummy variable for states with unrestricted trade agreements

eij is the error term

βo is the intercept and β1 – β6 are parameters to estimate

RESULTS AND DISCUSSION

Table 1. Pooled Ordinary Least Square

Variable	Coefficient	Standard Error	T-Statistic	Probability
C	7.492727	4.899257	1.529360	0.1285
Tij (-1)	1.19E-09	1.27E-10	9.334857	0.0000
LGDPj	0.303828	0.035808	8.485012	0.0000
POPj	1.20E-09	4.77E-10	2.513080	0.0131
LGDP i	0.145796	0.181554	0.803046	0.4233
PTA ij	1.054965	0.156194	-6.754186	0.0000
BDR ij	1.640150	0.571959	-2.867602	0.0048
Dij	-3.70E-05	1.41E-05	-2.631100	0.0095

Table 2. Reliability Analysis

R-sq	0.839129	F-stat	101.3427
Adj R-sq	0.830849	Prob(F-stat)	0.000000
Dependent Variable	LTij	D-W stat	0.762653

Table 3. LM Tests for Random Effects

	Cross-section	Time	Both
Breusch-Pagan	147.2831 (0.0000)	0.806432 (0.3692)	148.0895 (0.0000)

The LM test is used to determine if the Common Effect or the Random Effect model is more suitable. The appropriateness of the common effect is the LM-test's null hypothesis. As a result, we ratify the null hypothesis and use the PLS method to estimate the equation, if the probability is higher than 0.05. However, we reject the suitable common effect null hypothesis and use the random effect model if the p-value is less than 0.05. The estimation in Table 3 above demonstrates a noteworthy impact on the intercept. As a result, we proceed with additional model selection tests and use the random effect procedure to calculate the same equation before applying the Hausman test to further select between fixed effect and random effect models.

Table 4. Random Effects Model

Variable	Coefficient	Standard Error	T-Statistic	Prob.
C	7.492727	4.950255	1.513604	0.1324
Tij (-1)	1.19E-09	1.29E-10	9.238687	0.0000
LGDPj	0.303828	0.036180	8.397597	0.0000
POPj	1.20E-09	4.82E-10	2.487190	0.0141
LGDP i	0.145796	0.183444	0.794773	0.4281
PTA ij	-1.054965	0.157820	-6.684603	0.0000
BDR ij	-1.640150	0.577913	-2.838060	0.0052
Dij	-3.70E-05	1.42E-05	-2.603994	0.0102

Table 5. Reliability Analyses

R-sq	0.839129	F-stat	101.3427
Adj R-sq	0.830849	Prob(F-stat)	0.000000
Dependent Variable	LT ij	D-W stat	0.762653

Table 6. Hausman Test

Test Summary	Chi-Square Statistic	Chi-Square d.f.	Prob.
Period	0.000000	6	1.0000

The Hausman test has been applied to choose between a fixed-effect and a random-effect model. The Random Effect Model vs Fixed Effect Model comparison is made using the Hausman Test. The favored model, as per the Hausman test null hypothesis, is the random effect model. On the other hand, the fixed effect is a suitable alternative hypothesis. Given that the null hypothesis has been approved, the results shown in Table 4 suggest that the random effect model is suitable for this study. Hence, we do not employ the fixed effect approach in our calculations.

The outcomes of the Random effect model in Table 4 demonstrate that distance among trading states has an adverse impact on trade between them. The result is consistent with the study i.e., Aliyu and Bawa (2015). Although the GDP of Pakistan shows a positive effect on trade the relation is insignificant. However, the impact of the GDP of trading partners of Pakistan is positive and highly significant. The result is consistent with the study i.e., Alleyne and Lorde (2014). The population of trading partners of Pakistan is showing a significant positive impact on trade. Common border and preferential trade agreements between the trading partners have a significant negative influence on trade. The dependent variable is estimated in logarithmic form to confront the issues of heteroskedasticity and serial correlation in the model. Also, the first lag of the dependent variable is used in the model to address the problem of autocorrelation.

With an adjusted R-squared of 0.830849, the results indicate that 83% of the variation in the response variable can be described by the explanatory variables. With an F-status of 1%, it is clear that the model does a perfect job of fitting the data.

CONCLUSION AND POLICY IMPLICATIONS

This empirical work is designed to analyze the determinants of the trade potential of Pakistan. Hence the estimation confirmed that in the case of Pakistan, the larger the distance between Pakistan and its trading associate nation the smaller the trade between them, as the coefficient of distance showed a negative influence on trade. In other words, as the distance between Pakistan and its trading associate countries rises the trade among them decreases. Therefore, this study suggests that Pakistan should invest in improving its trading transport facilities in order to get more benefits from trade by acquiring larger markets around the globe. Although the GDP of Pakistan shows a positive effect on trade, the relation is inconsequential. However, the impact of the GDP of trading partners of Pakistan is significantly positive. This means that the GDP of Pakistan does not affect its trading potential significantly. However, it can be concluded that Pakistan has a greater trading potential with larger economies as compared to smaller ones. The population of trading partners of Pakistan is showing a significant positive impact on trade, which means that the greater the population of the trading partners of Pakistan greater the trade. Common border, however anticipated to have a positive impact on trade but shows converse results. This can be justified because of the geopolitical situation of Pakistan. Except for China, Pakistan does not have stable and harmonious relations with its neighboring border-sharing states. Also, illegal means of trading are common between Pakistan and its border-sharing countries. Therefore, the government of Pakistan should not only seek to have good relations with its neighboring countries but also strive to remove all illegal means of trading. Preferential trade agreements between Pakistan and its trading allies also show a substantial negative influence on trade, although expected conversely. This shows that Pakistan is not getting benefits from the trade agreements it has made. Therefore, this study proposes the Pakistani government act rationally in trade agreement policies.

LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

The gravity model, as believed by some authors, lacked a solid theoretical basis, even though it was first acknowledged for its ability to accurately anticipate trade flows between nations. (Anderson et al., 2003) Even though the model's theoretical foundation is now established, its practical use has given rise to several ongoing debates. These controversies revolve around the appropriate estimation technique and description of the gravity equation (Kareem, 2014). The

conventional Gravity Model, which takes into account macroeconomic characteristics like GDP, geographic distance, and various other variables, precisely replicates the size of trade between linked states. Nonetheless, it fails to imitate the very heterogeneous nature of international trade and instead predicts a network with a homogeneous topology (Almog et al., 2019). Longer periods and comparisons can be used to further expand the research and confirm or refute the constancy of the findings. To assess the dependability of the research's findings, it is also advised to repeat the study on a comparable sample after a predetermined amount of time.

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