
An Empirical Analysis of Pakistan's Bilateral Trade: A Gravity Model Approach

Shaista Khan¹
Ihtisham ul Haq²
Dilawar Khan³

This study aimed to investigate Pakistan's bilateral trade flows with major trading partners. Panel data for the time period 1990-2010 with a frequency of two years was analyzed. Gravity model was employed for the analysis of the data and proved to be successful in explaining Pakistan's bilateral trade flows by high values of R-square and adjusted R-square. Results revealed that GDP and GDP Per capita positively affect trade volume while distance and dummy variable for cultural similarities showed a negative relationship towards trade volume. Ratio of actual trade to predicted trade determined for each of the partner country for the year 2010 revealed that Japan, Turkey, Malaysia, India and Iran have greater unrealized trade potential with Pakistan which leads to policy implications.

Keywords: Trade volume, GDP, Gravity model, Trade Potential, Geographical distance

JEL Classifications: F1, E01, F14, F17.

¹**Shaista Khan**, Lecturer, Kohat University of Science & Technology, Kohat, Pakistan, shaista@kust.edu.pk

²**Ihtisham ul Haq**, Assistant Professor, Kohat University of Science & Technology, Kohat, Pakistan, ihtisham@kust.edu.pk

³**Dilawar Khan**, Assistant Professor, Kohat University of Science & Technology, Kohat, Pakistan, dilawar@kust.edu.pk

Introduction

Achieving sustainable development and reducing poverty are the main goals of almost all developing nations. International trade is one of the means available with developing nations to achieve these goals. Developing countries can attempt to reduce poverty by raising its share in the world's total exports.

Pakistan being a less developed economy can also realize its goals of poverty reduction and achieving development by increasing its total trade volume with the rest of the world. Therefore it is important to explore the major determinants of Pakistan's bilateral trade volume. These findings can then enable policy makers to formulate policies focusing on expanding Pakistan's trade volume.

The underlying study tries to investigate the role of some of the important factors in increasing trade volume of Pakistan with its major trade partners. The existing study is not confined to any particular regional bloc like majority of previous studies. This is for the purpose to concentrate equally on the analysis of trade situations in the cases where Pakistan is not having any trade agreement. This study carries considerable inferences for trade related policies. Furthermore, Gravity model is used by the current study in an $N \times 1$ setting for examining bilateral trade flows of Pakistan. Most of the past studies have used $N \times N$ setting for enquiring trade situations among pair of countries. Analysis conducted using $N \times 1$ setting leads towards policy inferences for a particular country while $N \times N$ setting gives policy implications equally suitable for N economies. Therefore $N \times 1$ setting is having advantage over $N \times N$ setting in a way that the former leads to policy implications for a specific country while the later leads to trade policies equally appropriate for N countries.

Hatab, Romstad and Huo (2010) conducted their study to investigate the important determinants of Egypt's agricultural exports to its main trading partners by using gravity model. Time period from 1994 to

2008 was considered for the analysis. Results of the analysis revealed that total agricultural exports of Egypt will be caused to increase by 5.42 percent as a result of an increase in GDP of Egypt by only one percent. GDP per capita of Egypt was however found negatively correlated with total exports. It was also found that depreciation of Egyptian Pound against the currencies of its trade partners will cause Egypt's agricultural exports to increase. Additionally, agricultural exports were found to have negative correlation with transportation costs.

Mike and Okojie (2010) attempted to examine the relationship between trade and economic growth in case of Nigeria. Findings of the study revealed that economic growth is positively affected by trade openness and negatively affected by political instability prevailing in Nigeria. Zaman, Aman, Khan and Awan (2010) applied the gravity model approach to explore empirically the prospect of bilateral trade between Pakistan and Turkey. Findings of the study suggested a strong positive relationship between GDP and bilateral trade. Also per capita income was found strongly correlated to the bilateral trade. Distance variable was evidenced as having a weak correlation with bilateral trade. Analysis suggested that attempting to increase bilateral trade between Pakistan and Turkey can bring economic prosperity for both the countries.

Zada, Mhammad and Bahadar (2011) investigated the major determinants of exports in case of Pakistan. Time series data for the time period 1975-2008 was used. The Generalized Methods of Moments (GMM) and empirical Bayesian techniques were employed for estimation. Results of the study revealed that Pakistan's exports are affected largely by international demand and international prices suggesting the significant role of demand side factors in determining Pakistan's exports. Comparatively small price and income elasticities were found on supply side. Demand for exports was found greater for countries in European Union, NAFTA and Middle East region

suggesting a need for greater concentration on establishing an increasing trade with these countries.

Dilanchiev (2012) attempted to analyze the trade pattern of Georgia using gravity model approach. For this purpose, panel data set for time period 2000 to 2011 was used. Results of the study showed that size of the economies positively affect Georgia's trade volume. Also GDP per capita and common history was explored by the findings to be important determinants of trade pattern of Georgia. A positive correlation of foreign direct investment with trade was also confirmed by the findings of the study.

Khiyavi, Moghaddasi and Yazdani (2013) used gravity model approach to explore important factors affecting trade in agriculture in case of developing countries including Iran, India, Malaysia, Pakistan, Thailand, Turkey, Brazil, Indonesia, Kenya, Venezuela, Tunisia, Romania, Chile and Mexico. Panel data for the time period between 1991 and 2009 was employed for the analysis. Growth of the market size of both the exporting and importing countries was found influencing trade in agricultural products. Agricultural trade volume of importing country was explored to be positively and significantly affected by its per capita income and vice versa in the case of exporting country.

Gravity model of trade is employed by the current study for analyzing the bilateral trade flows in case of Pakistan. This model is based on Newton's Law of Gravity, states that total trade volume between any two countries increases with an increase in the product of their economic sizes and decreases with the geographical distance between them. As such gravity model is lacking any theoretical foundation but empirically it is proved to be very successful. This is its empirical success that motivated economists to anticipate its theoretical foundation. For this purpose, gravity equation was derived in reduced form from various international trade models to make gravity equation orderly with a larger number of trade models (Sohn, 2005).

Main objective of the current study is to test the applicability of gravity model to bilateral trade flows in case of Pakistan. This study also attempts to capture the effect of cultural similarities existing between Pakistan and its trading partner on the trade volume between them. Gravity analysis is intended to be used for deriving important implications regarding Pakistan's trade policy.

Following are the hypotheses of this study:

- i. Trade volume of Pakistan with its trade partner increases with increasing product of their economic sizes.
- ii. Trade volume of Pakistan with its trade partner is negatively affected by the geographical distance between them.
- iii. Cultural similarities between trade partners positively affect trade volume.

Research Methodology

This research study aimed to examine Pakistan's bilateral trade flows through gravity model. Time period of 1990-2010, with a frequency of two years is employed by the study. Data has been taken from Economic Outlook Database of IMF and Pakistan Economic Survey (various issues). Annual data on trade (TR) is taken at constant 2000 US dollars. The distance variable (DST) represents the geographical distance between Pakistan's capital and its partner. Similarly annual data on Gross Domestic Product (GDP) and Per Capita (PC) is taken to measure the economic size of the economy based on Purchasing Power Parity. An attempt to capture the impact of cultural similarity has been done by this study. A dummy variable (DC) is used for this purpose. It seems difficult to define cultural similarity but to keep it simple, cultural similarity between Pakistan and its trade partners is decided on the basis of economic, religious and social similarities between them.

This study has employed gravity model for analyzing bilateral trade flows of Pakistan with its major trading partners that basically are mathematical models based on Newton's law of gravitational force. This concept of gravitational force is used by gravity models as an analogy to analyze various important issues such as exploring the unrealized trade potential and analyzing trade situations of the economies, migration among different states, capital flows across international borders and many more. Newton in his law states that:

“Every particle of matter in the universe attracts every other particle with a force that is directly proportional to the product of masses of the particles and inversely proportional to the square of the distance between them.” That is:

$$GF_{ij} = \frac{GM_iM_j}{D^{2ij}} \dots\dots\dots 2.1$$

Where

GF_{ij} = Force of gravity between the two particles

G = gravitational constant for converting proportionality into equality

M_iM_j = product of masses of the two particles

D^{2ij} = square of straight- line distance between the two particles

The gravity equation derived from Newton's Law of Gravity represented by equation (2.2) is as follows:

$$TR_{ij} = \alpha \frac{M_i \cdot M_j}{DST_{ij}} \dots\dots\dots 2.2$$

Where: TR_{ij} = trade volume between countries i and j in a particular year

α = constant for converting proportionality into equality

$M_i.M_j$ = product of the masses of the two countries i and j
 DST_{ij} = geographical distance between the two countries i
 and j

In order to make it conform to usual regression analysis, equation (2.2) is usually converted into its linear form:

$$\log(TR_{ij}) = \alpha + \gamma_1 \log(M_i.M_j) + \gamma_2 \log(DST_{ij}) + \mu_{ij} \dots \dots \dots 2.3$$

Masses of the economies can be represented by alternative variables which include Gross Domestic Product (GDP), GDP and population, Per capita GDP and by GDP and per capita GDP. The current study makes use of GDP and per capita GDP for representing mass of the economy of Pakistan and of its trade partners. The basic standardized form of gravity equation employed in the current study is:

$$\log(TR_{ij}) = \pi_0 + \pi_1 \log(GDP_i.GDP_j) + \pi_2 \log(PC_i.PC_j) + \pi_3 \log(DST_{ij}) + \varepsilon_{ij} \dots \dots \dots 2.4$$

In order to explore the possible effects of cultural similarities on the trade volume of Pakistan, a dummy variable namely DC is added to the basic gravity equation, so the resulting equation becomes:

$$\log(TR_{ij}) = \beta_0 + \beta_1 \log(GDP_i.GDP_j) + \beta_2 \log(PC_i.PC_j) + \beta_3 \log(DST_{ij}) + \beta_4(DC) + \varepsilon_{ij} \dots \dots \dots 2.5$$

Where $\log(TR_{ij})$ is natural log of trade volume between Pakistan and its trade partner $\log(GDP_i.GDP_j)$ is the natural log of product of GDPs of Pakistan and its trade partner. The $\log(PC_i.PC_j)$ is natural log of product of Per Capita of Pakistan and its partner country while $\log(DST_{ij})$ is the natural log of geographical distance between Pakistan and its trading partner. DC represents dummy variable for cultural similarities between Pakistan and its trading partner, DC will assume value of 1 if there are cultural similarities between the two countries

and will take the value of 0 if other wise. “ ε_{ij} ” is the regression error term. The expected signs of the coefficients of variables in the above model as suggested by the economic theory are such that β_1 is expected to have positive sign; β_2 is also expected to show positive sign as the theory proposes the per capita income to be a positively influencing factor for trade volume. Sign of β_3 advocated by the theory is negative while sign of β_4 is expected to be positive because cultural similarities are likely to increase and initiate trade between two economies.

Results of the Study

The results of OLS regression for the basic gravity equation (2.4) and full gravity equation (2.5) are presented in Table 1 and 2 respectively. R-squared values for both the equations are 0.826 and 0.839 respectively which indicates that the overall performance of the model is really good. The coefficient of determination (R^2) for the two models respectively suggest that eighty three and eighty four percent variations in the dependent variable is being explained by the explanatory variables. Value of adjusted R-Square is 0.819 and 0.831 for the basic gravity equation and for the full gravity equation respectively. Significance of both models reveals that the bilateral trade flows of Pakistan is better explained by gravity model. Also it is found to be well applicable to a single country case.

Estimation of basic gravity equation gave signs of coefficients as predicted by the economic theory. Result of basic gravity model revealed that Product of two countries' GDPs has positive and significant impact on bilateral trade. Its coefficient is 0.0847 and is significant at five percent level of significance. Its coefficient can be interpreted as keeping all other variables constant, a 1 percent point increase in product of the GDPs will on average lead to increase the

bilateral trade volume of Pakistan with the concerned trade partners by 0.0847 percent. The product of the two countries' per capita GDPs also has positive and significant effect on bilateral trade at one percent level of significance. The value of its coefficient is estimated to be 0.447 with a positive sign as was expected and can be interpreted as keeping all other variables constant, a 1 percent point increase in product of the per capita GDPs will on average lead to increase the bilateral trade volume of Pakistan with the concerned trade partners by 0.447 percent. Distance variable is having negative sign with its coefficient value of 0.326 and is found significant at five percent level of significance. Coefficient of the distance variable can be interpreted as keeping all other variables constant, a 1 percent point increase in distance will on average lead to decrease the bilateral trade volume of Pakistan by 0.326 percent.

Table 1

Regression Results of Basic Gravity Equation

Explanatory Variables	OLS Coefficient	t-value	Standard Error	p-value
Constant	-2.221	-1.25	1.767	0.2115
Product of GDPs	0.075	2.338	0.0321	0.0213**
Product of per capita GDPs	0.493	9.238	0.0534	0.000*
Distance	-0.114	-0.524	0.2186	0.6007

$R^2 = 0.826$, $R^2_{adj} = 0.819$, $F\text{-statistics} = 123.64$, $Prob(F\text{-statistics}) = 0.000$, $N=109$

Note: * and ** shows significance at 1% and 5% respectively.

Source of data: Author's estimation

In case of full gravity equation, as was expected, product of the two countries' GDPs is significant at five percent level of significance. Coefficient of the GDP variable is estimated to be 0.075 for full gravity equation. As predicted by economic theory, estimated coefficient of the GDP variable is having positive sign. The estimated coefficient can be interpreted as that keeping all other variables constant, a 1 percent point increase in GDP will lead to an increase of 0.075 percent point in trade volume of Pakistan with the considered trade partners. Sohn (2005) and Ricchiuti (2004) also confirmed the positive relationship between trade volume and product of the GDPs. The product of the two countries' Per Capita GDPs is significant at one percent in determining Pakistan's bilateral trade volume. The coefficient of Per capita GDP variable is positive with value equal to 0.493. This finding is also consistent with the basic hypothesis of the gravity model that the trade volumes will increase with an increase in economic sizes. Value of the coefficient can be interpreted as keeping all other variables constant; a one percent point increase in per capita GDP will increase Pakistan's bilateral trade volume with the considered trade partners, on the average, by 0.493 percent point. Tran (2004) also found the same result.

The coefficient of distance is found statistically non significant with negative sign as was expected with a value of -0.114. Great circle distance between capital city of Pakistan and that of its trade partner is taken in miles. This result resembles the findings of Sohn (2005) and Tran (2004). An important role is always played by third parties in setting trade pattern of any two countries and same is the case with Pakistan. Despite of having trade potential with the countries in its very proximity, Pakistan is having very low trade with them which would other wise yield high returns. This is the reason that distance has turned out insignificant in determining Pakistan's bilateral trade volume. Larger percentages of the total trade potentials are evidenced to be unrealized by Pakistan generally in case of most of the

neighboring countries for example Iran and specifically India which is having the lowest possible distance with Pakistan. Dispute of Kashmir is also playing its role in the situation. Political differences and external players are responsible for such results. The DC variable which is representing cultural similarities between Pakistan and its trading partner resulted to be significant at one percent level of significance with negative coefficient of 0.759 which means that sharing common culture with any of its trading partner is not affecting Pakistan's bilateral trade volume positively. This is because of external interferences in formulation and setting of international trade relations. History shows that our trade policies and trade pattern are always dominated by third parties. These external interventions are made for achieving certain political goals. In addition, Pakistan's imports mainly comprise of technological items and it is well known that developed and large economies are the main exporters of technology while majority of countries having cultural similarities with Pakistan for example Saudi Arabia are themselves dependent upon these developed economies for technology. Also Pakistan faces competition in exports of majority of products from the countries with which it is having cultural similarities. These are some of the prominent factors responsible for establishment of negative and significant relationship between cultural similarities and trade volume of Pakistan.

Table 2

Regression Results of Gravity Equation with DC Variable

Explanatory Variables	OLS Coefficient	t-value	Standard Error	p-value
Constant	-2.221	1.25	1.767	0.2115
Product of GDPs	0.075	2.338	0.0321	0.0213 **
Product of per capita GDPs	0.493	9.238	0.0534	0.000*

$R^2=0.839$, $R^2_{adj}=0.831$, $F\text{-statistics}=107.61$, $Prob(F\text{-statistics})=0.000$, $N=109$

Note: *and ** shows significance at 1% and 5% respectively.

Source of data: Author's estimation

In order to explore the unrealized trade potential of Pakistan with its trade partners, trade volumes which are estimated from full gravity equation are compared with the actual trade volume for the year 2010. Difference between predicted and actual trade volume for a specific trade partner for the year 2010 will represent the unrealized trade potential with it. Ratio of actual trade to predicted trade is taken for exploring the unrealized trade potential of Pakistan with its major trade partners. These ratios are presented in table. Comparatively lower ratios are shown by countries like Japan, Turkey, Malaysia, Iran and India that are fifty six percent (56%), fifty five percent (55%),

seventy nine percent (79%) forty eight percent (48%) and fifty three percent (53%) respectively. These lower ratios imply considerable barriers to trade that have resulted in a significant amount of un-exhausted potential for trade. Japan with a ratio of fifty six percent (56 %) implies that forty four percent (44 %) of its total trade potential with Pakistan is unrealized. Similarly in case of Turkey, Malaysia, Iran and India, forty five (45), twenty one (21), fifty two (52) and forty seven (47%) percent of the total trade potential are indicated to be unrealized by these ratios respectively. A lower ratio country indicates a better partner for Free Trade Agreement (FTA) because elimination of trade barriers through FTA will lead to realization of the un-exhausted trade potential, resulting in a larger expansion of trade by Pakistan.

Table 3

Actual and Predicted Trade Flows for the Year 2010 (Million US dollars)

Country	Actual Trade Flows(TR)	Predicted Trade Flows(PTR)	TR/PTR (%)
USA	4983	1905	262
Japan	1123	1995	56
Saudi Arabia	3124	2239	139
Germany	1621	1479	110
UK	1376	1007	137
Turkey	663	1202	55

Malaysia	2500	3162	79
India	900	1680	53
China	8700	2089	416
Iran	1000	2089	48

Source of data: Author's estimation

Conclusions

The current study attempted to investigate the extent of role of economic masses of Pakistan and its trading partners, geographical distance between them and cultural similarities in determining the bilateral trade volume of Pakistan. Gravity model was employed for the analysis of the data. High values of R-square and adjusted R-square for both the basic equation and full gravity equation proved that gravity model fits well in explaining the bilateral trade flows of Pakistan and exploring its unrealized trade potential. Estimation of full gravity equation resulted in a positive significant relationship between GDP and trade volume which means that trade volume of Pakistan with its trading partner was caused to increase by an increase in economic sizes. GDP per capita also showed positive relation to the trade volume and this relationship was found significant. Distance resulted in a negative relationship towards trade volume but it was found non significant in the determination of Pakistan's bilateral trade volume. Dummy variable for cultural similarities showed a negative significant relationship towards trade volume.

Ratio of actual trade to predicted trade for each of the partner country for the year 2010 was determined for exploring the unrealized trade potential of Pakistan with them. Comparatively lower ratios were found for Japan, Turkey, Malaysia, India and Iran which indicates their greater unrealized trade potential with Pakistan which make them

potential partners for Free Trade Agreements. This information is carrying policy implications for our economy which should be considered by the policy makers for realizing the differences between actual and predicted trade.

Dummy variable for cultural similarities has shown a negative and significant relationship with trade volume. This is because of external interferences in formulation and setting of our trade policies, pattern and international relations. . In addition, Pakistan's imports are mainly consisted of technological items and the exporters of technology are mainly large and developed economies while majority of countries having cultural similarities with Pakistan for example Saudi Arabia are themselves dependent upon these developed economies for technology. Policy recommendations based on research findings are under:

- i. Pakistan should take initiative to increase its trade with large economies as findings of the study showed a positive significant relationship between GDP and trade volume.
- ii. Political objectives should be settled according to economic objectives so that economic activities like trade may not suffer because of political disputes.
- iii. Countries like Japan, Iran, India, Turkey and Malaysia should be considered for trade agreements as findings of the study suggest larger percentages of unrealized trade potential with them.
- iv. Trade with neighboring countries should be increased as lower transportation costs may lead to an increase in demand for exports and imports.

References

- Obadan, M. I. and Okojie, I. E. (2010), “An Empirical Analysis of the Impact of Trade on Economic Growth in Nigeria”, *JOS Journal of Economics*, 4(1).
- Zaman, K., Qaiser, A., Adnan, K. and Zahid, A. (2010), “Empirical Evidence of Trade Integration between Pakistan and Turkey (A Gravity Approach)”, *Journal of Managerial Sciences*, 4(2).
- Zada, N., Malik, M. and Khan, B. (2011), “Determinants of Exports of Pakistan A Country Wide Disaggregated Analysis”, Discussion paper presented in The 27th Annual General Meeting and Conference of the PSDE.
- Khiyavi, P.K., Moghaddasi, R., and Yazdani, S. (2013), “Investigation of Factors Affecting the International Trade of Agricultural Products in Developing Countries”, *Life Science Journal*, 10(3s): 409-414.
- Hatab, A. A., Romstad, E. and Huo, X. (2010), “Determinants of Egyptian Agricultural Exports: A Gravity Model Approach”, *Modern Economy*, 1(3): 134-143.
- Dilanchiev, A. (2012), “Empirical Analysis of Georgian Trade Pattern: Gravity Model”, *Journal of Social Sciences*, 1(1): 75-78.
- Sohn, C. (2005), “Does the Gravity Model Fit Korea’s Trade Patterns? Implications for Korea’s FTA Policy and North-South Korean Trade”, Centre for International Trade Studies Working Paper.
- Ricchiuti, G. (2004), “Empirical Evidence on the North-South Trade Flows: an Augmented Gravity Model”, MPRA Paper No. 1326:23-34.

- Quan, T. N. (2005), “The Desirability of a Vietnam-Japan Free Trade Agreement: The Gravity Model Approach”, A Policy Proposal Submitted to National Graduate Institute for Policy Studies Tokyo, Japan.
- Government of Pakistan (2011), Pakistan Economics Survey (Various issues) Islamabad: Ministry of Finance, www.finance.gov.pk/survey/Accessed on June 2011.
- IMF (2008), World Economic Outlook Database, www.imf.org/external/pubs/ft/weo/Accessed on June 2011.

