An Analysis of Pakistan's Exports using Gravity Model

Dr. Javed Iqbal
Assistant Professor, Department of Economics, Abdul Wali Khan University Mardan

Abstract

Pakistan exports have been showing a declining trend. Pakistan exports have not been only concentrated in trading in few goods but also exporting to a few countries. This study uses a gravity model of trade and panel data estimation technique to explain the export trends of Pakistan. Gross domestic product of the trading partners or economic size of a country (both GDPs and Per capita GDPs) was found to be a statistically significant determinant of trade between the countries. Pakistan's exports are negatively related to the distance variable. Sharing a border was not found significant for Pakistan's exports. Disputes over territory and terrorism related incidents with India and Afghanistan making a common border as not significantly explaining the trade. It is suggested that the disputes may be resolved between the neighboring countries and strengthening the regional trade agreements.

Keywords: Exports, Gravity Model, Pakistan

Pakistan exports to different countries but its exports are highly concentrated in a few countries. Almost more than three quarters of its exports go to USA, Canada, Germany, Japan, UK, Australia, Hong Kong, UAE, France, Germany, Italy, Belgium, Spain, Korea, China, India, Bangladesh, Turkey, Sri Lanka, Netherlands, Afghanistan and Saudi Arabia. Among these countries, the share of Pakistan's exports to USA has almost doubled increasing from 12.50% in 1990 to 24.50% over the years. US has been traditionally the largest export market for Pakistani products followed by UAE and UK with 8.50% and 7.25% of Pakistan exports going to these two markets respectively. Pakistan exports to its large neighboring country India and with other *South Asian Association for Regional Cooperation (SAARC)* member countries has been less than one percent. The share of exports to Germany, UK, Hong Kong and Saudi Arabia remained almost stagnant with some fluctuations over the years.

Similar pattern can be observed in imports of Pakistan which originates from few countries. Leading import markets of Pakistan are UAE (11.72%), Saudi Arabia (11.70%), China (6.22%), US (6.43%) and Japan (6%) respectively. Pakistan imported only 1.5% of its imports from India. The share of Japan exhibited a declining trend because of the shift in the import of machinery/capital goods from other sources. On the other hand, the shares of Pakistan's imports from Kuwait and Saudi Arabia have been rising with some fluctuations because of the growing share of POL products in total imports. Import share of Malaysia has been fluctuating over the years mainly on account of fluctuations in palm oil prices.

Pakistan is a member of the South Asian Association for Regional Cooperation (SAARC) besides Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka which was established on December 8, 1985. The trade among the SAARC member countries has not been very significant due to political problems between the two big economies Pakistan and India which has been the big obstacle towards growing trade among them.

Looking at the diverse import and export markets for Pakistan it is pertinent to study what factors explain such a trend in trade. This study is an effort to find out the major determining factors of Pakistan trade using gravity model to the panel data. The emphasis would be to explain only the exports of Pakistan in this research paper.

Literature Review

Gravity model has a long history of empirically successful application to bilateral trade flows without well developed theoretical foundations. Gravity model owes its name to the Newtonian Physic's principle of Gravitational force. Gravity model of international trade by analogy to gravitational principle explains that the volume of exports between countries is directly related to the size of the both economies measured usually by national income and proximity to each other measured by distance between them. The gravity model was first introduced by Tinbergen (1962) and Poyhonen (1963) to analyze the trade flows between the European countries. Tinbergen (1962) related the bilateral trade flows between two countries to the GNP of exporting country as it determines the quantity of good that it can produce, GNP of the importing country as it determine how much an exporting country can sell to it, and the cost of transportation and other tariff and non-tariff barriers proxied by distance between the two countries. Linnemann (1966) expanded the model by introducing the population variable to account for the economies of scale. Other factors besides country size and distances from one another can also be included in the gravity model such as whether they share a common border, whether they are landlocked, whether they are a member of some regional trading blocks, whether they have a common language etc. The simplest formulation of the gravity model can be given as follows:

$$\ln X_{ij} = \alpha + \beta \ln Y_i + \gamma \ln Y_j + \delta \ln D_{ij} + \sum \psi Dummy_{ij} \quad -(1)$$

where X_{ij} is exports from country i to country j, Y_i and Y_j are gross domestic production in countries i and j, D_{ij} is the distance between countries i and j usually measured by the main business centers in two countries, and $Dummy_{ij}$ represents the variety of factors that affect the trade between countries like common border, membership of common trading block etc. Equation 1 has been traditionally applied to cross section data of trade across a single year or more recently pooled over several years.

Despite the tremendous empirical popularity of the gravity model, questions have been raised about its theoretical justification since long and been considered as an *ad hoc* model of trade. There have been continuous efforts to find theoretical foundations for the gravity model led by Anderson (1979). Anderson (1979) stated that after controlling for size, trade between two countries is decreasing in their bilateral trade barrier relative to the average barriers of the two countries to trade with all other partners called *multilateral resistance*. He emphasized that as a country is more resistant to trade with all others, the more it is pushed to trade with a given bilateral trade partner. He noted that traditional model either does not include any multilateral resistance or includes remoteness variables related to distance to all bilateral trade partners and if the distance is only trade barrier, it has been included in the remote index in such a way that it is at odds with the theory. Due to the above mentioned reasons the results are often biased and one ca not do the comparative static exercises.

Anderson and Van Wincoop (2003) is the recent attempt to develop a method that consistently and efficiently estimates a theoretical gravity equation and used the estimated general equilibrium gravity model to perform the comparative static exercises. They in order to solve the famous border puzzle due to McCallum (1995) included the multilateral resistance variables besides the output of two regions, bilateral distance, and whether they are separated by border. Anderson and Van Wincoop (2003) showed that the *Remoteness Variable (REM) defined as* $REM_i=\sum d_{im}/y_m$ which shows the average distance of region i from all trading partners other than j have been used in literature in the past is disconnected from theory and it has not been useful to add to the explanatory power of the model. Anderson and Van Wincoop (2003) paper used the constant elasticity of substitution (CES) preferences and CES expenditure system to derive the gravity model. They derived a trade resistance decomposed into the bilateral trade between region i and j, i resistance with all other regions and j resistance with all regions. They derived the traded goods share (demand) by maximization of CES utility function subject to budget constraint. They arrived at a demand for region i’s good by region j to be a function of income of two countries and prices indices in two countries called multilateral resistance factor which depends on the bilateral trade resistances. They showed that price indices are not the consumer price indices and they are unobservable but can be calculated from other observable variables in the model. They showed that the trade between two regions depends on the bilateral trade barrier between them relative to average trade barriers that both regions have with all other trading partners. They used the non-linear estimation method to determine the model parameters.

Bergstrand (1985) derived the gravity model from trade models with product differentiation and increasing returns to scale. Deardorff (1998) showed that the gravity equation is consistent with several variants of the Ricardian and Heckschser-Ohlin models. Frankel (1993), and Sharma and Chua (2000) used the sum of exports and imports as dependent variable and products of GNPs and product of per capita GNPs in place of GNP along with the distance and other dummy variables as explanatory variables in their gravity models. Although theoretical foundations have been established of late, the empirical application of the gravity model is still rather basic.

Traditionally, cross section data for a particular period have been used to estimate the gravity model. However, it has been emphasized in the literature that pooling of the cross section and time series data generally called penal data models give more information than the simple ordinary least squares estimation. The advantages and disadvantages of using penal data are outlined in detail in Baltagi (2003). Individual countries are heterogeneous in nature and cross section or time series studies individually do not account for such heterogeneity and thus the results are biased. In gravity model there are factors such as political regimes, colonial history, religion etc which affect the bilateral trade and that are country or time invariant. Also, most of the time, country's invariant or time invariant data are not available and thus their omission results in the biased results. Penal data estimation method is able to control for these variables. The penal data gives more information, more variability, less collinearity among variables, more degree of freedom, more efficiency and individual country effect can easily be obtained. Penal data model would be used in this study due to the fact that it has more advantages over cross section or time series models.

Research Methodology

Data

This study covers the data from 1980-2014 (34 years). For export of Pakistani goods, we chose 20 countries which are based on the common border (India, china and Afghanistan), membership of SAARC (India, Bangladesh and Sri Lanka), and other major Middle Eastern and European countries. Afghanistan was dropped from the analysis due to the unavailability of data for the major economic indicators. Thus, we have a penal of 680 observations.

All the data on GDP, GDP per capita, population, and exchange rates are obtained from World Development Indicators (WDI) of World Bank , International Financial Statistics (IFS) and Direction of Trade Statistics (DOTS) of IMF. The data on distance between Pakistan and other countries is obtained from website www.indo.com/distances.

Model Specification and Estimation

The gravity model used for this study is similar to the model used by Frankel (1993) and Sharma and Chua (2000). We have the log of exports of Pakistan to country j as dependent variable and log of product of GDPs of Pakistan and country j, log of product of GDPs per capita and the exchange rate between Pakistan and country j as the explanatory variables in the first stage of estimation. Second stage of estimation in the panel data analysis involves the regressing of individual country effects on the distance, and dummy variables such as whether Pakistan shares a border with a country that it is exporting to, whether a bilateral partner is a member of SAARC, and whether Pakistan had a democratic rule or military rule. The formal model is given as follows:

Equation to be estimated in stage I:

$$\log(X_{ijt}) = \alpha_0 + \alpha_1 \log(GDP_{it} * GDP_{jt}) + \alpha_2 \log(PCGDP_{it} * PCGDP_{jt}) + \alpha_3 \log(ER_{ijt}) + \varepsilon_{ijt} \quad --(2)$$

Equation to be estimated in stage II :

$$countryeffect_{ijt} = \beta_0 + \beta_1 dist_{ij} + \beta_1 SAARC_{ij} + \beta_1 DCB_{ij} + v_{ij} \quad ---------(3)$$

X_{ijt} is the total value of export in US dollars from Pakistan (country i) to country j in year t.

GDP_i (GDP_j) is the Gross Domestic Product of Country i (j) in constant 1995 US million dollars in year t.

$PCGDP_i$ ($PCGDP_j$) is the Per Capita Gross Domestic Product of Country i (j) in constant 1995 US million dollars in year t

ER is the exchange rate between Pakistan country (i) and country j in National Currency per US Dollar in year t.

Countryeffect is the country specific effects obtained from panel data estimation method from equation 1.

Dist is the distance between Pakistan (country i) and country j in Kilometers.

SAARC and DCB are the dummy variables representing whether a country is a member of SAARC and whether Pakistan shares a border with country j, respectively.

We expect positive coefficients for both GDP and Per Capita GDP as they are considered good proxy for economic development and as noted by Frankel (1993) that when country become more developed, they trade more. Similarly, when the exchange rate (in terms of number of national currency for one unit of currency of country j) increases i.e domestic currency depreciates/devalues, then exports must go up so we expect a positive sign for the coefficient attached to exchange rate. In panel data estimation, we can not include the variables that do not change over time, as their effect is eliminated during the transformation process. Therefore, in the second stage of estimation, we estimate equation 2 by ordinary least squares and we expect the distance to negatively relate to trade as it is considered a good proxy for the transaction costs. Also, we expect to get positive coefficients for the SAARC and common border.

We estimated both fixed effect and random effect models and tested which model would be more appropriate using the LM and Hausman's tests. The Higher values of LM (913.01) and Hausman's test (51.74) indicates that the fixed effect model is the appropriate model to be used for estimation Also, the group dummies for individual countries were tested using the F test statistic and the value of F has been greater than the critical value which indicates the presence of country specific effects and therefore panel data method may be a more appropriate strategy compared to simple ordinary least squares method.

Data Analysis and Results

In our fixed effect model given in equation 1, the intercept term is considered country specific effects and slopes are considered to be the same over time and across countries. Results from panel data estimation (Fixed effect) of Pakistan's exports are reported in table 1. The product of GDPs as expected has significantly positive impact on Pakistan's exports and the magnitude of coefficient of product of GDP's is consistent with the results in Sharma and Chua (2000), Frankel (1993) and Rahman (2003). The results here support the theory that trade increases with the growth or size of the economy. Similarly, product of Per capita GDPs also shows a positive impact on trade but it is significant only at 7 per cent level of significance. Theses results clearly show that economic size of a country (both GDPs and Per capita GDPs) has positively significant effect on the trade or exports from a country. Exchange rate (number of Pakistani currency units –Rupees per foreign currency in terms of US dollars) effect on Pakistan trade has been unexpectedly negative but insignificant. The magnitude of exchange rate impact is also very low. The exchange rate increase shows a deprecation of the Pakistani currency and should have a positive impact on the exports. Exchange rate has two impacts. Firstly, increase in exchange rate make the Pakistani's exports cheaper while it makes the imported raw materials more expensive so in Pakistan's case may be the later case dominates the former effect of exchange rate. The results in this paper are consistent with the results reported in Harris and Mátyás (1998). The model goodness of fit (55%) is reasonable for the panel data models which have both the cross section and time series data components.

Table 1. *Fixed Effect Estimation of Gravity Model of Pakistan's Exports*

Dependent Variable – Exports of Pakistan (i) to country (j)					
Independent Variables	Coeff.	Std. Error	t-ratio	Prob.	Mean
log (ER_{ijt})	-0.03	0.07	-0.43	0.67	0.15
$Log(GDP_{it*}GDP_{jt})$	0.65	0.33	1.96	0.05	8.65
$Log(PCGDP_{it*}PCGDP_{jt})$	0.98	0.55	1.79	0.07	5.52
R-squared	0.55				

Adjusted R-squared	0.53
F-Value	21.17

Results reported in table 2 indicates that Pakistan's exports are negatively related to the distance variable which is in conformity with the earlier results for gravity models. The coefficient on distance variable is also highly significant. The small magnitude of the coefficient on distance variable make sense in Pakistan as it seems that it does not have a very big impact on the Pakistan's exports due to the problems that Pakistan have with India and Afghanistan. China which is also close to Pakistan but their economy is highly protected. Similarly, big share of Pakistan's exports consist of textile and rice products and we are in direct competition with our neighboring countries China, India and Bangladesh and therefore due to the production of competitive products by all the major neighboring countries the potential for trade among them is minimal despite proximity of these countries to each other.

Pakistan has bigger share of trade with United States which is quite distant compared to some other country. The dummy variable for sharing a common border is not significant for Pakistan's exports due to the fact that it shares border with India, Afghanistan and china and with two former countries Pakistan has border and other disputes. Chinese economy has been traditionally much protected and border might have not a significant effect. The South Asian Association of Regional Cooperation (SAARC) has scientifically positive impact on Pakistan's exports.

Table 2. *Time Invariant variables effect in the Gravity Model of Pakistan's Exports*

Dependent Variable – Country Specific Effects					
Independent Variables	Coeff.	Std. Error	t-ratio	Prob.	Mean
Dummy Common Border	0.38	0.90	0.42	0.68	
Dummy SAARC	2.88	0.82	3.51	0.00	
DIST	-0.01	0.01	-2.40	0.03	5356.14

All the country specific effects can be seen to be highly significant (Table 3). Japan, France, and most of the European and North American countries have smaller propensity for the Pakistani's exports while Bangladesh, Sri Lanka, India (all SAARC member countries), UAE and Saudi Arabia have the larger propensities to Pakistan's exports respectively.

Table 3. *Estimated Fixed Effects from Panel Data estimation of Pakistan's Exports*

Group	coefficient	standard Error	t-ratio
United States	-26.51	2.72	-9.75
Canada	-26.75	2.68	-9.97
Australia	-26.69	2.72	-9.83

Japan	-27.61	2.87	-9.63
Belgium	-26.62	2.87	-9.28
France	-27.09	2.74	-9.89
Germany	-26.72	2.73	-9.79
Italy	-26.61	2.80	-9.50
Netherlands	-26.52	2.79	-9.52
Spain	-26.66	2.70	-9.87
United Kingdom	-25.69	2.64	-9.74
Bangladesh	-20.97	2.21	-9.49
China	-23.16	2.59	-8.97
Hong Kong	-24.72	2.83	-8.74
India	-23.21	2.56	-9.08
Korea	-25.62	2.66	-9.63
Sri Lanka	-21.53	2.16	-9.98
Turkey	-25.52	2.56	-9.97
Saudi Arabia	-23.95	2.53	-9.46
United Arab Emirates	-23.92	2.95	-8.11

Conclusion

The results in this study are quite consistent with the overall results obtained from gravity model used in other studies. We estimated both the fixed effect and random effect model but the Huasman and LM test showed the appropriateness of fixed model to be used for this study. Results showed that economic size measured by GDP and GDP per capita have significant impact on Pakistan's exports. Also, membership in the SAARC has positively significant impact on Pakistan's exports. Sharing a common border is not a big factor in explaining the Pakistan's exports. Distance variable though has expected negative significant sign but the magnitude of coefficient is very small. It indicates that there are other factors that might affect the trade which are not accounted for in our model. The exchange rate does not have the significant impact on Pakistan's exports.

Above given results indicate that economic size, membership in SAARC have the positively significant impact on trade. Therefore, it is suggested that Pakistan should try to normalize the relationship with India which is both a member of SAARC and also have a big economy. The country specific results show the propensities to exports with individual countries. It has been shown that SAARC countries have the largest propensities to Pakistan's exports; therefore, this factor must be taken into consideration while formulating the trade policies.

One of the limitations of this study is that the role of multi-lateral resistant factor is not considered for Pakistan's exports as it is very complex and not easy to calculate empirically. As noted by Anderson van Wincoop(2003) it may results in biased results. One of the constraints faced by this author was the unavailability of price indices for some of the important trading partners like UAE and Bangladesh etc which are the largest export markets for Pakistan in terms of export market shares and the omission of such important trading countries would have biased the results as well. Anderson van Wincoop (2003) multilateral resistant factor includes the trading cost and price indices for country i and j. The data on trading costs is also not easy to calculate and usually it is assumed that they vary with the distance directly. We have the distance variable in the model, so it could capture that affect.

References

Anderson, James E. and van Wincoop, Eric. 2003. Gravity with Gravitas: A Solution to the Border Puzzle. *The American Economic Review* 93 (1): 170-192.

Anderson, James E. 1979. A theoretical foundation for the Gravity equation. *The American Economic Review* 69 (1): 106-116.

Baltagi, B.H. 2001. *Econometric Analysis of Panel Data.* Second Edition. John Wiley & Sons, Ltd.

Bergstrand, Jeffrey H. 1982. The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence. *Review of Economics and Statistics* 67(3): 474-81.

Deardorff, Alan. 1998. Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? In Jeffrey A. Frankel ed., The Regionalization of World economy, University of Chicago for NBER, pp. 7-32.

Frankel, J.A. 1993. Is Japan creating a yen block in East Asia and the Pacific? In J. Frankel and M. Kohler (eds), Regionalism and Rivalry: Japan and the United States in Pacific Asia, University of Chicago, pp.53-87.

Funk, T. F. and A. T. Vincent. 1978. The farmer decision process in purchasing corn herbicides. Research Bulletin AEEE/78/2. Guelph: University of Guelph, School of Agricultural Economics and Extension Education, January.

Harris, M.N and Mátyás, László. 1998. The Econometrics of Gravity Models. Melbourne Institute working Paper No. 5/98. ISSN 1328-4991. ISBN 0 732 0967 X. The Melbourne Institute of Applied Economics and Social Research, the University of Melbourne, Parkville, Victoria 3052 Australia.

Linnemann, H. 1966. *An Econometric Study of International Trade flows,* Norh-Holland, Amsterdam.

McCallum, John. 1995. National Borders Matter: Canada-U.S. Regional Trade Patterns. *The American Economic Review* 85(3):615-623.

Poyhonen, P. 1963. A Tentative Model for the volume of Trade between countries. *Welwirtschaftliches archive* 90: 93-99.

Rahman, M. M.. 2003. A Panel Data Analysis of Bangladesh's Trade: The gravity Model Approach. Discipline of economics, University of Sydney. NSW 2006. Australia.

Sharma, S.C and S.Y. Chua .2000. ASEAN: Economic Integration and Intra-regional Trade. *Applied economic Letters* 7:165-169.

Tinbergen, J. 1962. *Shaping the World Economy: Suggestions for an International Economic Policy, The twentieth Century fund*, New York.

William H Greene. 1998. *LIMDEP Version 7:User Manual*, Econometric Software Inc., Plainview, NY.