Volume:1, Issue-2,
Page: 37-57
2017

ISSN 2520-4750

International Journal of Science and Business

How does the Size of an Economy Matter? A Panel Data Analysis of China's Trade by Using the Gravity Model

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Abstract

The larger the size of the stone the greater the frictions it has to endure while rolling, this is the law of general physics. On that same note, we consider the China's Economy which has been booming and racing fast towards becoming the NO. 1 economy in the world, is facing and will have to face challenges now and onwards. This paper has made the attempt to provide a brief theoretical justification for using the gravity model in the analysis of bilateral trade and apply the generalized gravity model to analyze the China's trade with its major trading partners as well as countries in BCIM using the panel data estimation technique. The effect of the size of the economies, per capita GNI differential of the countries involved and openness of the trading countries over the China's trade have been obtained as the results of the analysis.

Keywords: China's Trade, Gravity Model, GNI, Panel Data etc.

1. Introduction

Trade is an integral part of the total developmental effort and national growth of an economy. This is, in fact, a crucial instrument for industrialization while access to foreign exchange is essential for sustained economic development. Over the past three decades, China's two historic transformations, from arural, agricultural society to an urban, industrial one, and from a command economy to a market-based one, have combined to yield spectacular results. Since the institution of its reforms and Open Door policy in 1978, China's gross domestic product (GDP) has been growing at an average annual rate of more than 9 percent. In2010, it is poised to surpass that of Japan and become the world's second-largest economy.

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Industry spillovers to China's manufacturing sector, and in technology and management skill flows. Its accession to the World Trade Organization (WTO) was a key step giving China the opportunity to participate in world trade within a multilateral trade system.

Many signs point to a growth slowdown in China to near 8.5 % in 2011-15and to around 5% in 2026-30 due to some important developments especially within China. One reason of this is the tendency of the growth effect of shifting resources from agriculture to industry to decline, the rising capital-labor ratio. Another reason is the decrease in total factor productivity (TFP) growth, and technological progress. Moreover, the old age dependency ratio will double in the next two decades as a wrenching demographic change, and the size of China's labor force is projected to start shrinking as soon as 2015. All these factors mean a higher share of services and consumption in the economy, a lower share of exports, savings, investment and a decline in the trade surplus. China's current pattern of development, which has placed considerable stress on the environment—land, air, and water— has imposed increased pressure on the availability of natural resources. Therefore, the leaders of China are considering to ponder over the development patterns more than ever. Their focus on Export led growth is diverting more and more towards mutual economic cooperation and from that point of view the idea of Belt and Road Initiative (BRI) has been emerged. In case of international economic cooperation, international trade relations come first and both serve each other intensively.

In this context the aim of the study is to consider factors such as GDP and GNI of China and its trading partners, GNI per capita and free trade agreements made between China and its trading partners to increase bilateral trade. These factors are analyzed within the framework of augmented gravity model. The paper is organized as follows. Section 2 justifies the relevance of this study with the course. Section 3 provides a theoretical justification for using the gravity model in applied research of bilateral trade, and secondly, to apply this model in analyzing the trade pattern and trade relation of China with its major partner countries. Section 4 focuses on the previous related works in this same issue as literature review. Section 5 provides the procedure of econometric estimation of Gravity Equations. Section 6 and 7 focus on brief overview on the evolution of China's economy and trade flows as well as global trade scenario. Section 8 discusses the Sample size and data issue and Section 9 discusses on methodology. Section 10, 11 and 12 provide the estimations, results and interpretations and section 13 suggests some policy implications followed by the conclusion.

2. International Economic Cooperation and International Trade

In the post–World War II environment, countries came to realize that a major component of achieving any level of global peace was global cooperation—politically, economically, and socially. The intent was to level the trade playing field and reduce economic areas of disagreement, since inequality in these areas could lead to more serious conflicts. Among the initiatives, nations agreed to work together to promote free trade, entering into bilateral and multilateral agreements. The General Agreement on Tariffs and Trade (GATT) resulted from these agreements. World Trade Organization (WTO), which replaced GATT in 1995, has been influencing on international trade. In that regard, international trade could be deemed as one of the major component of international economic cooperation.

3. Background: Theoretical Justification of the Gravity Model in Analyzing Trade

The gravity model of trade in international economics, similar to other gravity models in social science, predicts bilateral trade flows based on the economic sizes of (often using GDP measurements) and distance between two units. The model was first used by Tinbergen in 1962. The basic theoretical model for trade between two countries (i and j) takes the form of:

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

Where F is the trade flow, M is the economic mass of each country, i and j, D is the distance and G is a constant.

The Newtonian physics notion is the first justification of the gravity model. The second justification for the gravity equation can be analyzed in the light of a partial equilibrium model of export supply and import demand by Linneman (1966). Based on some simplifying assumptions the gravity equation turns out to be a reduced form of this model. However, Bergstrand (1985) and others point out that this partial equilibrium model could not explain the multiplicative form of the equation and also left some of its parameters unidentified mainly because of exclusion of price variable. With the simplest form of the equation, of course, Linneman's justification for exclusion of prices is consistent. Bergstrand (1985, 1989) develops a microeconomic foundation to the gravity model. He opines that a gravity model is a reduced form equation of a general equilibrium of demand and supply systems. The micro-foundations approach also alleges that the crucial assumption of perfect product substitutability of the 'conventional' gravity model is unrealistic as evidence in recent times has shown that trade flows are differentiated by place of origin. It is shown by Evenett and Keller (1998) that the standard gravity equation can be obtained from the H-O model with both perfect and imperfect product specialization. Analyzing the theoretical foundations of gravity equations, they mention three types of trade models.

These models differ in the way specialization is obtained in equilibrium. They are:

(1) technology differences across countries in the Ricardian model,

(2) variations in terms of countries' different factor endowments in the H-O model,

(3) increasing returns at the firm level in the Increasing Returns to Scale (IRS) model.

The gravity model is widely used as a benchmark to estimate trade flows between countries. The gravity model has also been widely used in the applied literature to evaluate the impact of regional agreements, the border effect on trade flows, and trade potential.

4. Literature Review

There are wide ranges of applied research where the gravity model is used to examine the bilateral trade patterns and trade relationships. *Miranda et al.* modeled the international trade of U.S., Brazil and China during the period of 1995 through 2003 and showed temporal variables with expected sign and proper magnitudes, but the distance variable and the political effects had a poor performance (Miranda., Ozaki, Fonseca and Mortatti, 2007). A recent study on trade relations of Bangladesh with its eight major trading partner countries- India, China, Singapore, Japan, Hong Kong, South Korea, USA and Malaysia shows that partner countries' GDP has significant positive impacts, and partner countries' population has mixed impact on imports (Rahman, 2006). In the study named "Determinants of U.S. Exports to China", Bosworthand Collins show that the commodity composition of U.S. exports to China is similar to that to the world. It concludes that the asymmetry of the U.S. trade with China, small exports but large imports, is due to United States' low level of exports to all countries. (Bosworth and Collins, 2008). Bussiere and Schnatz (2006) used results from a gravity model to examine whether China's external trade with all trading partners is consistent with the economic fundamentals included in a gravity equation for the period 1980-2003. The results of a gravity equation model used to estimate the potential trade between Mainland China and Taiwan in case of the removal of trade restriction show that, given their sizes, the stages of their economic development, bilateral distance as well as other characteristics, Taiwan's imports from Mainland China should be more than double that of the current value if Taiwan can import freely from Mainland China, as other East Asian economies do (Xu and Yu, 2009). Zhang et all's work called "Chinese Bilateral Intra-Industry Trade: A Panel Data Study for 50 Countries in the 1992 2001 Period" intends to detect what country- specific factors influence bilateral intra-industry trade in the transition period for China and its trading partners by exploring a rich panel data set. Yu (2009) investigates the two-way causality between exchange rates and bilateral trade through data from China, Japan, and the United States during the 2002-2007 period. Drottz and Lantz conducted a study to estimate Sweden's export potential towards South-Korea from 1997 to 2005 by using basic gravity model, including GDP, distance in kilometer. In another study conducted to assess the actual trade between China and EU within Gravity model, although the results of the gravity model explain well the trade flows between China and EU countries (Jian, 2011).

In the empirical literature, the main reason for the studies to use augmented gravity model as an analysis tool is that trade data fits the gravity model well. In this study, trade flows of China with its 14 trade partners over the period 2011-2015 with yearly observations are analyzed. This study contributes significantly to literature since it focuses on the main role of China in world trade system with a particular emphasis on the 2011-2015 period.

5. Econometric Estimation of Gravity Equations

Since the gravity model for trade does not hold exactly, in econometric applications it is customary to specify

$$F_{ij} = G\left(\frac{M_i^{\beta_1} M_j^{\beta_2}}{D_{ij}^{\beta_3}}\right)\eta_{ij}$$

where F_{ij} represents volume of trade from country I to country j, M_i and M_j typically represent the GDPs for countries I and j, D_{ij} denotes the distance between the two countries, and η represents an error term with expectation equal to 1.

The traditional approach to estimating this equation consists in taking logs of both sides, leading to a log-log model of the form (note: constant G becomes part of β_o):

$$\ln(F_{ij}) = \beta_o + \beta_1 \ln(M_i) + \beta_2 \ln(M_j) - \beta_3 \ln(D_{ij}) + \varepsilon_{ij}$$

However, this approach has two major problems. First, it obviously cannot be used when there are observations for which F_{ij} equals to zero. Second, it has been argued by Santos Silva and Tenreyro (2006) that estimating the log-linearized equation by least squares (OLS) can lead to significative biases. As an alternative, these authors have suggested that the model should be estimated in its multiplicative form, i.e.,

$$F_{ij} = exp[\beta_o + \beta_1 \ln(M_i) + \beta_2 \ln(M_j) - \beta_3 \ln(D_{ij})]\eta_{ij}$$

using a Poisson pseudo-maximum likelihood (PPML) estimator usually used for count data (see the original paper for details). One of the authors' more surprising findings was that, when controlling for sharing a common language, having past colonial ties does not increase trade—a finding which contrasts with what more basic methods, such as OLS or even scatter plots of trade data, would indicate. Martin and Pham (2008) argued that using PPML on gravity severely biases estimates when zero trade flows are frequent. However, their results were challenged by Santos Silva and Tenreyro (2011), who pointed out that the simulation results of Martin and Pham (2008) are based on misspecified models and confirmed that the PPML estimator performs well even when the proportions of zeros are very large.

In applied work, the model is often extended by including variables to account for language relationships, tariffs, contiguity, and access to sea, colonial history, exchange rate regimes, and other variables of interest.

6. China's Economic Performance

In the 37 years between 1978 and 2015, annual growth of the Chinese economy averaged close to 10 percent and, between 2003 and 2007, it was over 11.5 percent. Along with this came the change of the destiny of several hundred millions of Chinese, which were lifted from abject poverty. However, the "good old days" cannot last forever. Growth decelerated to 7.7 percent in 2012 and 2013, and in the first three quarters of 2014, we saw a figure of 7.4 percent. President Xi described this situation as the "new normal". According to Xi, under the new normal conditions, China' s economy has still registered considerable increment albeit the slowdown; China's economic growth has become more stable and been driven by more diverse forces; the Chinese economic structure has been improved and upgraded, heralding a more stable development prospect.

Growth in China decelerated further, to 6.9percent in 2015, and to 6.7 percent in the first quarter of 2016, reflecting weak exports and slowing investment. Gradual domestic rebalancing is under way. A sharp slowdown in industrial activity has thus far been mitigated by steady growth in the services sector. In 2015,the services sector accounted for half of GDP and the majority of new urban jobs. This helped to offset layoffs in shrinking industrial sectors and kept urban labor markets tight (Lardy 2016). In addition, consumption growth continued to be robust, contributing 4.6 percentage points to GDP growth in 2015, compared to a contribution of 2.5 percentage points from investment.

Baseline projections envisage that growth in China will continue to slow moderately, to 6.7 percent in2016 and to an average of 6.4 percent in 2017-18,assuming reforms proceed as expected and their impact is smoothed by additional policy action. Positive tailwinds from lower oil prices and policy stimulus will continue to offset further declines of output in overcapacity sectors. Producer price deflation, underway since 2012, showed signs of bottoming out at the start of 2016, while industrial profits recovered. The labor market is expected to remain robust and support private consumption growth. The shift toward services will continue, facilitated by policies to ease business regulations.

7. Analyzing Global and Chinese Trade Scenario

7.1. Global Trade Situation

According to IMF, Global growth is projected to slow to 3.1 percent in 2016 before recovering to 3.8 percent in 2017.The forecast, revised down by 0.1 percentage point for 2016 and 2017 relative to April, reflects a more subdued outlook for advanced economies following the June U.K. vote in favor of leaving the European Union (Brexit) and weaker-than-expected growth in the United States. These developments have put further downward pressure on global interest rates, as monetary policy is now expected to remain accommodative for longer. Although the market reaction to the Brexit shock was reassuringly orderly, the ultimate impact remains very unclear, as the fate of institutional and trade arrangements between the United Kingdom and the European Union is uncertain. Financial market sentiment toward emerging market economies has improved with expectations of lower interest rates in advanced economies, reduced concern about China's near-term prospects following policy support to growth, and some firming of commodity prices. But prospects differ sharply across countries and regions, with emerging Asia in general and India in particular showing robust growth and sub-Saharan Africa experiencing sharp slowdown. In advanced economies, a subdued outlook subject to sizable uncertainty and downside risks may fuel further political discontent, with ant integration policy platforms gaining more traction. Several emerging market and developing economies still face daunting policy challenges in adjusting to weaker commodity prices. These worrisome prospects make the need for a broad-based policy response to raise growth and manage vulnerabilities more urgent than ever.

Table 1: Overview of the World Economic Outlook Projections (Percentage change)

		Projections	
	2015	**2016**	**2017**
World Trade (Goods & Services)	2.6	2.3	3.8
Imports			
Advanced Economies	4.2	2.4	3.9
Emerging & Developing Economies	-0.6	2.3	4.1
Exports			
Advanced Economies	3.6	1.8	3.5
Emerging & Developing Economies	1.3	2.9	3.6

Source: World Economic Outlook, October, 2016.

7.2. China's Trade Performance

China is the largest export economy in the world and the 37thmost complex economy according to the Economic Complexity Index (ECI). International trade makes up a sizeable portion of China's overall economy. Since economic reforms began in 1978, China sought to decentralize its foreign trade system to integrate itself into the international trading system. On November 1991, China joined the Asia-Pacific Economic Cooperation (APEC) group, which promotes free trade and cooperation the in economic, trade, investment, and technology spheres. China served as APEC chair in 2001, and Shanghai hosted the annual APEC leaders meeting in October of that year. After reaching a bilateral WTO agreement with the EU and other trading partners in summer 2000, China worked on a multilateral WTO accession package. China concluded multilateral negotiations on its accession to the WTO in September 2001. The completion of its accession protocol and Working Party Report paved the way for its entry into the WTO on 11 December 2001, after 16 years of negotiations, the longest in the history of the General Agreement on Tariffs and Trade. However, U.S. exporters continue to have concerns about fair market access due to China's restrictive trade policies and U.S. export restrictions. China's global trade exceeded $4.16 trillion at the end of 2013. It first broke the $100 billion mark in 1988, $200 billion in 1994, $500 billion in 2001, $1 trillion mark ($1.15 trillion) in 2004, $2 trillion mark ($2.17 trillion) in 2007, $3 trillion mark ($3.64 trillion) in 2011, and $4 trillion mark ($4.16 trillion) in 2013. The vast majority of China's imports consists of industrial supplies and capital goods, notably machinery and high-technology equipment, the majority of which comes from the developed countries, primarily Japan and the United States. Regionally, almost half of China's imports come from East and Southeast Asia, and about one-fourth of China's exports go to the same destinations. About 80 percent of China's exports consist of manufactured goods, most of which are textiles and electronic equipment, with agricultural products and chemicals constituting the remainder. Out of the five busiest ports in the world, three are in China. The U.S. trade deficit with China reached $232.5 billion in 2006, as imports grew 18%. China's share of total U.S. imports has grown from 7% to 15% since 1996.

The dollar values of China's agricultural and industrial output each exceed those of the US; China is the second after the US in the value of service sit produces. The most important agricultural products are rice, wheat, potatoes, corn, peanuts, tea, millet, barley, apples, cotton, oilseed; pork, and fish. With an 12.3% industrial production growth rate, China is a world leader in gross value of industrial output, which is as varied as mining and ore

processing, iron, steel, aluminum, and other metals, coal, machine building, armaments, textiles and apparel, petroleum, cement, chemicals, fertilizers, consumer products like footwear, toys, and electronics, food processing, transportation equipment, including automobiles, rail cars and locomotives, ships, and aircraft, telecommunications equipment, commercial space launch vehicles, and satellites.

To increase exports, China pursued policies such as fostering the rapid development of foreign-invested factories, which assembled imported components into consumer goods for export and liberalizing trading rights. In its latest Five-Year Program, China placed greater emphasis on developing a consumer demand-driven economy to sustain economic growth and address imbalances. Chinese Government is focusing more on Quality of trading Goods and Services rather than Quantity of trading Goods and Services.

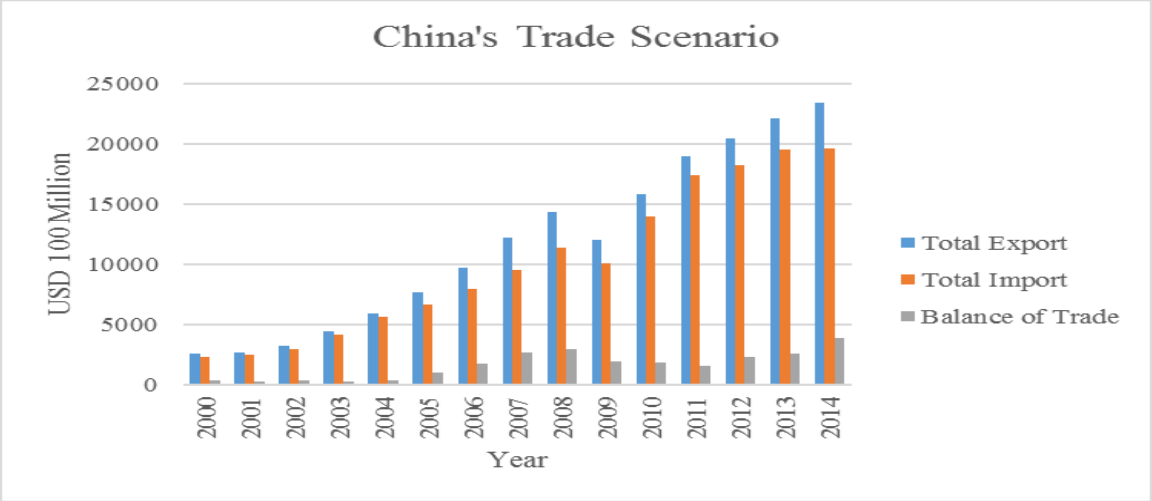
Table 2: Export performance during FY 2000-14 (Tabular Presentation).

(In 100 Million US$)

Year	Total Export	Total Import	Balance of Trade
2000	2592	2250.9	341.1
2001	2661	2435	226
2002	3256	2951.7	304.3
2003	4382.3	4127.6	254.7
2004	5933.3	5612.3	321
2005	7619.5	6599.5	1020
2006	9689.8	7914.6	1775.2
2007	12204.6	9561.2	2643.4
2008	14306.9	11325.7	2981.2
2009	12016.1	10059.2	1956.9
2010	15777.5	13962.4	1815.1
2011	18983.8	17434.8	1549
2012	20487.1	18184.1	2303
2013	22090	19499.9	2590.1
2014	23422.9	19592.3	3830.6

Source: National Bureau of Statistics of China.

Export performance during FY 2000-14 (Diagram Presentation)



The world's largest exporter, China shipped US$2.282 trillion worth of products around the globe in 2015. That figure represents roughly 12.2% of overall global exports estimated at $18.686 trillion. From a continental perspective, 50.8% of China's total exports by value in 2015 were delivered to other Asian trade partners. North American importers purchased 20.8% of Chinese shipments while 17.7% worth arrived in European countries. At 4.8%, a much smaller portion of Chinese exports were bought by African importers.

Table 3: List of China's Top Import Partners in 2015.

Rank	Partner Country	Total Trade (USD Billion)	% of Total Export of China
1	United States	410.8	18
2	Hong Kong	334.3	14.6
3	Japan	135.9	6
4	South Korea	101.5	4.4
5	Germany	69.2	3
6	Vietnam	66.4	2.9
7	United Kingdom	59.7	2.6
8	Netherlands	59.6	2.6
9	India	58.3	2.6
10	Singapore	53.1	2.3
11	Taiwan	45.1	2
12	Malaysia	44.2	1.9
13	Australia	40.4	1.8
14	Thailand	38.3	1.7
15	United Arab Emirates	37.1	1.6

Source: International Monetary Fund, World Economic Outlook Database.

China's current account surplus saw an upward trend during the review period. It totaled US$330.6 billion in 2015, and was equivalent to 3% of GDP. This higher surplus stems, to a large extent, from a large increase in the merchandise trade surplus. The merchandise trade surplus increased sharply in 2014 and 2015, when it reached US$567 billion or the equivalent of 5.2% ofGDP. This mainly reflected the decline in imports. Imports as a share of GDP declined to 14.5%in 2015, down from 17.5% in 2014 and 21.1% in 2011. This contraction is partly caused by loweroil import prices. China's traditional external current account surplus reflects the excess of nationalsavings over investment, which, after narrowing up to 2014, widened again in 2015 to 3.4% ofGDP.China stresses all-round development in its foreign trade. China adheres to developing economic and trade partnerships based on practical cooperation and mutual benefit with all countries, no matter they are big or small, rich or poor.

8. Sample Size and Data Issues

This study will cover a total of 14 countries which have been chosen considering the *Top 15* import partners, excluding Hong Kong, as China is an Exporting Country and *BCIM* Economies. It also has taken into account the availability of Data needed for the specified model and Myanmar has been excluded in that regard. ***Two*** countries of *BCIM*(out of four countries) – India and Bangladesh – have been included without Myanmar. From the *ASEAN* countries, ***Four*** countries – Singapore, Malaysia, Thailand, Vietnam – have been included. From the *NAFTA* ***One*** *Country* – USA has been considered. ***Three*** countries have been taken from the *EEC (EU)* group. These are Germany, Netherlands and the United Kingdom. ***One*** *Middle East* country - United Arab Emirates has been taken in the sample. ***Three*** *other* Countries – Australia, Japan, South Korea – have also been included in the sample for the analysis of China's trade.

The data collected for the period of 2011 to 2015. All observations are annual. Data on GNI, GDP, GNI per capita, total exports, total imports, taxes on international trade (% of current revenue) are obtained from the *World Development Indicators(WDI*) database of the World Bank. Data on export and import are obtained from the *International Financial Statistics (IFS)*. Data on China's total trade of goods and services (exports plus imports) with all other countries included in the sample are obtained from the *Direction of Trade Statistics Yearbook*(various issues) of IMF. Data on the distance (in kilometer) between Beijing (capital of China) and other capital cities of country j (as the crow flies) are obtained from the Website. GNI, GDP, GNI per capita are in constant 2010 US dollars measured in million US dollars.

9. Methodology

Classical gravity models generally use cross-section data to estimate trade effects and trade relationships for a particular time period, for example one year. In reality, however, cross-section data observed over several time periods (panel data methodology) result in more useful information than cross-section data alone. The advantages of this method are: first, panels can capture the relevant relationships among variables over time; second, panels can monitor unobservable trading-partner-pairs' individual effects. If individual effects are

correlated with the regressors, OLS estimates omitting individual effects will be biased. Therefore, panel data methodology has been used for this empirical gravity model of trade.

The generalized gravity model of trade states that the volume of trade / exports / imports between pairs of countries, X_{ij}, is a function of their incomes (GNIs or GDPs), their populations, their distance (proxy of transportation costs) and a set of dummy variables either facilitating or restricting trade between pairs of countries. That is, The generalized gravity model of trade states;

$$X_{ij} = \beta_0 Y_i^{\beta 1} Y_j^{\beta 2} N_i^{\beta 3} N_j^{\beta 4} D_{ij}^{\beta 5} A_{ij}^{\beta 6} U_{ij}$$

Where,
Y_i (Y_j) = the GDP or GNI of the country i (j)
N_i (N_j) = populations of the country i (j)
D_{ij} = the distance between the two countries' capitals (or economic centers)
A_{ij} = dummy variable
U_{ij} = the error term and
βs = parameters of the model.

For estimation purpose, model in log-linear form using per capita income instead of population in year t, is

$$lX_{ijt} = \beta_o + \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 lY_{it} + \beta_4 lY_{jt} + \beta_5 lD_{ijt} + \Sigma_h \delta_h P_{ij\,ht} + U_{ijt}$$

Where,

l = variables in natural logs.
P_{ijh}= a sum of preferential trade dummy variables.

Using the data set, this paper estimates gravity model of China's trade (exports + imports). For the model, this paper has followed Frankel (1993), Sharma and Chua (2000) and Hassan (2000, 2001). Since the dependent variable in the gravity model is bilateral trade (sum of exports and imports) between the pairs of countries, the product of GNI and the product of per capita GNI have been used as independent variables. Some additional independent variables have been added in the model.

Thus the gravity model of trade in this study is:

$\log (Y_{ijt}) = \alpha_0 + \alpha_1 \log (GNI_{it}*GNI_{jt}) + \alpha_2 \log (PCGNI_{it}*PCGNI_{jt}) + \alpha_3 \log (Tax_{it}*Tax_{jt}) + \alpha_4 \log (Distance_{ij}) + \alpha_5(PCGNID_{ijt}) + \alpha_6 (TR/GDP_{it}*TR/GDP_{jt}) + \alpha_7 (Border_{ij}) + \alpha_8 (j\text{-}FTAs) + U_{ijt}$

Where,

Y_{ij} = Total trade between China (country i) and country j,
$GNI_{it}*GNI_{jt}$ = Gross National Income of country i (j),
$PCGNI_{it}*PCGNI_{jt}$ = Per capita GNI of Country i (j),
$Tax_{it}*Tax_{jt}$ = Trade tax as % of revenue of country i (j),
$Distance_{ij}$ = Distance between country i and country j,
$PCGNID_{ijt}$ = Per capita GNI differential between country i and j,

TR/GDP_{it}*TR/GDP_{jt} = Trade- GDP ratio of country i (j),
$Border_{ij}$ = Land border between country i and j (dummy variable),
j –FTAs = Country j has Free Trade Agreements with Country I, PRC (dummy variable),
U_{ij} = error term,
t = time period,
α_s = parameters.

Hypotheses

1. The product of GNIs is considered as the size of the economy. As it is bigger, there will be more trade between the two countries; so we expect a positive sign for the coefficient of GNIs.

2. Per capita GNI provides a good proxy for the level of development and infrastructures that are essential to conduct trade, and as such the more developed the countries are; the more would be the trade between the pairs of countries. So we expect a positive sign for the coefficient of PCGNI variable.

3. Trade tax always prevents trade. Also trade flow is inversely related to the transport costs. So we expect negative signs for the coefficients of these variables.

4. According to the H – O theory, the sign of the coefficient of PCGNID would be positive. On the other hand, based on the Linder hypothesis, the sign would be negative.

5. TR / GDP variable indicates the openness of the country. The more open the country is, the more would be the trade. So we expect a positive sign for this variable.

10. Model selection

Equation, mentioned in the previous section, has been estimated taking all variables for 72 observations. Three main panel data models are applied for gravity model:

- Ordinary Least Squares (OLS)
- Fixed Effects Model
- Random Effects Model

The main difference among the above-mentioned methods is the constant term which is common for pooled regression. In the fixed effect model, there is a separateconstant term for all cross sections. For random effect model, the constant term isassessed as a random element.All the three models are applied in this case.

11. Estimations and Empirical Results

To obtain the results the following steps have been followed;

Step 1: Summarize

A general overview of the data in Stata showed that the panel data set is strongly balanced.

panel variable: country1 (strongly balanced)
time variable: year, 2011 to 2015
delta: 1 unit

Data set has been summarized to get an overview of the Data. In the following Table;

Table 4: Data Summarization (*STATA output complied by Author)*

Variable	Obs	Mean	Std. Dev.	Min	Max
log_totrade	70	25.27259	.9308303	22.83465	27.05361
log_gni_rp	70	56.97531	1.409311	54.91806	59.86979
log_pcgni_rp	70	18.06198	1.471875	15.17098	19.29993
log_tradee~x	70	44.9953	13.33063	0	56.30768
log_distance	70	8.339634	.567723	7.549609	9.363919
log_absolute	70	9.578606	1.390901	5.968859	10.80149
log_tradeo~r	70	6.686032	1.181294	4.791055	9.476244
border	70	.1428571	.3524537	0	1
ftas	70	.5	.5036102	0	1

We can find that the total 70 Nos of Observations are there in the Data set. It also shows the mean and standard deviation of the variables. Here, mean represents the average value and standard deviation quantifies the amount of variation or dispersion of the data set.

Step 2: Correlation

Table 5 displays the correlation among the variables. This correlation matrix measures the two-way relation between the mentioned variables. It indicates high correlation between variables pair wise.

Table 5: Correlation Matrix among the Variables (*STATA output complied by Author*).

	log_to~e	log_gn~p	log_pc~p	log_tr~x	log_di~e	log_ab~e
log_totrade	1.0000					
log_gni_rp	0.7655	1.0000				
log_pcgni_rp	0.5949	0.5387	1.0000			
log_tradee~x	0.1827	0.4088	0.2715	1.0000		
log_distance	0.3910	0.5988	0.7111	0.0508	1.0000	
log_absolute	0.4489	0.5284	0.8670	0.1480	0.7125	1.0000
log_tradeo~r	-0.6570	-0.0216	-0.2981	0.1931	0.0943	-0.0877
border	-0.1566	-0.1785	-0.6558	-0.5585	-0.3147	-0.4643
ftas	0.2493	-0.3077	-0.0081	-0.1587	-0.4626	-0.2112

Step 3: Ordinary Least Square (OLS)

This is the simple regression model which could show most importantly the value of R-squared which could show to what extent the independent variables can describe the dependent variable. In this case the value of R-squared is 0.996 which means that the independent variables can describe the dependent variable to a great extent.

Table 6: Regression Results of the Variable (*STATA output complied by Author*).

log_totrade	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
log_gni_rp	.4883841	.0081775	59.72	0.437	.4720323	.504736
log_pcgni_rp	.0288804	.0171103	1.69	0.097	-.0053338	.0630946
log_tradeetax	.0009237	.0008614	1.07	0.288	-.0007987	.0026462
log_distance	.0096313	.0266782	0.36	0.719	-.0437152	.0629777
log_absolute	-.0177661	.0116969	-1.52	0.134	-.0411556	.0056234
log_tradeofgdpreporter	-.498099	.0109017	-45.69	0.000	-.5198982	-.4762997
border	.0896943	.0364063	2.46	0.017	.0168954	.1624933
ftas	.006054	.0266727	0.23	0.821	-.0472813	.0593894
_cons	.287867	.4114615	0.70	0.487	-.5349011	1.110635

Considering the results, the equation could be written as;

$\log (Y_{ijt}) = 0.2878 + 0.48 \log (GNI_{it}*GNI_{jt}) + 0.028 \log (PCGNI_{it}*PCGNI_{jt}) + 0.0009 \log (Tax_{it}*Tax_{jt}) + 0.0096 \log (Distance_{ij}) – 0.017 (PCGNID_{ijt}) – 0.498 (TR/GDP_{it}*TR/GDP_{jt}) + 0.089 (Border_{ij}) + 0.006 (j\text{-}FTAs) + U_{ijt}$

Step 4: Fixed Effect Model

Fixed effects model represents the observed quantities in terms of explanatory variables that are treated as if the quantities were non-random. This is in contrast to random effects models and mixed models in which either all or some of the explanatory variables are treated as if they arise from random causes.

Table 7: Fixed Effect Estimations of the Variables (*STATA output complied by Author.*)

log_totrade |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
log_gni_rp |	1.635137	.3973939	4.11	0.453	.8373357	2.432939
log_pcgni_rp |	.5191833	.5159195	1.01	0.319	1.554935	.5165684
log_tradeetax |	-.0046699	.0073704	-0.63	0.529	-.0101268	.0194666
log_distance |	-.0086313	.0266782	-0.36	0.718	-.0426571	.0619196
log_absolute |	.0640101	.0462799	1.38	0.173	-.0289006	.1569209
log_tradeofgdpreporter |	4720301	.0201867	23.38	0.000	-.5125566	-.4315035
border |	.079694	.0364063	2.46	0.014	.0183392	.1610495
ftas |	.007054	.0266727	0.23	0.820	-.0462235	.0583315
_cons |	-56.17962	13.57099	-4.14	0.000	-83.42453	-28.93472

Step 5: Random Effect Model

Random effects model, also called a variance components model, is a kind of hierarchical linear model. It assumes that the data being analyzed is drawn from a hierarchy of different populations whose differences relate to that hierarchy. In econometrics, random effects models are used in the analysis of hierarchical or panel data when one assumes no fixed effects (it allows for individual effects). The random effects model is a special case of the fixed effects model.

Table 7: Random Effect Estimations of the Variables(*STATA output complied by Author*)

log_totrade |	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
log_gni_rp |	.4883841	.0081775	59.72	0.000	.4723566	.5044117
log_pcgni_rp |	.0288804	.0171103	1.69	0.091	-.0046552	.062416
log_tradeetax |	.0009237	.0008614	1.07	0.284	-.0007645	.002612
log_distance |	.0096313	.0266782	0.36	0.718	-.0426571	.0619196
log_absolute |	-.0177661	.0116969	-1.52	0.129	-.0406917	.0051595
log_tradeofgdpreporter |	-.498099	.0109017	-45.69	0.000	-.5194659	-.4767321
border |	0896943	.0364063	2.46	0.014	.0183392	.1610495
ftas |	.006054	.0266727	0.23	0.820	-.0462235	.0583315
_cons |	.287867	.4114615	0.70	0.484	-.5185827	1.094317

Step 6: Hausman Test

This is a statistical hypothesis test in econometrics which evaluates the consistency of an estimator when compared to an alternative, less efficient, estimator which is already known to be consistent. It helps one evaluate if a statistical model corresponds to the data.

Table 7: Hausman Test Results (*STATA output complied by Author*)

|	fixed	random	Difference	S.E.
log_gni_rp |	1.635137	.4883841	1.146753	.3973097
log_pcgni_rp |	-.5191833	.0288804	-.5480637	.5156357
log_tradee~x |	.0046699	.0009237	.0037462	.0073199
log_absolute |	.0640101	-.0177661	.0817763	.0447773
log_tradeo~r |	-.4720301	-.498099	.0260689	.0169899

The test result suggested to go with the Fixed Effect Model for this Data set and analysis as we got, Prob>chi2 = 0.0000.

12. Discussion of Results

As mentioned earlier, our gravity model suggested that, based on the Hausman test, FEM of Panel estimation is the appropriate strategy to be adopted. So the results of FEM would be discussed here for the said model. The estimation uses White's heteroskedasticity-corrected covariance matrix estimator. In these models, the intercept terms are considered to be country specific, and the slope coefficients are considered to be the same for all countries. The intercept terms in REM, of course, are considered to be random variables, instead of fixed country specific variables, and the slope coefficients are considered to be the same for all countries.

In our trade model, the coefficient of product of GNI is positive and highly significant as expected. This implies that China tends to trade more with larger economies. China's bilateral trade with country j would increase by 1.63% as the product of China's GNI and country j's GNI increases by 1%. The coefficient of per capita GNI differential between China and country j is also significant and has positive sign. The coefficient value 0.064 implies that bilateral trade with country j increases as the per capita GNI differential increases but less than proportionately. From the positive sign of this coefficient we can have an indication that the H - O effect (differences in factor endowments) dominates the Linder effect in case of China trade.

The trade-GDP ratio is the proxy of openness of countries. The coefficient of this variable for country j is found large, significant and have expected positive sign. This implies that China's trade with all other countries under consideration is likely to improve very significantly with the liberalization of trade barriers in these countries. Our estimate suggests that a 1% increase in the openness of trade in j countries could increase China's trade with these countries by as much as 0.47%. The coefficient of this variable for country i is also found to be significant at. Trade tax shows negative sign with little significance.

With regard to the country specific effects, we observe that these effects are strongly significant for all countries. The distance variable is significant and has anticipated negative sign which indicates that China tends to trade more with its immediate neighboring countries. Border dummy is found to be significant means China would trade more with countries having boarder with it. FTAs dummy is insignificant but with positive sign.

13. Policy Implications

- Obtained results show that all kinds of trade barriers in countries involved must be liberalized to a great extent in order to enhance the China's trade.
- Proper quality of the goods and services must be maintained as well as the varieties of goods and service must be increased as the China's exports largely depend on the foreign demand and processing trade.
- All partner countries' propensities to export and import must be taken into account sufficiently and adequately when trade policy is set as the China's trade is not independent of country specific effects.

Conclusion

The objectives of this paper were to provide a theoretical justification for using the gravity model in the analysis of bilateral trade and apply the gravity model to analyze the China's trade with its major trading partners using the panel data estimation technique. This paper has established that the application of the gravity model in applied research of bilateral trade is theoretically justified. Having estimated the generalized gravity models of trade, results show that China's trade (sum of exports and imports) is positively determined by the size of the economies, per capita GNI differential of the countries involved and openness of the trading countries. Transportation cost is found a significant factor in influencing the China's trade negatively. This implies China would do better if the country trades more with its neighbors. However, per capita income differential, both in the trade and the import models, supports the H-O hypothesis over the Linder hypothesis though this variable was found insignificant in the export model. China's bilateral trade and exports are also positively related to multilateral resistance factors. Trade diversification and mutual cooperation would promote the trade of China to a new level, but to achieve that goal China has to ensure technological advancement and quality of traded goods and services.

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ANNEX 1

Variables in Stata

Y_{ij}= log of Total trade between China (country i) and country j, **log_totrade**
GNI_{it}*GNI_{jt}= log of Gross National Product of country i (j), **log_gni_rp**
$PCGNI_{it}$*$PCGNI_{jt}$= log of Per capita GNI of Country i (j), **log_pcgni_rp**
Tax_{it}*Tax_{jt}= log of Trade tax as % of revenue of country i (j), **log_tradeetax**
$Distance_{ij}$= log of Distance between country i and country j, **log_distance**
$PCGNID_{ijt}$= log of Per capita GNI differential between country i and j, **log_absolute**
TR/GDP_{it}*TR/GDP_{jt}= log of Trade- GDP ratio of country i (j), **log_tradeofgdpreporter**
$Border_{ij}$ = log of Land border between country i and j (dummy variable), **border**
j –FTAs = log of Country j is member of SAARC (dummy variable), **FTAs**
U_{ij}= error term
t = time period
αs = parameters.

Citation:

Parvez, M. A. (2017). How does the Size of an Economy Matter? A Panel Data Analysis of China's Trade by Using the Gravity Model. *International Journal of Science and Business, 1*(2), 37-57.

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