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# DETERMINANTS OF CHINA'S TRADE WITH AFRICA: A GRAVITY MODEL APPROACH

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## ABSTRACT

This paper seeks to examine the determinant of bilateral trade between China and Africa using the gravity model of international trade. Panel data was used for ten African countries from 2000 to 2016. The generalized least squares random effect estimation technique was employed. The study used the standard gravity model and integrates population, exchange rate and strategic partnership. The study finds out that China's GDP, Africa's GDP, population of Africa, geographical distance, exchange rate and strategic partnership have significant impact on China's trade Africa. China's population is not a determining factor of trade flow with Africa. The study recommends that to increase bilateral trade flow between the two economies, there should be a robust strategic trade partnership that will eliminate most barriers to trade thereby creating easy flow of goods. African countries closer to China should take advantage of the proximity and trade more and Africa should export more of finished goods to China which will increase its GDP.

**Key words:** Bilateral trade, Gravity model, Panel data, Random effect
**JEL Classifications**: F1, F120, F230

## 1.0 INTRODUCTION

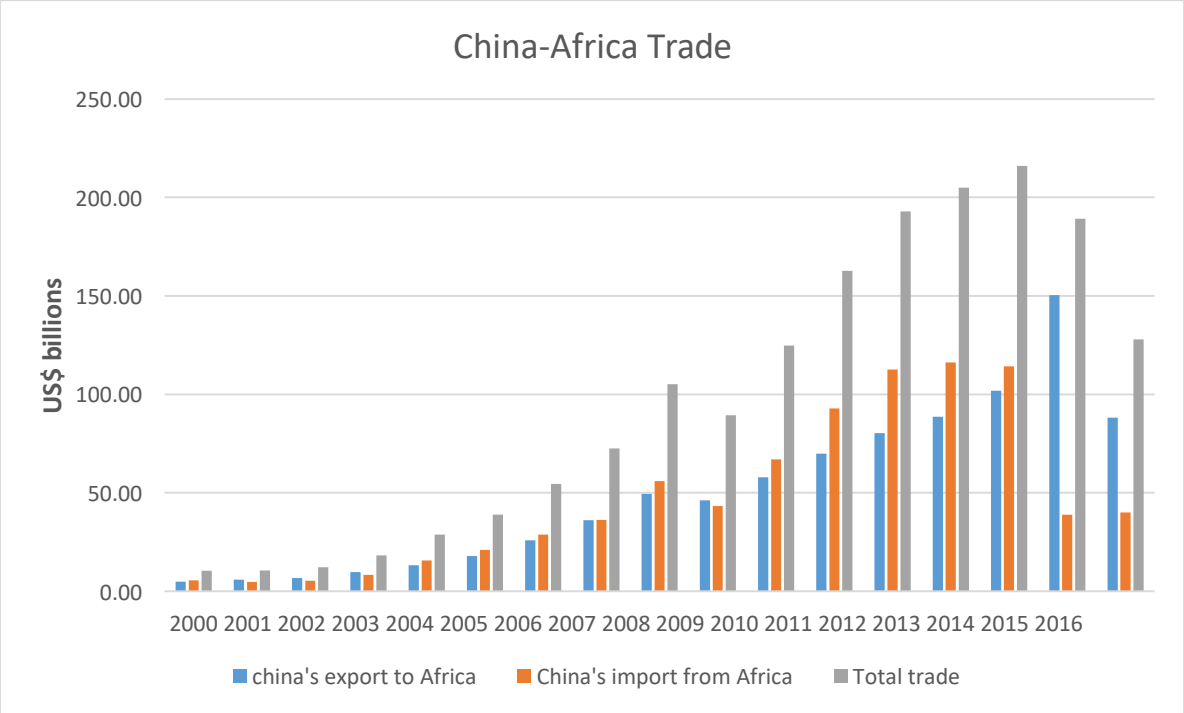
The main aim of this paper is to enquire about the determinants of China's trade with Africa using the gravity model. China and Africa have enjoyed mutual bilateral trade relations over the years. Historically, this can be traced back to the Han Emperors of the Second Century B.C., and then later in the 15$^{th}$ century by Chinese navigator Zheng who reached the coast of Africa debarking in Somalia and Kenya (Li, 2007). In recent times, China's trade with Africa took a progressive turn with the formation of the People's Republic of China in 1949, and there after the independence of many African countries. In 2000, this relationship climaxed with the establishment of the Forum on China-Africa Cooperation (FOCAC).

Chinese exports to Africa have been mainly consumer goods such as cutleries, electronics, textile, machineries, transport equipment, chemicals, food etc. Africa is widely known for accepting and using low priced commodities and the Chinese market offer this opportunity. China has advantage in labour intensive products through specialization thereby reflecting the

country's low labour cost. On the other hand, Africa export to China is majorly raw materials such as wood, solid minerals (copper, nickel, iron ore, etc), and crude oil. China's oil purchases have been mainly from Angola, Gabon and Nigeria. The bilateral trade relations between China and Africa have been influenced by the need to source for energy to foster economic development. The negative side of these trade relations is that China does not import finished products from Africa while cheap Chinese imports saturate the African market, making it extremely difficult for local industries to compete (Renard, 2011).

China-Africa trade relations over the years have been on unequal basis. Within the period of this study, China has exported more to Africa than imported. China Africa trade was approximately $10 billion in 2000 with both economies trading about the same amount. By 2008, the trade surpassed $100 billion and declined to $89 billion in 2009 due to the global financial crisis. And in 2010 the trade was worth $124 billion. The peak of these trade relations was in 2014, with China exporting goods worth $100 billion to Africa and importing goods from Africa worth $114 billion, thereby making China Africa's most important trading partner.

Figure 1 summarize this bilateral trade between China and Africa from 2000 to 2016.
Figure 1




**Source**: Authors computation using data from World Integrated Trade Solutions

It is against this background that we want to examine the factors that influence the bilateral trade between China and Africa using the gravity model. Central to GDP and geographical distance in

the gravity model are corroborating variables such as population, exchange rate and strategic partnership. The purpose of this study is to examine and measure the function of these variables through a gravity model from the period 2000 to 2016. The motivation is the fact that China in recent times has considerably shifted its approach to Africa in trade and infrastructural development and a better understanding of the factors that influence bilateral trade will help authorities to define specific economic and industrial policies. Knowledge of the determinants bilateral trade relations will help in enhancing long term growth of both economies.
This paper presents new empirical evidence about the determinants of China's trade with Africa based on the size of the Chinese economy, size of the African countries used for the study, market size of China and market size of Africa. We adapt the gravity models of Timbergen (1962) and Krugman and Obstfeld (2005) with modifications, in which we examined the bilateral trade between China and Africa based on panel data.

## 2.0 LITERATURE REVIEW

Mercantilism is one of the earliest theories of international trade and can be traced back to about 300 years ago. This theory is anchored on "commercial revolution" which involves transition from local economies to national economies, from feudalist system to *laissez-faire*, from crude trade to foreign trade. The theory postulates that the world holds a constant quantity of wealth and to raise a country's wealth, there have to be transfer of wealth from one country to another. This theory was widely criticized because of state control of economic life. Production was regulated with the aim of ensuring genuine and low-cost goods making the country succeed in international trade.

In 1776, in his famous book "an inquiry into the nature and causes of wealth of nations". Adam Smith a Classical Economist challenged the mercantilist position about what makes up the wealth of nations. His theory was that of absolute advantage which states that a country should specialize in the production of those goods that it could produce most efficiently and exported while those goods which cannot be manufactured or are more expensive to produce are imported. This contradicts the position of the mercantilist that in international trade a country will benefit at the cost of other countries. Adams Smith advocated for an economy that is highly competitive with high division of labour and specialization. Through this the wealth of a nation will increase. However, he was unable to resolve why trade takes would place between two countries if one country has absolute advantage in the production of both commodities.

David Ricardo through his theory of comparative advantage improved the Adam Smith theory of absolute advantage which he showed that even if a country does not have absolute advantage in production over another, international trade would still be profitable. He argued that if one country is efficient in producing both commodities and the other country inefficient, the two countries can benefit from such trade based on the cost of production.

The modern theory of international trade or the Hecksher-Ohlin theorem postulates that countries have the same constant returns to scale of production function for each good, but different amount of capital relative to their labour supply. In the presence of autarchy, commodities which require large amount of labour in relation to capital would be relatively cheaper in more labour ample countries and relatively costlier in more capital rich countries. If trade becomes open, countries export goods intensive in the use of their more available factor, and import goods intensive in the use of their scarce factor. This tends to equate relative prices in different countries.

However, many theories of international trade were unable to establish the determinants of trade between two countries. One model that seek to do that is the gravitational trade model. The model describes how geographical distance and the size of an economy affect the bilateral trade between two countries. This model was formed by Isaac Newton and first used in Physics and later by Tinbergen (1962), a Dutch economist applied it extensively to international trade. According to Newton's gravitational law, "every particle attracts every other particle in the universe with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres". In economic sense, the model in its most simple means that the trade between two countries is proportional to the product of their GDP and inversely proportional to the distance between them. The trade between two countries is compared to the gravitational force between two particles.
In this paper, we use the gravity model of international trade to examine the determinants of bilateral trade between China and Africa.

By using the gravity model to examine bilateral trade activities between Vietnam and 60 countries from 2000 to 2010. Binh, Duong and Cuong (2012) established that economic size of Vietnam, economic size and market size of foreign partners, distance and culture have enormous effects on bilateral trade flows between Vietnam and the 60 countries. Rahman (2009) used the gravity model to examine the trade potential for Australia across a section of 50 countries. The outcome revealed that Australia's bilateral trade is affected positively by GDP per capita, openness, common language, economic size and negatively between the distance of the trading partners. George and Mohammed (2009) employed the augmented gravity model to study the changing pattern of Ghana's bilateral trade flows. They established that Ghana's export sector has greater trading potentials with emerging or developing economies than rich or high-income countries.

Sohn (2001) applied the gravity model to analyse Korea's trade pattern in order to identify vital factors determining bilateral trade flow. It was established that Korea's bilateral trade pattern conform to the basic gravity model and recommend bilateral trade with countries of close proximity and large economies. Thai (2006) examined the bilateral trade between Vietnam and twenty-three European countries using the gravity model. Their estimate showed that economic

size, market size and real exchange rate of Vietnam and the trading partners play crucial role in bilateral trade however; distance and history are not drivers.

By using the ordinary least squares and the augmented gravity model, Batra (2004) examines India's universal trade potential. The study reports that India has the highest trade potential with the Asia-Pacific region, Western Europe and North America. Khan and Mahmood (2000) applied the gravity model to establish the relationship between bilateral trade in Pakistan and real exchange rate, tariffs, distance, GNP, per capita GDP, language and common border. All the variables were found to be significant except for common border. Frankel (1997) asserts that countries with large population are more capable of utilizing economies of scale in their domestic market as compared to smaller countries.

Gul and Yasin (2011) applied the gravity model to estimate Pakistan trade potential across 42 countries using a panel data for the period 1981 – 2005. Their results show that Pakistan has high trade potential with countries in the Asia – Pacific region, the European Union, the Middle East, Latin America and North America. While the volume of trade was low with members of the South Asian Association for Regional Cooperation and Economic Cooperation Organization. In another study, Rasoulinezhad and Kang (2016) used a gravity model to determine South Korea's trade with OPEC countries. The estimation results show that the gravity equation fits the data and there exist long term relationships between bilateral trade flows and GDP, GDP per capita.
Changes in real exchange rate will affect exports and imports. However, in theory, currency devaluation can enhance trade flows if the relative prices among the country and its trading partners with other factors are unchanged (Chua and Sharma, 1998).

## DATA

This study uses the yearly data of China, South Africa, Nigeria, Angola, Kenya, Egypt, Zambia, Sudan, Ethiopia, Tanzania, Congo and Gabon to determine China's trade with Africa. These countries represent 90% of the bilateral trade between China and Africa within this period of study (WITS, 2016). The dependent variable, annual trade, was obtained from the World Integrated Trade Solution of the World Bank. China's GDP, trading partners GDP, China's population, trading partner's population and exchange rate were obtained from the World Bank data base. Distance was measured in kilometres. It is measured from Beijing the capital city of China to the capital city of the trading partners. It is derived from Jon Haveman international trade data set (Haveman, 2010). Strategic partnership was represented by a dummy variable. 1 if China and trading partner have a strategic trade agreement and then 0 if none exist. By signing a trade agreement, a country becomes a strategic trade partner with another. This variable was proxied by the bilateral investment treaties (UNCTAD, 2014).
All the data were from the period 2000 to 2016. The data was arranged in panel data format which gives a total of 187 observations. The choice of this period of study is due to the strategic

partnership China established with Africa through FOCAC in 2000 which has greatly enhanced trade between the two economies

## MODEL

To find out the determinants of China's trade with Africa, we adapt the gravitational trade model which was first used by Timbergen (1962) and later by Krugman and Obstfeld (2005). The model is presented as follows:

$$TT_{iiii} = AA\frac{YY_{ii}YY_{ii}}{DD_{iiii}^{2}} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (ii)$$

**Where**

$TT_{iiii}$ is the total trade flow between country $ii$ and country $jj$

$YY_{ii}$ is the economic size of country $ii$ measured by the GDP

$YY_{ii}$ is the economic size of country $jj$ also measured by the GDP

$DD_{iiii}$ is the geographical distance between country $ii$ and $jj$

$AA$ is a constant term.

This model was adapted and modified to suit this study by including population of country $ii$, population of partner countries, $jj$, exchange rate and a dummy for strategic partnership. Oguledo and Macphee (1994) established that almost fifty different variables were used in former works to explain bilateral trade flow aside GDP and geographical distance. The model is estimated in logarithm form as follows:

$$llllTT_{iiiiii} = \alpha\alpha_0 + \alpha\alpha_1 llllYY_{iiii} + \alpha\alpha_2 llllYY_{iiii} + \alpha\alpha_3 llllll_{iiii} + \alpha\alpha_4 llllll_{iiii} + \alpha\alpha_5 llllDD_{iiii} + \alpha\alpha_6 EE_{iiiiii} + SS_{iiiiii} + ee_{iiiiii} \cdots\cdots\cdots (iiii)$$

**Where**

$ii = 1$ (China)

$jj =$ South Africa, Nigeria, Angola, Kenya, Egypt, Zambia, Sudan, Ethiopia, Tanzania, Congo, Gabon

$tt =$ 2000, 2001, 2002, 2003, 2004, $\cdots\cdots\cdots\cdots\cdots$, 2016

$TT_{iiiiii} =$ China's trade with country $jj$ in year $tt$

$YY_{iiii} =$ China's GDP in year $tt$

$YY_{iiii} =$ Country's $jj$ GDP in year $tt$

$ll_{iiii} =$ China's population in year $tt$

$ll_{iiii} =$ Population of country $jj$ in year $tt$

$DD_{iiii} =$ Distance in kilometres between China and country $jj$

$EE_{iiiiii} =$ Exchange rate between China and country $jj$ in year $tt$

$SS_{iiiiii} =$ Strategic partner dummy variable for strategic partnership between China and country $jj$.

The dependent variable $TT_{iiiiii}$ is the annual trade (exports plus imports) of China and partners (countries$jj$). It is derived by adding exports and imports of China with each of the trading partners.

The values of the GDP, $YY_{iiii}$ and$YY_{iiii}$ , is used to measure the size of the Chinese economy and the African economy in terms of production activities. Bigger countries with a higher production capacity have the potential of attaining economies of scale and this will lead to increase export as a result of comparative advantage enjoyed. The large domestic economy is also able to absorb imports. $YY_{iiii}$ and $YY_{iiii}$ are expected to have a positive relationship with annual trade. Population is used as a proxy for market size which affects the trade between China and Africa. The larger the markets size the more the trade. Population of China is expected to have a positive relationship. Also, the population of trading partners is expected to have a positive relationship with annual trade. Distance from Beijing to the Capital cities of the trading partners is anticipated to have a negative relationship because the more the distance the more the cost of transport and other logistics which affect the annual trade negatively between China and Africa. This is used as a proxy for trade cost.

The relationship between annual trade and exchange rate is indeterminate. An increase in the value of trading partners' exchange rate means devaluation. This will make import costly and export cheaper. However, a reduction in the exchange rate will make import cheaper and export expensive. Strategic partnership involves any signed economic agreement. It is expected to have a positive relationship because most of the economic agreement remove trade barriers and allow the free flow of goods between China and Africa.

Table 1 gives a descriptive statistic for the data

**Table 1**

| Variables | Observation | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| $TT_{iiiii}$ | 187 | 1.12e+07 | 1.45e+07 | 136933 | 6.52e+07 |
| $YY_{iiii}$ | 187 | 3.58e+13 | 2.15e+13 | 1.00e+13 | 7.44e+13 |
| $YY_{iiii}$ | 187 | 1.08e+13 | 2.20e+13 | 9.17e+10 | 1.03e+14 |
| $ll_{iiii}$ | 187 | 1.32e+09 | 3.48e+07 | 1.26e+09 | 1.38e+09 |
| $ll_{iiii}$ | 187 | 6.92e+07 | 4.70e+07 | 1.64e+07 | 1.86e+08 |
| $DD_{iiii}$ | 187 | 10595.03 | 1957.75 | 7548.28 | 12968.71 |
| $EE_{iiiii}$ | 187 | 64.59 | 57.04838 | 3.47205 | 253.492 |
| $SS_{iiiiii}$ | 187 | .5411765 | .5012589 | 0 | 1 |

**Source: Authors computation.**

## Estimation Method and Techniques

From the model, we have a balanced panel since all entities have measurement in all time periods making us have a well-organized panel data. We will employ the GLS random effect estimation technique to estimate the parameters of our model. The random effect model takes the following form

$$yy_{iiii} = \beta\beta_1 + \beta\beta_2 xx_{2iiii} + \cdots\cdots + \beta\beta_{kk} xx_{kkiiii} + (ee_{iiii} + uu_{ii})$$

$$yy_{iiii} = \beta\beta_1 + \beta\beta_2 xx_{2iiii} + \cdots\cdots + \beta\beta_{kk} xx_{kkiiii} + vv_{iiii}$$

Where $\beta\beta_1$ is the intercept parameter and the error term $vv_{iiii}$ is composed of a component $uu_{ii}$ that represents a random individual effect and the component $ee_{iiii}$ which is the usual regression random error.

GLS random effect estimation technique will be considered because it handles the constants not as fixed but as random parameters. It has fewer parameters to estimate compared to the fixed effect method. It also allows for additional explanatory variables that have equal value for all observation within a group, i.e. time invariant variables.

## Discussion of Results and Findings

### Breusch Pagan Langrangian Multiplier Test for Random Effect Model

We carried out a pre-estimation test to find out if the GLS random effect is the appropriate technique for our model. Breusch and Pagan (1980) suggested a test for random individual effects against a null based on the Lagrange Multiplier (LM) principle. The hypothesis states that:

$$HH_0 : \sigma_{uu}\sigma^2 = 0$$
$$HH_1 : \sigma_{uu}\sigma^2 > 0$$

If the null hypothesis is rejected, then we conclude that there are random individual differences among sample members, and that the random effect model is appropriate. But if the null hypothesis is not rejected then pooled OLS will be most appropriate.

The LM test is 288.85; we reject the null hypothesis in favour of the random effect model ($ll < 0.000$)

**Table 2 presents the estimation results.**

Table 2

| **VARIABLES** | (1) $TT_{iiiii}$ |
|---|---|
| $YY_{iiii}$ | 2.618*** |
| | (0.388) |
| $YY_{iiii}$ | 0.224** |
| | (0.113) |
| $ll_{iiii}$ | 8.204 |
| | (0.542) |
| $ll_{iiii}$ | 0.439*** |
| | (0.280) |
| $DD_{iiii}$ | -4.100*** |
| | (0.444) |
| $EE_{iiiiii}$ | 0.00666*** |
| | (0.00219) |
| $SS_{iiiiii}$ | 0.622*** |
| | (0.200) |
| Constant | -20.57*** |
| | (4.207) |
| Observations | 187 |
| Number of countryid | 11 |

**Standard errors in parentheses**
*** p<0.01, ** p<0.05, * p<0.1

The variables which determine China's trade with Africa are: China's GDP ($YY_{iiii}$), the GDP of the trading partners ($YY_{iiii}$), population of the trading partners ($ll_{iiii}$), geographical distance between China and trading partners ($DD_{iiii}$), exchange rate ($EE_{iiiiii}$), and strategic partnership ($SS_{iiiiii}$). China's population is not a determining factor of trade flow with Africa because the result is not significance.

The size of the Chinese economy has a positive impact in influencing trade flow with Africa. For a 1% increase in the GDP growth of China, trade flow is expected to increase by 2.62%. This is with a probability value of less than 0.001. An increase of 1% in the GDP of trading partners, the volume of trade is anticipated to increase by 0.22%. This is significant at probability of less than 0.05. At a probability level of less than 0.01, a growth in the population of Africa by 1% will increase China's trade with Africa by 0.44%. Geographical distance between China and Africa negatively affect trade flows. A 1% increase in geographical distance is expected to reduce trade flow by 4.1%. This is significant with a probability value of less than 0.01. If the exchange rate of Africa increases by 1%, trade flow with China is expected to decline by 0.01%. This is at less

than 0.01 probabilities. Africa signing a 1% more strategic partnership with China is expected to increase trade volume by 0.62%. This is also significance at probability of less than 0.01

## CONCLUSION AND RECOMMENDATION

The purpose of this study has been to examine as well as measure the factors that affect the bilateral trade between China and Africa using the gravity model. The results indicate that China's GDP, Africa's GDP, African population, geographical distance between China and Africa, exchange rate and strategic partnership are all important variables that determine bilateral trade between the two economies.

The implication of this is that, both China and Africa should work and enhance a healthy trade relation. At the moment China and Africa has had a strategic partnership over the years through FOCAC. There is a productive cooperation between China and South Africa under the BRICS (Brazil, Russia, India, China and South Africa) and the Belt and Road Initiative, which South Africa is a key player and a major beneficiary across the continent. The strategic trade partnership between China and Angola led to the establishment of the Orientation Commission for Economic and Trade Cooperation between China and Angola. The trade relation between China and Egypt led to the formation of the China – Egypt Suez Economic and Trade Cooperation Zone. Therefore, both economies should pursue policies that enhance this partnership which will increase more bilateral trade flow.

Africa has a population of about 1.2 billion people. This has created a large market size for China to export to Africa. Population has a positive impact on bilateral trade flows. Our result also shows that real exchange rate plays a significant role in the bilateral trade of China and Africa. The higher the distance, the lower the trade volume as transportation cost increases. Geographically, Northern African countries such as Egypt, Algeria, Morocco, Libya and Tunisia are closer to China and should take advantage of the proximity to increase the volume of trade as compared to countries in the West and South of the continent which are farther away from China.

A high GDP for the Chinese economy implies higher production capacity, a big local market, and a large variety of goods available for trade. An increase in the GDP will lead to increase in trade volume. Big economies will be inclining to import more because of higher income and export more because of the varieties of output or production. The exports of African goods to China should be more than just raw materials. There should be massive industrialization with enhanced product quality, whereby Africa's finished goods can find place in the Chinese market. This will help increase the GDP of Africa.

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