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Technological Innovations of Nigeria's Trading Partners and Trade Flows: An Empirical Application of Gravity Model

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Abstract

This study seeks to examine Nigeria's trade flows and the effect of technological innovations. Data were collected from the World Bank, International Monetary Funds (IMF) and the Central Bank of Nigeria (CBN) from 2008 to 2014 for 18 countries. The Gravity panel data was used, and the results reveal that technological innovations negatively impact on Nigeria's trading flows with partners by 0.16%. This implied that imported technology no matter how cheap it is does not positively impact on the trade flows of Nigeria. This study, therefore, recommends that, Nigeria should develop its own technology (new production methods) rather than depending on other trading partner's technology. The dependence on other nations' technological transfers only leads to decreased trade flows. This is because most technology transfers are not complete transfers. The little transfers are given with conditions, which leads to the employment of expertise from the transfer country. This action leads to capital flights from Nigeria. Also, Nigerian government should follow the steps of countries like China and Japan who developed their own homegrown technology for their advancement.

Keywords: Technological Innovation, Gravity panel model, Trade flows, International trade.
JEL Code: F14, F1, F13, O24, Q55

Contribution/Originality:
The study contributes to the existing literature on technological innovation and trade flows. Gravity model was applied in the analysis. It recommends that Nigeria should develop its own technology or new production methods than depending on other trading partners. Therefore, the work contributes to technological development and trade policy.

1.0 Introduction

International trade results in increase in income, in the level of investment and in the state of technical knowledge in the country. The increase in investment and improvements in innovation and technological progress then leads to increased productivity, competitiveness, trigger a further increase in trade and in income. This however, is seen contrary to the Nigerian economy, as the economy suffered its slowest growth over the years and decline in trade flows. The decline in Nigeria's trade flows is attributed to the global macroeconomic crises and the changes in the international trade pattern in the era of globalization. For instance, the trade flows from Nigeria with other countries of the world has been on the decline. This is because Nigeria's total merchandise trade reduced to N3.65 trillion in the fourth quarter of 2015, compared to N4.02 trillion in the previous quarter of 2014. The country's total trade value of 2015 stood at N16.42 trillion, which is N7.25 trillion or 30.6 percent less than the total trade value for 2014 (Obinna & Emejo, 2016; National Bureau of Statistics NBS, 2015).

Trade flows between countries depend on a number of factors. Earlier studies like Beckerman (1956), Ullman (1956), Smith (1964), Linneman (1969), Yeats (1969), suggested that distance, product

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category, political instability, cultural similarity, colonial past, membership in an economic union, and standard demographic variables such as GDP and population are determinants of trade. Consequently, in the context of developing economies like Pakistan, India, China, Bangladesh and Sri Lanka, the determinants of trade are Tariff, import duty, Inflation, Foreign Direct Investment (FDI), Exchange Rate, Transportation Cost and Gross Domestic Product (GDP), based on gravity equation framework in which foreign trade depends on between countries.

Scholars in Nigeria such as Aliyu and Bawa (2015); Adewuyi and Bankole (2012) have applied the gravity methodology to examine the determinant of trade flows in Nigeria. These scholars did not consider the impact of technological innovations within and outside Nigeria. Consequently, other studies, for example in Germany, Matthias and Königer (2012) reported that improvements in innovations and technological progress lead to increased productivity and competitiveness, and triggers a further increase in trade and income. Contrary to Matthias and Königer (2012), the findings of Fink, Mattoo and Neagu (2005) who investigated the effect of communication costs on bilateral trade flows taking into account sector-heterogeneity that communication costs have a greater impact on trade in differentiated products than on trade in homogenous products and reported that communication costs have a significant effect on international trade and that they are of greater importance for trade in differentiated products than for trade in homogeneous products.

Technological innovation is seen as a key determinant of economic competitiveness between two or more nations engaging in bilateral trade. Innovation in technology is an instrument which solves current global challenges related to environment and health domain. Engaging in technological innovation results in increasing production, employment and environmental protection, which has attracted the interest of economists (Adam, 1776).

Nigeria's trading partners apply or adopted any of the following technological innovation as explained by Schumpeter (1934): new produces, new production methods, exploitation of new markets, new ways to offer products on the market and new ways of business organization. In this sense, product technological innovation is the result of producing and commercialization of new goods (products or services) or with improved performance characteristics, while process technological innovation corresponds to the implementation or adoption of a new or improved production process.

Therefore, it is on this premise that this research seeks to examine the impact of technological innovation on Nigeria's trading partners on Nigeria's trade flows with the application of gravity model. This study is divided into five sections: Section one is the introduction, which explains the motivation and background to the study. Section two, is the literature review that explains the concepts, theories and empirical reviews as well as the effect of technological innovations on Nigeria's trade flows, while section three discusses the methodology which covers sources of data and

method of data analysis, sections four is the result and discussion of findings and lastly section five provides the conclusion and recommendations.

2.0 Literature Review

2.1 Conceptual Issues

2.1.1 Trade Flows

International trade is concerned with the study of the causes and consequences of the international exchange of goods and services, and of the international movement of factors of production. Economists have found that foreign trade is often favourable to growth as well as a necessary condition for rapid growth for both big and small countries (Arodoye & Iyoha, 2014). The condition for a rapid growth rate of any country is based on the trade flows. Trade flows to measure the balance of trade (exports-imports). This is the number of goods that one country sells to other countries minus the number of goods that a country buys from other countries.

The net-exporting countries have a trade surplus due to the fact that they sell more goods to the international market than they purchase from it. Demand for that country's currency then increases because international clients must buy the country's currency in order to buy goods. This causes the value of the currency to rise (Long, 2009). Consequently, net-importing countries experience trade deficit due to the purchase of more foreign goods than they sell to the international market. In order to purchase these goods at the international markets, importers must sell their domestic currency and buy a foreign currency. This causes the value of the domestic currency to fall. Clearly, a change in the balance of payments from one country to another has a direct effect on currency levels.

Therefore, it is important for countries to keep abreast of economic data relating to this balance and understand the implications of changes in the balance of payments (Long, 2009). This study adopts the trade flows measure of trade (exports-imports). Which is the number of goods that one country sells to rest of the world minus the number of goods that a country buys from rest of the world as a measure of trade flows.

2.1.2 Gravity model

The concept of gravity model assumes that trade between countries can be compared to the gravitational force between two objects: it is directly related to countries' size and inversely related to the distance between them (Ravenstein, 1889; Tinbergen, 1962). Exports from country *i* to country *j* are explained by their economic sizes, their populations, direct geographical distances and a set of dummies incorporating some characteristics common to specific flows. Gravity models employ the gravitational force concept as an analogy to explain the volume of trade, capital flows, and migration among the countries of the world. The gravity model establishes a standard for trade-flow volumes as determined by Gross Domestic Product (GDP), population, and distance. The effect of policies on

trade flows can then be evaluated by adding the policy variables (technological innovation) to the equation and estimating deviations from the baseline flows (Anderson, 2011).

2.1.3 Technological innovations

Technological innovation has been defined as a country's "absorption capacity", the ability to put information from abroad into practice by developing new products and processes which play a key role in international trade and economic development (Zahra & George, 2002). The development of relevant indicators to measure the level of technological innovation — seen as absorption capacity — across countries is of great interest in a knowledge – based economy with high and increasing dependence on information technology and human capital. Based on Márquez, Martínez, Lucas and Burguet, (2007) technological innovation can be defined as the countries' capacity to put new ideas into practice by developing new products and processes which play a key role in international trade and economic development. According to Márquez *et al*., (2007), one measure that was used to capture technological innovation in a relatively broad manner is the Technological Achievement Index (TAI), which has been used in empirical analyses (Martínez & Márquez, 2010; Márquez, *et al*., 2007). This index has been constructed using indicators of a country's achievements in four dimensions: the creation of technology, diffusion of recent innovations, diffusion of old innovations and human skills. In a study, Wakelin (1997) classified different proxies for technological innovation and pointed out that the main choice of technological innovation proxies was between using an input to the innovation process, such as Research and Development (R&D) expenditure or the number of scientists and engineers employed in research departments, or an output, such as number of patents.

Economic theory views technology as a factor determining the patterns of trade. According to traditional theory, trade occurs because countries are different and one of these differences is technology. In shaping comparative advantage, technological differences between countries help to shape the patterns of trade. In the simplest Ricardian model, a country exports the good which it is relatively more efficient at producing than its trading partner – that is, the good with the lowest opportunity cost. Technological differences between countries are an important determinant of income levels and trade. Empirical research has shown that the accumulation of physical and human capital can only partially explain different income levels across countries (Easterly & Levine, 2001; Prescott, 1998) and different trade patterns. The residual is commonly attributed to technological differences between countries, whereby technology is defined as the information or knowledge required for production.

Technological innovation has had a major impact on trade costs. The introduction of containerization and jet engines has significantly reduced sea and air transport costs. More recently, the use of radio frequencies, identification tags, and the internet has allowed firms to keep track of where a product is at any time. This has significantly improved logistics services and made possible the development of a

more efficient multi – modal transport system. Technological advances have also significantly reduced communication costs. Exporters need information on profitable trading opportunities. Importers need information on suppliers of intermediate goods, on product specifications, and on scheduling production processes. Mobile phones are becoming increasingly important to commerce, especially in developing countries, because they require fewer infrastructures and are untied to location.

2.2 Theoretical Review

2.2.1 Comparative advantage theory

There are several theories in international trade and international trade flows, such as absolute advantage theory, comparative advantage theory and Hecksher-Ohlin theory. This study leans on the Comparative Advantage Theory by Ricardo (1817), which attempts to answer the question of a situation where a country has an absolute advantage in the production of two or more goods. Ricardo demonstrated that external trade arises not from differences in absolute advantage but from the difference in comparative advantage. In a model of two countries, two commodities and one factor of production, Ricardo maintains that a country should export the commodity it has a comparative advantage in relation to the comparative cost of producing the commodity. In another word, a country should export the commodity which its comparative cost of production is lower and import that commodity which its comparative cost is higher in pre-trade evaluation with another country.

The justification for using this theory is because Nigeria is technologically backward compared to some of her trading partners who have advanced technologically. Hence, Nigeria needs to trade with other countries so as to import their advanced technology in order to boost production which in turn increase trade flows by exporting the output to other partners who have a comparative disadvantage.

2.3 Empirical Review

2.3.1 China's technological innovative growth: A lesson for Nigeria

Since the late 1990s, China has attempted to maximize technology transfer through foreign direct investment (FDI) in particular by encouraging multinational corporations (MNCs) to conduct more of their R&D in China (Zhang and Long, 2011). The transfers and spill overs induced have fallen short of expectations with research analysing Chinese and international experience suggesting that MNCs thus far have generated few technological spill overs and those too mostly in the vertical plane and in high tech sectors. China is redoubling its own efforts at technological upgrading, indigenous innovation, (Gao, Zhang and Liu, 2007) takeover of foreign firms and their brands by China's leading challengers, and determined efforts by Chinese firms to innovate, build their own brand image and expand their share of global markets. This approach is exemplified by Lenovo (Tzeng, 2011).

In early 2006, the government announced its National Program Outline for Medium and Long Term Development of Science and Technology (S&T) (2006–2020). Its key pillars include indigenous innovation", "a leap-forward in key areas," "sustainable development", and "setting the stage for the future." The strategy calls for increasing R&D in priority areas including ICT, biotechnology, Nano-sciences and nanotechnologies, materials, energy, and others; it seeks to encourage enterprise-led innovation; to strengthen intellectual property protection; create a favourable environment for S&T innovation; attract S&T talents; and improve the management and coordination of S&T. During the 11th Plan period, the central government's outlay on science and technology rose by 22 percent per year. By 2010, R&D accounted for 1.75 percent of GDP and it is projected to reach 1.85 percent by end 2011(China 2030).

2.3.2 Technological innovations and trade flows

Differences in technology levels account for a major portion of cross-country income and growth disparities (Caselli, 2005). While industrialized economies have the advantage in terms of innovation, the majority of the world, which operates below the technological frontier, adopts technology developed by other countries. This fact brings to backward economies an important advantage because imitation and adaptation of new technologies are less expensive and risky than creating them (Gerschenkron, 1962). Importing foreign technology is, then a mechanism with which to increase growth and reduce the income gap across countries. Technology crosses borders via a variety of formal and informal channels, such as contracts for technology transfer, trade, Foreign Direct Investment (FDI), the migration of skilled labour and imitation. A significant amount of recent evidence has supported the idea that trade is an important channel in technology diffusion both among developed countries (Coe & Helpman, 1995) and between developed and developing countries (Coe, Helpman and Hoffmaister, 1997, Busse and Groizard, 2007) and among different potential channels, trade is perhaps the most consistent one (Keller, 2004). Hence, understanding the technology adoption process through trade is an open debate. The factors that influence technology diffusion through trade and the role of development in this process is less straightforward. For instance, there are several studies showing that stronger Intellectual Property Rights (IPRs) encourages trade (Maskus and Penubarti, 1995; Falvey, Foster and Greenaway, 2006) but there is no clear evidence that IPRs encourages technology imports. Additionally, human capital, domestic investment or openness are somehow perceived in the literature as factors enhancing technology diffusion, however evidence on their respective contributions is scarce.

3.0 Methodology

Data for the study were collected from the World Bank, International Monetary Funds (IMF) and the Central Bank of Nigeria (CBN), from 2008 to 2017 for 18 countries on Nigeria's trade flows and Nigeria's trading partners for GDP, distance, technological innovation were obtained. Nigeria's major

trading partners as 31st March, 2017 used for this study includes, United States of America (USA), Brazil, South Africa, Netherland, Spain, India, United Kingdom (UK), Indonesia, France, China, Belgium, Germany, South Korea, Japan, Thailand, United Arab Emirate (UAE) and Ivory Coast.

3.1 Model specification

This study followed the model of Frankel (1997), Sharma and Chua (2000) and that of Hassan (2000; 2001) which were modified to suit the Nigerian situation. This study adopted a panel regression estimation technique. Panel data is an important method of longitudinal data analysis because it allows for a number of regression analyses in both spatial (units) and temporal (time) dimensions. In Panel regression, there are three possibilities: Pooled Regression Model, Fixed Effect Model, and the Random Effects Model. These three are commonly used in empirical studies (Greene, 2008). The model is stated as, thus:

$$\ln GDP_{ijt} = \alpha + \beta_1 \ln GDP_{jt} + \beta_2 \ln GDP_{jt} + \beta_3 \ln D_{ijt} + \beta_4 TC^{I}_{ijt} + \nu_i + \mu_t + \varepsilon_{ijt} \text{-------} (1)$$

Where:
ln = Natural Logarithm
TF_{ijt}= trade flows, the balance of trade (exports-imports) from $_i$ to $_j$ at time $_t$,

GDP_{it}= Gross Domestic Product of country $_i$

GDP_{jt}= Gross Domestic Product of country $_j$

D_{ijt}= the distance between countries $_i$ and $_j$ at time $_t$

TC^{I}_{ijt}= technological innovation of country $_i$ to $_j$ at time $_t$

v_i = country fixed effect

u_t = time effect

ε_{ijt}= component error term

α = constant

β_1 β_2 β_3 and $\beta_4 > 0$ the slope values of the independent variables.

4.0 Estimation and Results

4.1: Results

Table 4.1: Results of pooled, fixed, and random regression estimates

	Expected sign	Panel A Pooled coefficient	P-value	Panel B Fixed coefficient	P-value	Panel C Random coefficient	P-Value
$\ln GDP_{it}$	+	0.52133	0.001**	.3445916	0.080***	0.5213273	0.00**
$\ln GDP_{jt}$	+	0.00856	0.757	.0314044	0.696	.0085603	0.024**
$\ln D_{ijt}$	-	0.01631	0.869	Dropped	Dropped	.0163057	0.144
TC^{I}_{ijt}	+	-0.00161	0.727	-.0679531	0.062***	-.0016104	0.019**
CONSTANT		12.53141	0.000*	14.46247	0.000*	12.53141	0.000*
R^2		0.3903		0.0647		0.3903	
N		126		126		126	
F*		8.25	0.000*	14.42	0.000*	56.56	0.000*
Hausman Test		-	-	3.73	p-value	0.5892	
Corr(Ui, X)		-	-	-0.9181	-	0	-

Dependent variable: TFijt.
*Note: * ** *** show significance at 1%, 5% and 10% respectively*
Source: Authors computation, 2018.

The data and models for this study were subjected to sensitivity and robustness tests. The results indicate that they have a correct functional form, serially uncorrelated, normally distributed (p-value, 0.9123) and homoscedastic (p-value, 0.2710). Hence, the results reported are valid for reliable interpretation. The Hausman specification test in Table 4.1 shows that the random effects model is a better estimator than the fixed effects model since the Hausman test result is not significant at 5% level of significance with a chi-square value of 3.73, with a p-value of 0.5892.

Table 4.1 showed the result of the relationship between the dependent variable (trade flows) and the independent variables (Gross Domestic Product for countries i and j, distance between them and technological innovation. Pooled, fixed and random effects regressions were estimated.

The pooled regression from Panel A shows a positive (0.52133) effect of Nigeria's GDP on its trade flows, the fixed effect in Panel B showed a positive (0.3445916) effect of Nigeria's GDP on its trade flows and the random effect in Panel C showed that the impact of Nigeria's GDP on its trade flows is also positive (0.5213273). Based on the results, the approaches (the pooled, fixed and random effects) showed a positive effect of Nigeria's GDP on trade flows. However, Nigeria's GDP showed a

significant effect in all the approaches. This implies that for every 1 unit increase in Nigeria's GDP, trade flows will increase by:

a. 0.52133 points in the pooled effect model and
b. 0.3445916 points in the fixed effect model and
c. 0.5213273 points in the random model.

According to the pooled regression result in Panel A, the impact of importer countries' GDP on Nigeria's trade flows is positive but insignificant with a coefficient of 0.00856. The fixed effect estimation in Panel B shows that GDP of importer countries impacts on Nigeria's trade flows is positive but insignificant with a coefficient of 0.0314044. The random effects result in Panel C however, shows a significant and positive impact of importer countries on Nigeria's trade flows with a coefficient of 0.0085603. The positive impact of importer countries GDP on Nigeria's trade flows will increase by 0.00856 units for pooled regression, 0.0314044 units for fixed effect and 0.0085603 for random effects as a result of 1 unit increase in importer countries GDP.

The result of the pooled regression from Table 4.1 in Panel A shows that distance between the importer and exporter countries is insignificant and positive with a coefficient of 0.01631. The fixed effect in Panel B shows no effect as the result indicated that it was dropped. The random effects result shows that distance impact on Nigeria's trade flows positively but not significant with a coefficient of 0.0163057. It implies that long-distance trading does not affect the trade flows of Nigeria from the results of the pooled and random effect regression.

The impact of technological innovation on Nigeria's trade flows is negative for pooled, fixed and random regression result in Panels A, B, and C respectively. This means that a unit increase in the technological innovation will bring about a decrease in Nigeria's trade flows by 0.00161 units for the pooled, 0.0679531 units for the fixed effect, and 0.00161 units for the random effect model.

4.2 Discussion of Findings

Technological innovation is negative but significant from the random effects result. This means that a unit increase in the technological innovation from other trading partners will bring about a decrease in Nigeria's trade flows. But based on literature reviewed, technological innovation had a major impact on trade costs. The introduction of containerization and jet engines has significantly reduced sea and air transport costs. More recently, the use of radio frequencies, identification tags, and the internet has allowed firms to keep track of where a product is at any time. This has significantly improved logistics services and made possible the development of a more efficient multi – modal transport system. Technological advances have also significantly reduced communication costs. Exporters need information on profitable trading opportunities. Importers need information on suppliers of intermediate goods, on product specifications, and on scheduling production processes. Mobile phones are becoming increasingly important to commerce, especially in developing countries, because they require fewer infrastructures and are untied to location.

Since the p-value (0.019) is lower than the level of significance of 0.05. The findings do not corroborate with that of Matthias and Königer (2012) who reported that improvements in innovations and technological progress lead to increased productivity and competitiveness, and triggers a further increase in trade and income. Similarly, the result also differs from the findings of Fink, Mattoo, and Neagu (2005) who found that communication costs have a significant effect on international trade and that they are of greater importance for trade in differentiated products than for trade in homogeneous products.

The result does not support the theory of this study, which is comparative advantage theory by Ricardo (1817), which attempts to answer the question of a situation where a country has an absolute advantage in the production of two or more goods. Ricardo demonstrated that external trade arises not from differences in absolute advantage but from the difference in comparative advantage.

The inconsistency in the result is attributed to economic theory which views technology as a factor determining the patterns of trade. This is because in the traditional theory, trade occurs because countries are different and one of these differences is technology. In shaping comparative advantage, technological differences between countries help to shape the patterns of trade. In the simplest Ricardian model, a country exports the good which is relatively more efficient at producing than its trading partner – that is, the good with the lowest opportunity cost. Technological differences between countries are an important determinant of income levels and trade.

5.0 Conclusion and Recommendations

This research empirically examined the Nigeria trade flows and the effect of technological innovations on Nigeria's trading partners by application of the Gravity model. The study formulated a static model with trade flows as the dependent variable while GDP of the host country, GDP of trading partners, the distance between trading partners and Nigeria and technological innovation as independent variables. A Panel regression (pooled, fixed and random effects) econometric technique was used to achieve the desired objectives. The findings of the study shows that technological innovation has a significant negative impact on Nigeria's trade flows. Hence, the study recommends that, Nigeria should develop its own technology (new production methods) rather than depend on other trading partners' technology. The dependence on other nations' technological transfers only leads to decreased trade flows. This is because most technology transfers are not complete transfers. The little transfers are given with conditions, which leads to the employment of expertise from the transfer country, this action leads to capital flights from Nigeria. Nigerian Government should also take examples from China and Japan who developed their own home grown technology for their advancement.

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