

Empirical Test of Heckscher-Ohlin Theory between Nigeria and USA

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Abstract

This study empirically tested if Nigeria patterns of production and trade are consistent with the Heckscher-Ohlin framework. The theory predicts that countries export the products that use their abundant factors intensively. As such, Secondary sources of data were collected from Central Bank of Nigeria and United Nation Conference on Trade and Development (UNTCTAD). The data for the study were transformed into nine sectors, namely manufacturing sector, Agricultural sector, mining sector, service sector, consumption sector, trade, Electricity, export and import sectors which formed the input-output table. The study utilizes an estimation methodology used by Leontief in the construction of input-output table. The study observed that the value of capital/labour ratio imported from U.S.A to Nigeria showed a value of (2.09) which exceeds the critical value of (1) or a representation of 55.7% of Nigeria total major imports from USA. This empirical result showed that Nigeria's pattern of production and trade are inconsistent with the prediction of Heckscher-Ohlin theory. This is because; Nigerian experience has proven Heckscher-Ohlin theory a dynamic model as against static model argued by others. This is indeed a major departure of Nigerian experience of Heckscher-Ohlin theory from others countries of the world. As such, the key policy implication from the study is that Nigeria should shift her patterns of production and trade from capital intensive oil production to labour intensive agricultural production as capital is scarce resources in Nigeria and at the same time make intensive use of her relatively abundant endowed labour resources, rich soils and favourable climatic conditions. Though, the study observed that there are some agricultural commodity and activities that Nigeria cannot do without employing labour intensive, such as groundnut, cocoa and palm products harvesting.

KEYWORDS: *Heckscher-Ohlin theory, labour intensive, imports, input-output matrix & capital intensive*

Background of the Study

The main determinants of patterns of production, specialization and trade among nations are the relative availability of factor endowments and factor intensity (Heckscher-Ohlin 1933). According to Kenen (1996), the Heckscher-Ohlin approach to trade theory also known as the factor endowment and factor proportions approach is based on two suppositions, namely relative factor endowment and factor intensity. He further argued that goods differ in their factor requirements. For instance, cars require more capital per worker than say furniture or cloth and aircraft require more capital per worker than cars. In other words goods can be ranked by factor intensity. On the other hand countries differ in their factor endowments. Some countries have much capital per worker and some have very little. In other words countries can be ranked by factor abundance. Heckscher-Ohlin model shows that trade between countries is proportion to their relative amount of capital and labour. In countries with relative capital abundance, wage rates tend to be high; therefore, labour-intensive products like textiles are more costly to produce internally. In contrast, capital-intensive products like automobile, cars are relatively less costly to produce internally. Thus the Heckscher-Ohlin theory predicts that a country will tend to export those commodities that use relatively intensively its relative abundant factor of production, and import those commodities, which use relatively intensively its relatively scarce factor of production (Nageri, Ajayi, Olodo & Abina, 2013).

This was supported by the work done by Fujita, & Krugman, (2004), that pointed out that economists have strong prior belief that relative factor endowments have much evidence for predicting the production and patterns of trade, and that the Heckscher-Ohlin model is the most sensible way of embodying these links.

Interestingly, these arguments do not in any way negate the fact that both relative factor endowments and factor intensity theory of trade play vital roles in predicting the basis for and patterns of trade existing among nations of the world (Krugman, & Obstfeld, 2003). Therefore, there is need to examine, measure, explain and empirically test whether Nigerian pattern of trade is consistent with the Heckscher-Ohlin framework. This derives from the fact that no attention has been given to the patterns of trade existing between Nigeria and other nations.

Indeed, actual patterns of trade in the Heckscher-Ohlin framework confirm that developing countries should specialize in the production and export of traditional agriculture, primary goods and labour intensive manufactures goods whose factors of production are relatively abundant.

It has been shown that a country with successful patterns of trade and other prudent economies and developmental policies would wean themselves from heavy reliance on foreign aids and use trade as one of their engines for economic development (Bernhofen & Brown, 2010). Bernhofen and Brown further, shows that the pattern of trade that gives a nation greater access to world market is more stable to secure and maintain trade advantages over the rest of the world.

Beside, the increasing importance of inter-industry trade theory in predicting the patterns of trade in developing world trade, little or no studies have been conducted to empirically examine whether Nigerian's pattern of trade is consistent with trade regime characterized by Heckscher-Ohlin theory. Therefore, the aim of this study is to integrate the measures of factor abundance and factor intensity measures to examine whether Nigeria's pattern of trade is consistent with the framework of Heckscher-Ohlin.

The broad objective of this study is to examine empirically whether Nigerian's patterns of production trade were consistent with a trade regime characterized by the Heckscher-Ohlin framework. *The specific objectives are; to examine whether Nigerian exports to USA are relatively labour intensive or capital-intensive goods as well as to ascertain if Nigerian imports from USA are relatively capital-intensive or labour intensive goods.*

The main thrust of Heckscher-Ohlin framework is to encourage a nation to use relatively intensively their abundant factors of production to satisfy domestic production and international markets for the purpose of achieving and accelerating economic growth and development. One thing is at least very clear; Nigeria is endowed, both in natural and human resources.

Performance of Nigerian's Production and Merchandise

Before oil was discovered, in the late 1950s, Nigeria basically survived on its labour intensive agricultural production for its economy and for its food. Today agriculture is still part of the domestic economy but by the late 1970s oil replaced cocoa, groundnut and palm products as the largest foreign exchange earner (Olaleye, Edun, & Taiwo, 2013).

Kotil and Konor, (2010) emphasized that there had been wide range of decline and fluctuation in the growth of agricultural sector contribution to GDP despite concerted efforts to reduce the excessive dependence on oil. In another development, Abayomi (1997) and Samson, Gisaor and Ojiya,(2013) described the decline in production of some Nigeria leading agricultural exports commodities as worrisome. Surprisingly agricultural production declined and so did the export of cash crops. Eventually the import of crops had to increase. Part of the effects of the oil boom was that there was a significant rural-to-urban migration caused in part by the lure of high wages and consumer-oriented life style of the city. This took a lot of the labour force away from the rural farms, leaving the very young, the old and infirm to cultivate the land. Abayomi, Obida and Gobna, (2011) also added that the share of agricultural exports in total export declined drastically from 97.3% in 1960 to 17% in 1972, 3.1% in 1981 and 1.25% in 1996 and by 2002 and 2007 it stood at 7.9% and 3.22% respectively. While the share of oil export to total export stood at 91.5% in 2008; 84.5% in 2009; 70.4% in 2010; 71.7% in 2011; and 69.2% in 2012 a feat attributed partly to fluctuation in the oil price due to crisis in the middle-east and government conscious strategies to promote non-oil export.

Furthermore, the trade relation between Nigeria and the USA in 2012 showed a similar trend in other years from mid 1980 till date as observed in the study. What is interesting about this breakdown is that for the largest sector, that is crude oil, Nigeria exports to the USA in 2012 was capital intensive products, but Nigeria was not particularly endowed abundantly with capital resources. Furthermore, Nigeria that is endowed with abundant fertile land, and labour resources used them intensively, but not in great extent in the production of agricultural products since it represent only 4.59% share of the total exports to the USA in 2012. See table 1.1 and table 1.2 for details.

Table 2.1: Nigeria's trade relation with USA (Major Imports) in 2012

S/N	Product name	Trade value	% share	Cumulative % share
1	Wheat	\$99.6m	5.47	5.47
2	Passengers vehicles	\$850.8m	46.76	52.23
3	Oil field & drilling equipment	\$434.1m	23.86	76.09
4	Trucks & special purpose vehicles	\$272.8m	14.99	91.08
5	Plastic Materials	\$79.1m	4.34	95.42
6	Industrial Engine	\$82.8m	4.44	99.97

Source: compiled from United Nation Conference on Trade and Development (2012)

Table 2.2: Nigeria's trade relation with USA (Major Exports) in 2012

S/N	Product name	Trade value	% share	Cumulative % share
1	Crude Oil	\$45.1b	96.28	96.28
2	Fuel Oil	\$463.6m	2.06	98.36
3	Cocoa beans	\$4.3m	0.02	98.36
4	Natural Rubber	\$22.9m	0.4	98.76
5	Feedstuff & food grains	\$9.2m	0.02	98.96
6	Palm oil & palm kernel	\$2.6m	0.01	98.97

Source: compiled from United Nation Conference on Trade and Development (2012)

From table 1.1, some of the Nigerian main imports from USA are; auto products, tyres and inner tubes, commodities, sugar, frozen fish, powder milk, wheat, salt, food products: biscuits, baking products, tomato paste, canned product, vegetable oil, tobacco, cosmetic, household equipment, etc. While table 1.2 shows that most of the goods exported from Nigeria to USA consist of the following Petroleum and oil, agricultural products; ornamental fishes, animal hides, wood timber, minerals, processed goods, etc

Literature Review

The Heckscher-Ohlin model developed by Swedish economists Eli Heckscher-Ohlin (1919) and Bertile Ohlin (1933) describe a world in which every country faces the same technological frontier and has productive factors with the same qualities. The only difference between countries is in terms of the physical quantities of the factors of production, and as such, the Heckscher-Ohlin model is an account of trade based on factor endowments. It builds on David Ricardo theory of comparative advantage by prediction patterns of trade and production based on relative factor abundance and factor intensity of a trading region (Wales 2002). Furthermore Heckscher-Ohlin (1933) maintained that a relative endowment of the factors of production, labour and capital determines the country's comparative advantages in those goods for which the required factors of production that are relatively abundant. They expanded the number of factors of production from one to two. The model assumed that labour and capital are used in the production of two goods. Here capital refers to the physical machines and equipment that is used in production. Thus machine tools, conveyors, trucks, computer, office buildings supplies and much more is considered capital. Further Heckscher-Ohlin (1933) maintained that a relative endowment of the factors of production labour and capital determines the country's comparative advantages in those goods for which the required factors of production are relatively abundant. Heckscher-Ohlin (1933) notes that different countries of the world have different quantities or endowments, of capital and labour available for use in the production process thus, some countries like USA are well endowed with physical capital relative to labour force. In contrast many less developed countries have very little capital but are well endowed with large labour forces. We use the ratio of the aggregate endowment of capital to the aggregate endowment of labour to define relative factor abundance between countries.

Furthermore, Heckscher-Ohlin noted that the ratio of the quantity of capital to the quantity of labour used in production process is the capital-labour ratio. Heckscher-Ohlin imagined and therefore assumed that different industries, producing different goods have different capital-labour ratios. It is the ratio (or proportion) of one factor to another that gives the model its generic name-the factor proportions model. Thus Heckscher-Ohlin model assume that the only differences between countries are those variation in the relative endowments of factors of production. It is most certain that trade will occur, and that trade will be naturally advantageous and will have characterable effects upon prices, wages and rents, when the nations differ in their relative factor endowments and when different industries use factors in different proportions, (Appleyard & Field 1994), and (Thompson & Dajun, 2005).

In support of the above statement, Wales (2002) showed that prices of goods are ultimately determined by the prices of their inputs. For instance, goods that require inputs that are locally abundant will be cheaper to produce than those goods that require inputs that are locally scarce. Thus, the exports of capital-abundant countries will be from capital-intensive industries, and labour abundant countries will import such goods, exporting labour-intensive goods in return. From this scenario Heckscher-Ohlin (1933) concludes that the differences in relative commodity prices between two countries are the evidence of their comparative advantage, which form the basis for their mutually beneficial trade. This is contrary to Samson, Gisaor and Ojiya, (2013) findings that globalization has had no serious impact on Nigeria's economic growth. This is because differences in comparative advantage will arise between countries because of differences in the relative abundance or scarcity of the factors of production. Comparative advantage will be found in those activities that make intensive use of the abundant productive resources, (Adak. 2010).

According to Nageri, *et al*, (2013), the Heckscher-Ohlin theory has three fundamental features. They are:

- Each country exports goods that are intensive in the country's relatively abundant factors.

- Trade based on factor endowments benefits abundant factors and hurts scarce factors.
- International trade results in a tendency toward factor-price equalization.

Though, Vani and Gandhi (2002) argued that specialization in production and trade between countries generate according to this theory a higher standard of living or greater economic welfare if the assumptions of perfect competition in commodity as well as factor market and mobility internally and immobility of factors internationally are valid.

In line with Vani and Gandhi (2002) observations, Todaro & Stephen (2009) emphasized that under the Heckscher-Ohlin theory, productivity factors are assumed to move from areas of low remuneration to areas of high remuneration, lowering supply in the first region and raising it in the later. The forces of the market then rose the earning of the migrating factors in the land of departure and lower it in the land of arrival, thus tending to equalize factor rewards the world over.

In examining Japan's 19th century move from autarky to free trade, to test the general validity of the Heckscher-Ohlin theorem, Bernhofen and Brown (2010), employ Ohlin's measure of factor scarcity, where autarky factor prices impose a single refutable prediction on the economy's factor content of trade. Combining factor price data from Japan's late autarky period with commodity trade data and the economy's technology matrix constructed from input requirements at the task level for Japan's tradable and key intermediate goods. The study shown that the early period of trade openness, Japan's factor content of trade correspond the autarky factor prices. This shows that Japan's commodity trading pattern behaved in accordance with the Heckscher-Ohlin hypothesis and provided upper bound estimates of the gains from trade.

Heckscher-Ohlin analysis of the relationship between trade and income inequality, Ann, McLaren, & McMillan, (2010) observe that one implication of this framework is that trade increases the real return to the factor that is relatively abundant in each country and lowers the real return to the other factor - known as the Stolper-Samuelson Theorem. This means that in developed countries, with an abundance of skilled labor, wages of skilled workers should increase relative to unskilled workers and inequality should rise with trade. The opposite was expected to happen in developing countries that were well-endowed with unskilled labor: inequality should have declined with trade. While, Usman, (2011) estimates the Heckscher-Ohlin model with annual US data from 1949 to 2006 for outputs of manufactures and services with inputs of fixed capital assets and the labor force asserts that factor price equalization does not hold for labor and capital in US. Because of the inconsistency note, the study suggested within-industry effects due to heterogeneous firms as a way to tackle trade inequality.

Summary, in all the works reviewed, only Ann, *et al*, (2010) that made attempt to predict the classical writers and majority of the modern trade theories such as Stolper-Samuelson Theorem, Ricardo comparative advantage among others does not hold true for developing countries like Nigeria. But the prediction of Heckscher-Ohlin still holds true for developing countries. Finally, all other works on trade did not test Heckscher-Ohlin relatively labour intensive or capital-intensive goods between Nigerian exports to USA to ascertain the validity. Nageri, *et al* (2013), only limited there study to total trade, FDI flow, and degree of openness without specific interest on Heckscher-Ohlin. Therefore, this work fills this gap, as it concentrates on the validity of Heckscher-Ohlin hypothesis because of some insight into the effects of international trade on factor use and factor rewards.

METHODOLOGY

The data for this study were analyzed using Leontief's input-output technique. The design for the estimation procedures will include: Schematic representation of static input-output table (Model), step by step analysis of the processes involved in the estimation of the input-output system and the specification of models of the study. The mathematical structure of computation framework is proposed with which a family of country level input-output model can be constructed from input-output table. Nine sectors namely; Agriculture, Mining, Trade, Manufacturing and services are used in the construction of input-output table. Generally, Leontief (1966) input-output analysis considers inter-industry relations in an economy, depicting how the output of one industry goes to another industry where it services as input, and thereby make one industry dependent on another, both customer of output and a supplier of input. The input output analysis tells us that there are industrial inter-relationship and inter-dependence in the economic system as a whole.

In this study input-output table was constructed from nation's level data sets consisting of nine sectors, namely: Agriculture, manufacturing, trade, oil mining, Electricity, import, export, other services and consumption. General production function of Nigeria will be constructed from the nation's data set to examine the total factor intensity. From the table constructed the researcher will determine whether Nigeria produces and exports those goods that require intensively that factor she has in abundance and import those goods that require intensively factors that is scarce.

According to Davis (1990), Jhingan (1982) and OECD (1992), assumptions of input-output approach are;

- The basic input-output analysis assumes constant return to scale.

Table 5.1: Nine sectors of updated input-output table for Nigeria in 2012.

Economic activities	Agric	Manufact	trade	Oil/mining	Other services	Comsumpt.	electricity	export	import	Final demand	Gross Dom. Output
Agric	1755 73.6	5853 7.21	0	0	0	20653 7	0	1437 143	1245 20.4	2869 6611	48719 72
Manufact	4094 6.72	5912 2.27	2370 9.89	6396. 65	2727 .5	68007	66.25	3788 9.27	8544 64	9255 82.4	20189 11.9
Trade	2712 28	4941 23	6.57 E+08	13903 9	522. 81	0	2938 1	6621 304	1779 602	1738 891	66840 0229
Oil/mining	5119 .25	3548 5.8	4375 2.74	5525. 23	0	53752	4944. 94	2984 584	2789 28.5	3090 233	64933 25.5
Other services	564. 67	1138 .36	4284 6.25	0	3659 .64	0	42.14	3468	5270. 81	6249 7.54	11948 7.41
Consumpt.	9239 .2	7143	3510. 42	11269 .92	75.6 9	95756 5	746.3	0	0	0	98954 9.53
Electricity	864. 6	2598 .89	1633. 22	726.7 7	58.0 3	32146 5	66.95	5352 6	4115 2.83	8859. 15	43095 1.44
Export	51	3684 21	6.57 E+08	0	3503 4	0	0	6621 304	0	2156 49	66430 7124
Import	2711 77	1257 02	2594 74	13903 9	2048 1	0	2938 1	0	1779 602	5267 074	78919 30
Value added	2584 220	4926 61.3	1319 222	28425 84	9968 4.88	85757 85	6698. 23	6.52 E+08	5701 347	-	67358 0431
Total input	3358 984	1644 933	1.32 E+09	31445 81	1622 43.6	10183 111	7132 6.81	6.7E +08	1056 4887	1417 8447	2.0029 E+09

Source: Researchers input-output computation. **NB:** Each entry gives the volume of sales (in million naira) by the sector named at the left to the sector numbered at the top. The sectors numbered across the top correspond to the sectors numbered in the table.

The Leontief inverse matrix results for examining whether Nigerian exports to USA are relatively labour intensive or capital-intensive goods as well as to ascertaining if Nigerian imports from USA are relatively capital-intensive or labour intensive goods is presented below. That is, Table 5.2 shows the summary estimated coefficients of capital and labour used in the production of exportable and importable bundles between Nigeria and USA respectively in 2012.

Table 5.2 The coefficient of capital and labour

	Capital requirement	Labour requirement
Exports	$Ak_x = 6.51$	$\alpha L_x = 6.411$ man years
Imports	$Ak_m = 3.606$	$Al_m = 1.72$ man years

Source: Researchers capital/labour computation

$$K_x = ak_x / \alpha L_x = \#1.02(1296)$$

$$K_m = aK_m / \alpha L_m = \#2.09(128)$$

Factors were aggregated into two categories namely labour and capital. Each horizontal row gives the amount that a particular industry sold to all sectors including itself and to the final demand or final users. Also the individual vertical column indicates how much each sector purchased as input from other sectors. The transactions were measured in naira.

From table 5.2, Nigeria seems to have been endowed with more labour per worker than USA in 2012, but exported capital-intensive goods and also imported capital-intensive goods. Therefore Nigeria's production and trade patterns were inconsistent with what Heckscher-Ohlin predicts. Their predictions state that countries export those commodities, which require for their production relatively intensive use of those productive factors found locally in relative abundance.

We tested for the validity of results obtained by conducting Leontief Statistics for factor intensity and factor abundance. It is observed value of capital \ labour ratio is (1.02) which is greater than the critical value of 1. This implies that Nigeria which seems to have been endowed with more labour than USA in 2012 exported crude oil (which represented 92.2%) as her major export product to the USA and whose production requires

intensive use of the relatively scarce capital resources, it therefore implies that Nigeria imported the capital resources needed for the production of crude oil.

Again, it is equally observed that the value of capital/labour ratio imported from U.S.A showed a value of (2.09) which exceeds the critical value of (1). This indicates that Nigeria's imports from USA are relatively capital-labour intensive goods, which represented 55.7% of her total major imports. This indicates that the USA made intensive use of her relatively endowed abundant capital resources and technology in the production of her exports to Nigeria.

Summary of Findings

This study has investigated on the empirical issues pertaining whether Nigerian exports to USA are relatively labour intensive or capital-intensive goods and made the following findings:

- Nigeria produced relatively capital-intensive product (crude oil) for export to USA. This implies that Nigeria exports to USA are not relatively labour intensive.
- Nigeria's imports from USA are relatively capital intensive goods.
- Because USA is capital abundantly endowed and Nigeria is capital scarcely endowed, it results to trade imbalance between Nigeria and USA. In other words, Nigeria will be experiencing favourable trade balances since it is not exporting commodities that she produced with abundant factor.
- This study revealed that Nigeria is a labour-abundant country, but produced and exported capital intensive and imported labour intensive goods.
- Though, Nigeria used more capital per worker than labour in the production of her merchandize exports, there are commodities that she cannot do without labour, such as groundnut, cocoa and palm products harvesting.
- Nigeria's patterns of production and trade were inconsistent and variance with Heckscher-Ohlin framework. This is because; Nigerian experience has proven Heckscher-Ohlin theory a dynamic model as against static model argued by others. This is indeed a major departure of Nigerian experience of Heckscher-Ohlin theory from others countries of the world.

RECOMMENDATIONS AND CONCLUSION

Having tested empirically if Nigeria's patterns of production and trade were consistent with Heckscher-Ohlin framework, it is necessary to make some policy recommendations, after careful examination, the following recommendations are put forward in line with the findings of the study as thus:

1. Government should also adopt restriction trade policy that would inhibit the importation of those agricultural commodities that could be produced locally with the relatively abundant endowed labour resources and import capital.
2. Government should encourage foreign investors in agricultural business to make use of locally abundant labour resources in their production.
3. Government should shift or diversify her patterns of production from capital intensive oil productions to labour intensive agricultural production as capital is scarce resource and in order to make intensive use of the relatively abundant endowed labour resources, rich soils and favourable climatic conditions prevalent.

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