Determinants of Fish Trade Flows in Africa

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**Abstract**

Given that fish and fishery products are ranked among the most traded food commodities globally, with developing countries accounting for the bulk of the world’s fish exports, the analysis of fish trade flows is of key importance for any policy measure in the fisheries sector. This study evaluates the determinants of fish trade flows by applying the generalized gravity model. Using panel data covering a period of 14 years for 54 African countries, the gravity model is estimated using the Tobit regression to overcome estimation challenges in the presence of zero trade observations. The results suggest that a 1% increase in exporters’ GDP, importers’ GDP, population, exporters’ fish production, and countries sharing a common border increased fish trade flows by 8%, 14 %, 4%, 36% and 60%, respectively. On the other hand, importers’ fish production, and distance reduced fish trade flows by 5% and 17%, respectively. The results further shows that the belonging to ECOWAS, EAC, SADC and AMU has significantly enhanced intra-fish trade flows thereby contributing to gross trade creation for fish. The results indicate that the current demand for fish is very high such that current production is unable to meet the consumption needs. This calls for consolidated efforts in investment and development of the aquaculture sector as an alternative to the dwindling fish supplies from the wild environment. The findings also demonstrate the need for regional blocs to improve the transport networks on the continent by, among others, adopting a regional cooperation strategy centered on infrastructure development.

**Keywords:** gravity model, fish trade flows, regional economic communities, zero trade flows

**1. Introduction**

Trade in fish and fish products among African countries are becoming increasingly important for the region’s food security and nutrition and economic development. Trade plays a major role in the fishery industry as a creator of employment, food supplier, income generator, and contributor to economic growth and development for many countries (Mwina, 2012). Fish and fishery products exported from developing countries comprise 20% of all agricultural and food processing exports. Even though fish is Africa’s leading agricultural export commodity (in terms of quantity), the continent is a net importer of low value fish and fish products (Cocker, 2014). During the past ten years, population growth and decline of capture fisheries has led to demand now significantly outweighing supply and most countries importing fish for consumption. As a result, African domestic and regional markets are expected to continue being the main destination of locally produced fish as demand expands.

Fisheries represent the leading agriculture export commodity for Africa hence forming a significant element of some national economies. Fisheries and fish trade also play an important role in poverty alleviation and attainment of food security of the sub-Saharan African population (Béné, 2008). This trade is particularly important in Africa, where it has been noted that high fish production is limited to a few countries making trade in fish and fish products among African countries increasingly important. Fish exports from Africa is dominated by a few countries such as Namibia, South Africa, and Senegal while Nigeria, Ghana, and the DRC are the leading fish importers (Gordon *et al*., 2013). Despite the food security and poverty alleviation potential of fish trade in Africa, this type of trade is often overlooked and neglected in national and regional policy (Ayilu *et al*., 2016). The analysis of the determinants fish trade flows is of key importance for any policy measure in the aquaculture and fisheries sectors (Shortte, 2013).

The intra-regional fish trade understanding in Africa is limited in a number of key areas including the determinants of fish trade flows in Africa and the effects of the RECs on fish trade flows. While Empirical studies in Africa have used aggregated data to analyze the factors affecting agricultural trade, and general trade, the trade effects of Regional Economic Communities (REC’s) and the effects of non-tariff barriers on trade flows in the region (Hatab, 2015: Hatab, 2010; Ntembe and Tawah, 2012; Hallaert *et al.*, 2011; FAO, 2007; Meyer *et al.*, 2010; Babatunde, 2006; Teweldemedhin and Chiripanhura, 2016; DaSilva, 2010; Kareem, 2014), there has been little analysis, if not none, of the determinants of trade with special focus on fish trade on the continent. This has resulted into a knowledge gap as regard to the determinants of fish trade flows and their economic effects in Africa, which has served to stimulate this study. In order to harness the economic benefits associated with fish trade, there is need for an appropriate policy framework and policy process which can be informed by research in regional fish trade. Inappropriate policy frameworks put at risk the benefits of increased fish trade for national development (FAO, 2007).

This study was conducted to assess the determinants of fish trade flows in Africa so that policy considerations are put forward to promote fish trade on the continent. The research used data generated within Africa focusing on understanding drivers and trends in fish trade. Understanding the drivers of fish trade flows in Africa is crucial if fish trade is to be promoted and improved in Africa. It can also aid in the formulation of country specific fish trade policies and regulations that can help in reducing trade barriers that affect intra-regional fish trade and exacerbate informal fish trade. It is also important to understand the role of RECs on the continent such as ECOWAS, ECCAS, COMESA, SADC, AMU and EAC in fish trade creation within the region as this can help in strengthening their performance and enhancing collaboration.

**2. Theoretical and Empirical literature**

The theoretical literature on the factors affecting trade flows and impact of RECs on trade is very diverse. The gravity model has been applied to almost all kinds of commodities ranging from consumable to non-consumable goods. The model is applied to explore the influence of primary production, food consumption, prices, exchange rate, population, income, GDP, trade agreements and geographical distance on trade of various commodities. Natale *et al.* (2015), for instance, assessed the factors that affect international seafood trade. In Egypt, Hatab *et al.* (2015) employed a gravity model to analyze the main factors influencing Egypt’s agricultural exports to its major trading partners and found that GDP, exchange rate, distance, common border and common language significantly influenced Egypt’s trade with its major trading partners. The gravity model has been used to analyze the trade effects of the various regional economic blocs within Africa and elsewhere (Babatunde, 2006; Teweldemedhin and Chiripanhura, 2006; 2009; Negasi, 2009; Zannou, 2010; Simwaka, 2011; Hatab, 2015; Koo *et al.*, 1994; Karemera *et al*., 1999; Karemera *et al*., 2009; Karemera *et al*., 2015; Dembatapitiya and Weerahewa, 2015).

The gravity model has proven to be an effective tool in explaining bilateral trade flows as a function of exporter’s and the importer’s characteristics, together with factors that aid or restrict trade. One prominent issue is how to deal with zero observations especially when disaggregated data is used. The logarithmic form of the gravity model does not allow the use of zero trade values in the estimation which are more common in disaggregated trade data, such as fish trade data. Furthermore, the log linear transformation of the gravity equation in the presence of heteroskedasticity possesses challenges on the validity of the parameter estimates (Silva and Tenreyro, 2006; Kareem *et al.*, 2016). Nevertheless, the literature is very diverse on estimation techniques for addressing zero trade flows.

Common practices in dealing with zero values include substituting the zeros by a small arbitrary number and removing the zeros (Kareem *et al.*, 2016). These methods, however, have been criticized for lacking concrete theory behind. Zero trade flows arise due to trade flows recorded as zero or missing. If these are disregarded, then important information explaining low trade is lost and can lead to biased results. The dropping of zero values also leads to sample selection bias (Kareem *et al.*, 2016; Gomez-Herrera, 2011). Because of this, non-linear estimation techniques have become common recently. Such non-linear methods include Tobit, Heckman model and Poisson Pseudo Maximum Likelihood (PPML) (Martin and Pham, 2015; Sun and Reed, 2010). The Tobit estimator, proposed by Tobit (1959), fits well on data observable over some range (Kareem, 2013). The Heckman model is built to deal with non-random elimination of zeros, which could otherwise result into selection bias. The work on the use of the PPML was pioneered by Silva and Tenreyro (2006) who recommended it in the presence of heteroskedasticity and zero observations.

Despite the rich literature on the techniques for dealing with zero values, there is still debate among researchers on the most appropriate estimation technique for a gravity model. Kareem *et al*. (2016) found that the nature of the dataset and the process of generating the error term should guide researchers on the technique to use. They recommended an encompassing toolkit approach of the methods so as to establish robustness. Similarly, Linders and De Groot (2006) argued that the choice of estimation method of the gravity model should be based on both economic and econometric considerations. Natalie *et al*. (2015) noted that the gravity model is still an open field of research from an econometric perspective and that the choice of estimation technique in the presence of zero trade flows should be inconclusive from previous studies.

**3. Methodology**

*3.1 The Traditional Gravity Model*

The traditional gravity model drew on resemblance with Newton’s Gravitation Law and has been applied to services and commodities. Theoretical foundations of gravity equation are found in Tinbergen (1962), Anderson (1979) and Bergstrand (1985, 1989). Both Tinbergen (1962) and Linneman (1966) proposed a similar approach of explaining trade flows using the gravity model. The underlying idea of the model is that there is a positive relationship between trade and trading pairs’ income and a negative relationship with distance between them. The theoretical foundation in Anderson (1979) is based on Cobb-Douglas or CES preference function. Bergstrand (1985, 1989), on the other hand, provided a theoretical foundation based on monopolistic competition model of New Trade Theory.

According to the generalized gravity model of trade, the volume of trade flows between pairs of countries,, is a function of their incomes (GDPs), their populations, their geographical distance and a set of dummies. The commodity-specific gravity model, as specified in Linneman (1966), Anderson (1979), and Bergstrand (1985, 1989), can be specified as follows:

(1)

is the value of trade flows from country to country at time, and are GDP of country and country respectively, is the geographical distance between country and country , represents any factors aiding or restricting trade between country and country , and is a normally distributed error with .

*3.2 Empirical Model Specification: The Generalized Gravity Model*

A typical gravity model contains three variable components which are economic factors affecting trade flows in the origin countries, economic factors affecting trade flows in the destination countries, and natural or artificial factors enhancing or restricting trade flows such as trade policies (Koo *et al.*, 1994). The traditional gravity model is revised for a single commodity and applied to fish trade in Africa. The augmented commodity specific gravity model is used to determine factors affecting fish trade flows in Africa. The model specification of the gravity model for African fish trade flows is shown in equation (2).

(2)

Where

is the monetary value of exports of fish between countries and at time .

is GDP for the exporting country (country .)

is GDP for the importing country (country *j.*)

represents population of the exporting and importing countries respectively.

represents the shortest geographical distance between countries &

is primary fish production in exporting country

is primary fish production in importing country

represents fish prices in exporting country

represents fish prices in importing country

represents bilateral real exchange rate

is a dummy for “common colony”, if pair countries were under the same colonial rule; otherwise

is a dummy for “common language”, if pair countries share a common language; otherwise

is a dummy for “common border”, if pair countries share a common border; otherwise

The dummy variables SADC, EAC, COMESA, ECOWAS, ECCAS and AMU represent trade between members of the same regional trading blocs.

for trade flows between SADC countries; 0 otherwise;

for trade flows between COMESA countries; 0 otherwise;

for trade flows between ECOWAS countries; 0 otherwise;

for trade flows between EAC countries; 0 otherwise;

for trade flows between ECCAS countries; 0 otherwise;

for trade flows between AMU countries; 0 otherwise;

Table 1. Operational explanation of the variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Variable type** | **Measurement** | **Expected sign** |
| Trade Flows | Continuous | US$ |  |
| Distance | Continuous | Kilometer | - |
| Exporter's GDP | Continuous | US$ | + |
| Importer's GDP | Continuous | US$ | + |
| Exporter's Population | Continuous | Number | + |
| Importer's Population | Continuous | Number | - |
| Exporter's Fish production | Continuous | Tonnes | +/- |
| Importer's Fish production | Continuous | Tonnes | - |
| Exporter's Fish price | Continuous | US$/Kg | + |
| Importer's Fish price | Continuous | US$/Kg | - |
| Real Exchange rate | Continuous | Conversion | +/- |
| Common Border | Dummy | Dummy | + |
| Common colony | Dummy | Dummy | + |
| Common language | Dummy | Dummy | + |
| SADC*c* | Dummy | Dummy | + |
| EAC*c* | Dummy | Dummy | + |
| COMESA*c* | Dummy | Dummy | + |
| ECOWAS*c* | Dummy | Dummy | + |
| ECCAS*c* | Dummy | Dummy | + |
| AMU*c* | Dummy | Dummy | + |

*3.3 Data Sources*

The data used in this study is on bilateral trade on fish exports between 54 African countries from 2001 to 2014. All the 54 African countries which were included in the bilateral trade flows of fish are shown in Table 2. The time period 2001 – 2014 was chosen mainly because bilateral fish exports data were available for that period. GDP and exchange rate data were obtained from data base of the World Bank. Data on bilateral exports of fish were obtained from Trade Map. The production data were obtained from FishStatJ, software for fishery statistical time series hosted by the FAO. Fish prices were calculated by dividing the fish monetary value in a given year by the associated quantity in that particular year, obtained from FishStatJ. The calculations on distance were based on the nearest commercial centers of the trading countries. Data analysis was done using Stata Version 12.

Table 2. RECs and member countries

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SADC | EAC | ECOWAS | COMESA | COMESA | ECCAS | AMU |
| Angola | Burundi | Benin | Burundi | Swaziland | Angola | Algeria |
| Botswana | Kenya | Burkina Faso | Comoros | Uganda | Burundi | Libya |
| DRC | Rwanda | Cabo Verde | DRC | Zambia | Cameroon | Mauritania |
| Lesotho | Tanzania | Côte d'Ivoire | Djibouti | Zimbabwe | Central African Republic | Morocco |
| Madagascar | Uganda | Gambia | Egypt |  | Chad | Tunisia |
| Malawi |  | Ghana | Eritrea |  | Congo |  |
| Mauritius |  | Guinea | Ethiopia |  | DRC |  |
| Mozambique |  | Guinea-Bissau | Kenya |  | Equatorial Guinea |  |
| Namibia |  | Liberia | Libya |  | Gabon |  |
| Seychelles |  | Mali | Seychelles |  | São Tomé and Príncipe |  |
| South Africa |  | Niger | Madagascar |  | Rwanda |  |
| Swaziland |  | Nigeria | Malawi |  |  |  |
| Tanzania |  | Senegal | Mauritius |  |  |  |
| Zambia |  | Sierra Leone | Rwanda |  |  |  |
| Zimbabwe |  | Togo | Sudan |  |  |  |

*3.4 Model Estimation*

The estimation procedure uses panel data. Panel data estimation allows the modeling of the involvement of variables through time and space which helps in controlling for omitted variables in form of unobserved heterogeneity which if not accounted for can cause omitted variable bias (Kareem, 2013). This study estimates two gravity models to ensure robustness of the results. The Tobit model and the Poisson Pseudo Maximum Likelihood (PPML) (as recommended by Gedaa and Seid, 2015) estimation techniques have been estimated in this study and the results from the four techniques are compared and the best model is used in the discussion of results.

**4. Results and Discussion**

*4.1 Estimation Results*

Two gravity models were estimated using nonlinear estimation methods, Tobit regression and Poisson Pseudo Maximum Likelihood (PPML). The Tobit estimator is applied to fit dataset when data set are only observable over some range. The Tobit model used in gravity data censors the zero observations at the left tail. Results of the Tobit regression are presented in Table 3. Santos Silva and Tenreyro (2006) pioneered the work on the use of the PPML in estimating the gravity model and assessed its performance using Monte Carlo simulations. They recommended the use of the PPML technique in the presence of heteroskedasticity and zero trade flows. Santos Silva and Tenreyro (2006) noted that the PPML provides unbiased and consistent estimates that are robust to the presence of heteroscedasticity in the data and naturally take care of the zero observations of the dependent variable. Table 3 shows results of the Tobit and PPML regression.

Table 3. Estimates of a gravity model with zero trade flows (Tobit and PPML)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | PPML | | | Tobit regression | | |
| **Coefficient** | **Std. Err.** | **Z-score** | **Coefficient** | **Std. Err.** | **Z=score** |
| Distance | -0.8161\*\*\* | 0.0798 | -10.23 | -1.46384\*\*\* | 0.243004 | -6.02 |
| Exporter's GDP | -0.3449\*\*\* | 0.0500 | -6.9 | 0.654848\*\*\* | 0.167407 | 3.91 |
| Importer's GDP | 0.5403\*\*\* | 0.0616 | 8.77 | 1.18158\*\*\* | 0.184478 | 6.4 |
| Exporters Population | 0.2523\*\*\* | 0.0495 | 5.09 | 0.361912\*\* | 0.130989 | 2.76 |
| Importers Population | -0.1849 | 0.1125 | -1.64 | 0.2501 | 0.2161 | 1.16 |
| Exporter's production | 1.9774\*\*\* | 0.1555 | 12.72 | 3.1157\*\*\* | 0.2600 | 11.98 |
| Importer's production | -0.4588\*\*\* | 0.0618 | -7.42 | -0.4010\*\* | 0.1363 | -2.94 |
| Exporter's Fish price | -0.1863 | 0.1798 | -1.04 | -0.2041 | 0.1513 | -1.35 |
| Importer's Fish price | 0.0799 | 0.1309 | 0.61 | -0.1412 | 0.1727 | -0.82 |
| Real Exchange Rate | 0.0062 | 0.0108 | 0.58 | -0.0037 | 0.0086 | -0.44 |
| SADC*c* | 2.0541\*\*\* | 0.1489 | 13.79 | 5.8099\*\*\* | 0.6784 | 8.56 |
| EAC*c* | 1.8762\*\*\* | 0.4077 | 4.6 | 7.4747\*\*\* | 1.7520 | 4.27 |
| ECOWAS*c* | -0.0042 | 0.3605 | -0.01 | 3.9632\*\*\* | 0.8616 | 4.6 |
| ECCAS*c* | -3.8922\*\*\* | 0.5444 | -7.15 | -2.2497 | 1.3912 | -1.62 |
| AMU*c* | 0.1073 | 0.2620 | 0.41 | 6.3237\*\*\* | 1.6910 | 3.74 |
| Common Colony | -0.6150\*\* | 0.2162 | -2.84 | 0.7415 | 0.5893 | 1.26 |
| Common Language | 1.9686\*\*\* | 0.4281 | 4.6 | 0.2310 | 0.6043 | 0.38 |
| Common Border | 0.3849 | 0.1954 | 1.97 | 4.5179\*\*\* | 0.7454 | 6.06 |
| Constant | -15.0758 | 2.2789 | -6.62 | -81.9454 | 5.1606 | -15.88 |
| Observations | 31157 | | | 31157 | | |
| Log Likelihood | -9709772 | | | -8602.4102 | | |
| Wald chi2 |  | | | 717.91 | | |
| Prob > chi2 |  | | | 0 | | |
| AIC | 1.94E+07 | | | 17246.82 | | |
| BIC | 1.94E+07 | | | 17422.1 | | |

\*\*\*, \*\* *denotes statistically significance at the 1%, and 5% respectively*.

The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) selection criteria were used to select the best gravity model estimated by the maximum likelihood method. The selection criterion is to choose the model with the smallest AIC and BIC. From the results, the Tobit model was found to have the least AIC and BIC parameters, with most of its coefficients having expected signs (unlike the PPML estimator). The interpretations of the gravity model, therefore, is based on the estimates of the Tobit model with censoring at zero as shown in Table 4. COMESA was dropped during the analysis due to high overlap of member countries with other RECs

Table 4. Marginal effects after a Tobit regression

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **dy/dx** | **Standard Error** | **T-Score** |
| Distance | -0.1697\*\*\* | 0.0280 | -6.06 |
| Exporter's GDP | 0.0759\*\*\* | 0.0195 | 3.88 |
| Importer's GDP | 0.1370\*\*\* | 0.0214 | 6.39 |
| Exporters Population | 0.0419\*\* | 0.0151 | 2.78 |
| Importers Population | 0.0290 | 0.0251 | 1.16 |
| Exporter's production | 0.3611\*\*\* | 0.0283 | 12.74 |
| Importer's production | -0.0465\*\* | 0.0158 | -2.94 |
| Exporter's Fish price | -0.0237 | 0.0176 | -1.35 |
| Importer's Fish price | -0.0164 | 0.0200 | -0.82 |
| Real Exchange Rate | -0.0004 | 0.0010 | -0.44 |
| SADC*c* | 0.8015\*\*\* | 0.1096 | 7.32 |
| EAC*c* | 1.1324\*\*\* | 0.3427 | 3.3 |
| ECOWAS*c* | 0.5177\*\*\* | 0.1266 | 4.09 |
| ECCAS*c* | -0.2434 | 0.1407 | -1.73 |
| AMU*c* | 0.9167\*\*\* | 0.3039 | 3.02 |
| Common Colony | 0.0848 | 0.0665 | 1.28 |
| Common Language | 0.0267 | 0.0696 | 0.38 |
| Common Border | 0.6010\*\*\* | 0.1137 | 5.29 |
| Observations | 31157 | | |
| Log Likelihood | -8602.41 | | |
| Wald chi2 | 717.91 | | |
| Prob > chi2 | 0.0000 | | |

\*\*\*, \*\* *denotes statistically significance at the 1%, and 5% respectively*.

The results of the Tobit regression show that distance, Exporters’ and Importers’ GDP, Exporters’ and Importers’ production, common border, the RECs fish trade creating dummies of SADC, EAC, ECOWAS and AMU had the expected signs and are significant factors influencing fish trade flows in Africa. The remaining variables were not significant. The chi-square statistic, which was significant at p<0.01, shows that the data fitted the model well.

*4.2 Discussion*

4.2.1 The Effects of GDP

GDP explains both the supply side and demand side effects on trade flows. As shown in Table 4, if exporters GDP increases by 1 percent, fish trade flows will increase by 7.6 percent. The GDP in this case reflects the production capacity. For the importing country, if GDP increases by 1 percent, trade flows increases by 13.7 percent. The GDP in this scenario indicate the income of the consumers in the importing country. The magnitude of the coefficients of exporters GDP and importers GDP shows the relative importance of the two in fish trade flows. Both coefficients are significant at 1 percent level. Results obtained from both exporters’ GDP and importers’ GDP are in line with theory and results of previous studies. For instance, Eita (Undated) found a positive relationship between Namibia’s exports and its GPD as well as of the importer. Similarly, in Egypt, Hatab (2015) found that an increase in Egypt’s GDP by one percent point increased Egyptians Agricultural Exports by 5.42 percent point increase despite noting an insignificant coefficient of the importers’ GDP. The results suggests that economic development strengthens fish trade through increased production for both countries.

The study finds that the coefficient of importers GDP is very elastic. A one percent increase in importers’ GDP results into 15.8 percent increase in fish exports. This could be due to the importance of fish as major animal protein source in Africa, hence an increase in income entails an increase consumption. Allison (2011) noted that developed economies have a higher per capital fish consumption than developing economies including the SSA. This is reflected in average Africa per capita fish consumption which stands at 8.3 kilogram against the world average of 18.9 kilograms. This means that increase in income is indeed more likely to result into increase in fish consumption since the current consumption is very low. The coefficient of Exporters’ GDP was, however, found to be less than of the importers. This means that fish exports are not much sensitive to increase in GDP. This could be due to the fact that a large proportion of fish exports come from capture fisheries. In recent years, the sector in Africa has been dwindling due to, among others, overfishing and use of destructive fishing gears (AUC-NEPAD, 2014); TIPS and AusAID, undated; Kirema-Mukasa, undated). This means that much as efforts to increase production may be put in place, such efforts are hampered by the low catches. This necessitates the need to invest more in the aquaculture sector. Currently, only Egypt is the leading producer of aquaculture fish in Africa (Mapfumo, 2015).

4.2.2 Fish Production

The exporters’ fish production and the importers fish production have correct signs and are significant at 1 percent and 5 percent, respectively. Exporters’ fish production reflects its ability to supply fish, both to the domestic and international markets. From Table 4, it can be shown that increasing fish production by 1 percent increases fish exports by 36.11 percent. On the other hand, if production rises in the receiving country, imports will reduce as it would mean more fish available locally. A 1 percent increase in fish production in the importing country will result into a 4.7 percent reduction in fish imports. Production capacities of both the importing and exporting countries are usually used for commodity specific gravity models. For instance, studies have been done applying a gravity model on meat (Karemera *et al.*, 2015; Koo *et al.*, 1994), vegetables and fruits (Karemera *et al*., 2009) and seafood (Natalie *et al.*, 2015). In most of these studies, the results were consistent with theoretical foundations. Koo *et al.* (1994) found that the direction of world meat trade flows is influenced largely livestock production.

From the analysis in Table 4, it can be shown that the estimated coefficient of exporters’ fish production is larger, implying that the current levels of fish production do not meet the demand on the market. The estimated coefficient of importers’ fish production is negative implying that fish production in the importing country will help meet the domestic demand without much need to import. However, the small coefficient of importers’ fish production (0.029) shows that much as their own production will help reduce fish imports, the reduction in imports is so small signifying the large demand for fish in the importing country. This just shows that fish demand is high in Africa such that the current levels of production are not enough to meet demand. Fish demand has been increasing on the continent due to increasing population, increasing urbanization and the consumer need for healthy diet from food such as fish.

4.2.3 Population

Population is used to account for the market size in both the exporting country and importing country. The expected sign of population for both the exporting country and the importing country is positive. The study found that an increase in the exporters’ population and importers’ population increased fish trade flows by 4.2 and 2.9 percent respectively. For the exporters’ population, this signifies that the large population may provide enough resources, especially labour, to the domestic country to produce whatever resources to satisfy the domestic market and provide surplus for trade. For the importing country, an increase in population provides the much needed market for fish such that imports of fish increases. Larger countries are better able to absorb imports than smaller countries and are better able to experience economies of scale and thus develop a comparative advantage in their export industries than are smaller countries. The study has, however, found that the increases in fish trade flows due to increase in exporters’ and importers’ population is very small. For the exporting country, this could be due to low investments in other means of fish production such as aquaculture such that even though there is high population in Africa to provide the much needed labour for aquaculture related activities and enhance fish trade through surplus production, such labour has not been put into use due to lack of aquaculture ventures. It is therefore important for African countries to fully develop their aquaculture and make use of the surplus labour on the continent. For the importing country, the results shows that despite the increase in population, fish imports are very low. Again this is a characteristic of the low fish consumption in Africa.

4.2.4 Geographical Distance and Common Border

The estimated coefficient of distance is negative suggesting that if distance increases between trading countries by 1 percent, trade in fish reduces by 16.97 percent (Table 4). This is because more distance means more transportation costs incurred. Similar results were found by Zannou (2010) who found that an increase of 10% in the distance reduced intra-ECOWAS trade from 8 to 13%. Shinyekwa and Othieno (2013) also found similar results. It has been noted that the more the distance the more the geographical factors impeding trade flows as well as cultural dissimilarities that impede trade. The study also found that sharing a Common border increased fish exports by 60 percent. The coefficient of common border is larger than that of distance emphasizing that the closer the countries are the lesser the transportation costs and the more the trade.

4.2.5 The Effects of Africa’s RECs on Fish Trade Flows

The augmented gravity model was also used to assess trade effects of the various RECs on regional fish trade. COMESA was dropped during the analysis due to high overlaps of membership to other RECs from most countries. All the fish trade creating RECs dummies, with the exception of ECCAS, were significant with the correct signs. This means that the formation of SADC, ECOWAS, EAC, and AMU have effectively enhanced fish trade flows hence contributing to gross trade creation for fish. From Table 4.8, it can be shown that the membership to SADC increased fish trade by 80.15 percent, membership to ECOWAS increased trade by 51.77 percent, membership to EAC increased trade by 113.24 percent, and membership to AMU increased trade by 91.67 percent. The increase in trade is much greater for SADC (80.15) followed by AMU (91.67) and ECOWAS (51.77), suggesting that countries in these three blocks have significantly increased trade flows among them.

The results of the trade creation agrees with findings of (Marinov, 2014; Sun and Reed, 2010; Gedaa and Seid, 2015; Meyer *et al.*, 2010) who found that the creation of RECs in SSA such as COMESA, ECOWAS and SADC has significantly increased trade flows among the member countries to varying degrees. However, most of these studies used disaggregated data and have highlighted low intra-regional trade. This study, on the other hand, has found that there is increased intra-regional fish trade. This could be due to the increasing fish trade worldwide, with about 40 percent of fish production being traded internationally. Gordon *et al.* (2013) noted that the existing frameworks for promoting trade among the trade blocks are not specific to fish such that they fail to address industry needs. Furthermore, there is lack of policy harmonization among the different trading blocks.

SADC has been found to create more trade to its members. One reason for this is the presence of SADC protocol on fisheries that is in force. The protocol, among others, stipulates the need to reduce trade barriers to promote trade in the region (SADC, 2001). The creation of the free trade area in SADC could also be a contributing factor to the increased trade flows, although it has been notice that some countries have not fully implemented the FTA agreement. Similarly, the results of the study found that ECOWAS membership has increased intra-regional fish trade by 51.77 percent. This could be due to the fact that some ECOWAS countries are landlocked and depend on inland fisheries whose catches are significantly low. Such countries also have a lower per capita fish consumption which entails more demand for fish and more intra-ECOWAS fish trade (Katikiro *et al.*, 2010). Countries like Senegal and Nigeria are some of the Africans leading producers of marine fish such that these countries supplies fish to other ECOWAS members. Nigeria is also the second leading aquaculture producer in Africa after Egypt (FAO, 2014). The results of the trade diversion of ECOWAS were found to be positive but not significant. The insignificance of the positive coefficient could be due to the fact that most ECOWAS exports are geared towards EU countries and other world markets other than in Africa. Nearly one third of the ECOWAS exports go to the EU (Marinov, 2009).

**5. Conclusion and Policy Implications**

The main objective of this study was to assess the determinants of fish trade flows in Africa by applying a generalized gravity model. The results of the study indicate that the supply of fish on the continent is not meeting the demand on the market. It has been noted that increase in GDP of the importing country is associated with increase in fish imports. Furthermore, an increase in fish production of an importing country is associated with a very small reduction in fish imports. It has also been noted that more fish production entails more fish exports. The study has also found that distance is one of the main barriers to intra-regional fish trade flows through its associated costs and poor infrastructures such as roads, railways, port infrastructure and handling equipment. The study has also revealed that the formation of SADC, ECOWAS, EAC and AMU have effectively enhanced fish trade flows hence contributing to gross trade creation for fish which supports the theory of welfare economics.

To further increase fish trade levels and subsequently spur economic growth, it is important that the regional trade blocs go beyond trade creation to implement policies aimed at increasing productivity within the region. The study has found that fish trade flows are less sensitive to increase in GDP, and that the current demand for fish on the continent is very high such that current production is unable to meet the consumption needs. This calls for consolidated effort in the investment and development of the aquaculture sector to as an alternative to the dwindling fish supplies from the wild environment. It has been noted that distance hinders fish trade flows as there is high transportation costs among others due to poor infrastructure development such as roads, railways, port infrastructure and handling equipment which are essential for both domestic and international transportation. It is therefore important for the regional blocs to improve the transport networks on the continent by, among others, adopting a regional cooperation strategy centered on infrastructure development.

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