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Multilateral Trade Resistance, International Competitiveness and African International Exports: A Network Perspective

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Abstract

Understanding and interpreting trade flows between trading partners/countries requires knowing whether countries are hubs or peripherals in the global trade network. These network statistics have been included in the gravity model in recent empirical works in international trade, to capture the notion of multilateral trade resistance While the network statistics logically captures the third-country effect, the literature, especially in Africa, has mainly focused on bilateral effects between trading partners, neglecting the multilateral nature of trade. Employing an Augmented gravity model, we estimated the effect of multilateral trade resistance/competition effect (Captured by the Clustering coefficient) and international competitiveness (captured by out-degree centrality) and importer openness (captured by in-degree centrality) on African international trade and found that these network statistics have robust and significant, but contrasting effects on African international trade flows. While an increase in degree variables increases African international trade flows on average, a higher clustering coefficient is found to have a negative impact on African export- which is consistent with the theory and our expectation. It is therefore advisable that the attention of African country exporters and policymakers should be geared towards encouraging the degree centrality and discouraging strong connection of African exporters within themselves to boost African international exports.

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1. Introduction

Contemporary empirical research in international trade tries to emphasize the potential importance of trade barriers other than observable and traditional trade costs. While some empirical trade studies focus on geography (Redding & Venables, 2003), others on infrastructure, and still others (e.g., Groot et al., 2004) on institutional quality independently. Even studies that combined the aforementioned determinants tended to focus on bilateral effects between trading partners, ignoring the multilateral aspect of trade. Nonetheless, bilateral trade is not only influenced by bilateral factors but also by multilateral elements. This concept of the third-country effect was introduced by Anderson & Wincoop(2003). This model however is challenging as the multilateral trade resistance is not observable. Besides the model considers only the intensive margin of trade. Helpman et. al,(2008) on the other hand extended the model by considering the extensive margin of trade. Recent empirical studies in international economics are focussing on the convenient way of capturing the third-country effect from the perspective of trade networks. In this regard, recent empirical works such as Bruyne et al., (2013); Bernard & Moxnes (2018) argue that trade is a logically networked activity in which the vast majority of trade transactions involve at least one large firm with a large number of trading partners. While the AVW focuses on the third-country effect on bilateral trade, the HMR model focuses on international competitiveness. Network analysis allows us to combine and naturally incorporate the above two lines of studies into the bilateral models (Bruyne et.al., 2013).

In this regard, recent works in international trade research such as (Fagiolo, Reyes, & Schiavo, (2010), Benedictis & Tajoli, (2011), Chaney, 2014) used network indicators to explain trade flows. In empirical studies of international trade, network analysis has recently been used as an alternative to capture multilateral trade resistance. Nonetheless, the literature is limited, and it is absent from African studies of international trade. In terms of Africa, the literature on the determinants of African trade flows has made significant progress in recent years, and various empirical works have produced different explanations for Africa's marginal contribution to global trade. Empirical studies in the field. However, empirical studies in international trade focus on geography and infrastructure as major determinants of trade flows, ignoring the third-country effect on trade. Using an augmented gravity equation, this study employs a network perspective to estimate the impact of multilateral trade resistance on African export flows. This paper adds to the existing empirical gravity literature by including, and emphasizing, the impact of networks to capture the third country effect or multilateral trade resistance and firm heterogeneity on African countries' international exports. As a result, we employ the rapidly expanding literature on networks to examine how bilateral trade between any African country and its trading partner is influenced by both trading

The remainder of the sections proceeds in the order listed below: Section two examines existing empirical work on the determinants of international trade in general, as well as the gravity model's consideration of multilateral trade resistance. Section three is about data and data analysis methods. The fourth section goes over the regression results for a simple and extended gravity model with various specifications. The last section deals with the conclusion.

2. Review literature and Hypothesis

The traditional gravity model considers the income of trading countries and vectors of distance variables to be the most important factors in explaining bilateral trade flows. While some empirical works, such as Anderson & Wincoop,(2004), contend that trade expenses incurred as a result of physical distance and formal trade barriers are important roadblocks to global trade, others, such as Deardorff (2004), argue trade costs can’t be entirely explained by perceived trade costs as trade costs include the unobserved costs as well. The conventional models of trade focused on geographic distances such as physical remoteness ((Redding & Venables, 2004)), lack of common borders (Rose & Spiegel, 2002). Not a few empirical studies have included economic distance measures such as the difference in income, differences in costs and qualities of natural resources, infrastructure, financial, human, information, or knowledge. Aside from that, the vast majority of empirical studies have included administrative distance measures such as a lack of colonial ties, a lack of shared monetary or political associations, and institutional weakness(Araujo, Mion, & Ornelar, 2016; Álvarez et al., 2018). Recent empirical research, on the other hand, has added cultural distance metrics such as Common language (Melitz J., 2008; Melitz & Toubal, 2014; Egger & Lassmann, 2015), common religion (Lee, 2013; Lewer & Berg, 2007;), ethnicity (Rauch, 2012; Rauch & Trindade, 2002; Felbermayr, Jung, & Toubal, 2010). It is, however, standard practice in the present version of the empirical gravity model, it's important to incorporate not only bilateral trade obstacles, but also multifaceted trade blockades, or multilateral trade resistance, as Anderson and Wincoop (2003) term it. According to Baier and Bergstrand (2009), the traditional gravity model has been questioned in part because it fails to consider the fact that costs of trade between trading countries should be influenced by trade costs between trading countries compared to the rest of the globe. When we fail to account for multilateral resistance, we tend to exaggerate the impact of changes in trade barriers on bilateral trade flows (Behar & Nelson, 2014).

Since the multilateral trad resistance proposed by AvW (2003 is not directly observable when estimating the gravity model, several proxying methods are employed. For instance, Baier & Bergstrand, (2009) have used a "remoteness" variable as a proxy for Multilateral trade resistance. Other lines of studies such as Feenstra (2004) and Redding and Venables (2004), Baldwin & Taglioni (2006), Melitz(2007), and others have used destination and origin fixed effects. Time-varying bilateral fixed effects were also employed by Baier and Bergstrand (2007) and Baier et al (2008Fally (2015) argues that PPML can be employed as a simple tool to capture the index. Poissonnier (2018), on the other hand, demonstrates that Multilateral Trade Resistance is unique and can be computed iteratively. The incorporation of the concept of Multilateral trade resistance into the gravity model captures the third-country effect on trade very well. However, studies focusing on this multilateral trade resistance have ignored the implications of firm heterogeneity (Behar & Nelson, 2014). On the other hand, a large body of research following the prominent work of Helpman, Melitz, & Rubinstein (2008) argue for the inclusion of firm heterogeneity into the traditional gravity model. In their phenomenal empirical work where the intensive and extensive margins of trade are explained with fixed export costs and heterogeneous firms in a gravity setting, the study contends that firms should cover their fixed cost to make exporting their products to a specific destination country profitable. Trade flows among developing countries like African are characterized by a significant number of zero trade flows mainly arising from the absence of trade flows and/or missing data. HMR argues that failure to account for firm heterogeneity causes standard gravity estimation to bias the impact of trade costs on both margins. However, as a trade-off, the HMR model does not consider third-country dependence (Bruyne, et.al, 2013). The small but growing literature on bilateral trade flows has attempted to incorporate the two most recent waves of the MTR (AvW) and firm heterogeneity (HMR) into gravity model theory. Behar and Nelson (2014), for example, presented a gravity model for which they computed comparative statics that accounts for the effects of firm heterogeneity as well as multilateral resistance. Recent empirical publications, such as (Gervais, 2017), have merged and extended the work of (Redding & Venables, 2004)and (Helpman, Melitz, & Rubinstein, 2008) to establish an approach that takes multilateral resistance, firm heterogeneity, and country selection into consideration in trade. Ever since the concept of multilateral trade resistance was introduced by AvW(2003) Empirical studies in trade have treated the issue in different alternatives. Recent yet limited empirical study approach to multilateral trade resistance based on network theory concepts.

Recent theories in international trade (example, Fagiolo et al., 2009; De Benedictis and Tajoli, 2011; De Benedictis et al., 2014) are shedding light on the role of the network in international trade. Chaney (2014) contends that firms can only sell in locations where they have contact, emphasizing the importance of networks in international trade. The function of the network in international trade is being shown by recent theories in international trade. According to Chaney (2014), businesses can only sell in places where they have contacts- emphasizing the role of the trade network in trade. For him, firms look for trading partners on their own, but they can also leverage their existing network of contacts to look for new ones remotely. In the trade literature, empirical network studies range from un weighted (Garlaschelli and Loffredo (2004))versions of the World Trade Network to weighted (Serrano and Boguñá,2003 and Reyes, Garcia, and Lattimore,2007 Fagiolo, Reyes, & Schiavo,(2010)versions of the world trade Network have employed network indicators in the study of international trade. The weighted versions of the indicators take into consideration trade (import plus export) values between nations, whereas the former look at whether trade relations exist or not at the country level. De Benedictis and Tajoli (2011) used the un weighted degree of trade network as regressors in a gravity model. Benedictis et al., (2014) use the 1995–2010 BACI-CEPII dataset, which is a 178-country variant of Comtrade that uses a reconciliation methodology to reduce the number of missing values and show that t the WTN is characterized by its increasing density and strong heterogeneity. Some others have used network statistics to measure the degree of regional trade integration. A recent study by Beato, et.al.(2017)) applies a network analysis framework to analyze the regional and global integration of Latin American and Caribbean countries. Closest to our work is that of Bruyne et. al. (2013) who have proposed an alternative empirical approach to capturing Multilateral trade resistance, namely using network indicators(both weighted degrees and clustering) reflecting the effect of international competitiveness and third countries on bilateral trade linking them to the models of AvW and HMR . In terms of Africa, the literature on trade costs has advanced significantly in recent years, and several empirical studies have produced various explanations for Africa's negligible contribution to global trade. However, empirical studies in the field of international trade focus on geography and infrastructure as primary determinants of trade flows, ignoring the impact of third-country on international trade. These days, as an alternative to capturing multilateral trade resistance, network analysis has been used in the study of global trade. Nevertheless, the literature is not that abundant and it is missing in African studies of international trade. Within an augmented gravity equation, this study uses a network technique to assess the influence of multilateral trade resistance on bilateral trade flows. From the preceding discussion, it is clear that higher exporter out-degrees and higher importer in-degrees measure an exporting country's international competitiveness and an importing country's import openness, respectively.

As a result, the following hypotheses are made based on the economic intuitions of the network measures:
H$_1$: Given other factors, the greater the degree centrality of the country, the greater will be the bilateral trade flows between African countries and the trading partners. The other network indicator used here is the clustering coefficient. Importer, exporter, and importer-exporter characteristics, as well as third-party characteristics, are likely to influence the likelihood of a country initiating trade with a new partner/country.

Accordingly, we forward the following hypothesis:

H2: The higher the clustering coefficient, the less bilateral trade there will be between these trading countries and the initial country, ceteris paribus.

3. Data and Methodology of Data Analysis

3.1. Data

Our empirical approach necessitates the collection of data on African countries' exports as well as various gravity variables. The first set of estimates are based on data from the UN database COMTRADE, which includes exports from 41 African countries to 168 trading partners from the rest of the world. The data was gathered for the period 2000 through 2018. While data on geographic distance and other indicators used in the gravity model are collected from the BACI dataset from CEPII, the network indicators are computed with the open-source network analysis program Gephi (9.2).

3.2. Empirical Model: The Augmented Gravity Model

According to Silva and Tenreyro (2006), the parameters of log linearized models estimated using OLS lead to deceptive estimations of the true elasticity. In the circumstance with heteroscedasticity problems with considerable null trade flows, the study proposes PPML, which it claims is a more resilient method for estimating the gravity equation. As a result, the Poison family regression is utilized to estimate the exponential gravity equation. The Poisson model is given by Burger et.al.(2009) as follows:

$$\Pr(X_{ijt}) = \frac{\exp(-\mu_{ijt})\mu_{ijt}^{X_{ijt}}}{X_{ijt}!} \quad \text{.............1}$$

Where

X_{ijt} denotes the average exports from African countries(i) to importing partners (j) at time t

T_{ij}, an exponential function of regressor variables, is connected to the conditional mean, μ_{ij}

$$\mu_{ijt} = \exp(\beta_0 + \beta' T_{ijt} + \eta_i + \eta_j + \gamma_t) \quad \text{.............2}$$

Even though the PPML model deals with zero trade flows which are an apparent problem in developing countries' trade data, Its basic premise is that it presupposes equidispersion. While overdesperation of the dependent variable is a regular occurrence in the existence of unobserved heterogeneity (Green 1994; Burger 2009), failure to account for this problem results in a consistent, yet inefficient estimation of the dependent variable (Cameron & Trivedi, 1986).

To correct for the overdispersion, a family of poison models known as the Negative binomial model, which is regarded as a modification of the poison regression model (Greene, 1994) is mostly employed. While the expected value of the trade flow is in both the poison model and the negative binomial model are the same (Burger, van Oort, & Linders , 2009), but the variance in the negative binomial model is specified as a function of a conditional mean (μ) and the dispersion parameter(α), hence integrating unobserved heterogeneity into the conditional mean.

The NB model is, thus more formally expressed as:

$$pr(x_{ij,t}) = \frac{\Gamma(x_{ij,t} + \alpha^{-1})}{x_{ij,t}!\Gamma(\alpha^{-1})} \left(\frac{\alpha^{-1}}{\alpha^{-1} + \mu_{ij,t}}\right)^{-\alpha} \left(\frac{\mu_{ij,t}}{\alpha^{-1} + \mu_{ij,t}}\right)^{x_{ij,t}} \quad \text{.............3}$$

The parameter, α is a parameter that defines the extent of dispersion in prediction. The larger the value of α, the larger will be the degree of dispersion in the data which signals the use of NBML over the PPML model. More formally a likelihood ratio test is employed to test whether the NB model is preferred over the PPML model. The likelihood ratio test states that if α is considerably different from 0, the NBML model is preferred over the PPML model; or else, the NB model simplifies to the PPML model.

The vector of independent variables(T_{ijt}) in equation (3.8) above is defined as:

$$T_{ijt} = CV_{ijt} + NW_{ijt} \qquad \text{.....4}$$

Substituting (4) into (3) and including the expected explanatory variables, the model to be estimated is defined as:

$$X_{ijt} = \exp(\beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{jt} + \beta_3 t_{ijt} + \beta_4 k_{it}^{out} + \beta_5 k_{jt}^{in} + \beta_6 C_{it} + \beta_7 C_{jt} + \eta_i + \eta_j + \gamma_t)\varepsilon_{ijt} \qquad \text{.....5}$$

With the bilateral trade cost function, t_{ij} is defined as follows:

$$t_{ij} = \delta_1 Dis_{ij} + \delta_2 Cont_{ij} + \delta_3 lang_{ij} + \delta_4 CC_{ij} + \delta_5 CT_{ij} + \delta_6 WTO_{ijt} + \delta_8 RTA_{ijt}) \qquad \text{.....6}$$

Some of the basic gravity variables included in the model as control variables include income of trading countries measured in USD, the distance between the capitals cities of the trading countries measured in km. Contiguity is included to analyze the effect of the common border and it takes a value of 1 if both countries share a common border and 0 otherwise, common language takes a value of 1 if the trading partners use the same official language and 0 otherwise and the remaining dummy variables such as membership to world trade organizations and regional trade agreements are defined in the same way. On the other hand, the Network indicators (NW_{ijt}), which capture the various aspects of multilateral trade resistance, are the variables of interest in this model. More specifically, the Network indicator includes degree statistics and Clustering coefficients. Besides, origin, destination, and year-fixed effects are included to control for unobserved heterogeneity.

4. Results and Discussions

4.1. Basic results and Model Selection

Before delving into the effects of trade networks, we will first go over a set of gravity equation specifications that considers basic variables commonly used. The results are depicted in table 4.1. Regarding the interpretation of the regression results, while the dependent variable in Poisson family regression is not logged, which is the main advantage of this method, the coefficients are interpreted just the identical as in OLS because Poisson family regression estimates the exponential model, whereas the OLS model estimates the linearized version of the same model. That is the coefficients on logged regressors are elasticities. On the other hand, the percentage trade impact of non-logged explanatory variables in the gravity equation are calculated as follows: $(e_k^{\beta}-1)*100$.

Specifications 1through 3 in table 1 estimated the gravity model of African exports using the PPML model while the fourth column shows the result of the Negative Binomial model. In the first specification, we regress African exports on the natural log of GDP of both exporting and importing countries as well as their geographic distance. This is based on trade theory models that state that whereas trade is positively affected by the GDP of the trading countries, it is inversely related to the bilateral distance between them. The intuition behind this argument is based on the fact that GDP is a measure of market size while bilateral distance is a proxy for the size of transportation costs.

We find that GDP has a positive and significant effect on African foreign exports, which is consistent with the gravity model literature on bilateral trade. The gravity model includes the GDP of both the origin and destination nations individually to see if the influence of income on export differs across exporters and importers. This rationale is based on the fact that we are concentrating on exports rather than total trade. The findings suggest that export flows is income inelastic: a 1% rise in income of the exporter increases African export on average by about 0.842%, whereas a unit increase in importer income increases African international exports by 0.802% and the results are statistically significant at 1% level of significance. When it comes to the coefficient of distance, the results show that the volume of African international exports is negatively affected by the bilateral distance. The estimated result shows, a 1%

increase in the bilateral distance reduces African international exports by about 1.241 percent, and the coefficient is statistically significant as well. The findings are in line with the notion that trade barriers are important in explaining trade patterns. Column (2) in table 1 allows for the effect of the level of per capita income difference between the exporter and importing partners, expressed in absolute terms, to test for the Linder hypothesis, which argues that the less the income difference between the trading countries, the higher will be their product preferences which lead to the production of identical but differentiated products. These similar tests and production are believed to boost trade among them. Consequently, the higher the value (in absolute terms) of the index indicates the existence of higher-income disparity between the trading partners which is expected to reduce bilateral trade. In column (2), a variable for the Linder index is included besides the basic gravity variables in column (1) in the PPML model. The Linder hypothesis has attracted the interest of academics for decades due to its sharp contrast with the predictions of the Heckscher-Ohlin theory which suggests that the absolute difference would be positive, but the empirical evidence has been mixed (Hallak, 2006) . The prediction of the Heckscher-Ohlin theory based on the model of comparative advantage capital intensive, high-income countries would trade comparatively more with labor-intensive, low-income countries. The Linder hypothesis, on the other hand, argued that the Heckscher-Ohlin theory ignored demand-related factors, which are critical in explaining patterns of international trade. He argues that the majority of trade should take place between countries with similar demand structures and income levels. As a measure of income dissimilarity measured by the absolute difference in the income per capita between the trading countries, the Linder term is expected to have a negative effect on international trade. The result indicates that the inclusion of this variable has not affected the sign and significance of the basic gravity variables and while the negative coefficient of the variable is consistent with the theoretical expectation, yet the effect is statistically insignificant indicating that there is no clear support of the Linder in African international trade using the PPML. But column (4) estimates the model using the NB model in which the Linder hypothesis applies in African international export. Variables that are expected to control for shared historical, economic, and cultural backgrounds are estimated and the results are shown in column (3). Following the inclusion of these variables, the basic gravity model variables remain unchanged, with the effect of bilateral distance reduced to about 0.9 percent. Despite the numerical changes in the estimates, the effect does not differ significantly from the traditional gravity equation presented in specifications 2 and 3. These variables could be used as trade-facilitating variables, causing the size of the bilateral distance decay to decrease. Thus, including these variables reduces the estimated impact of distance on African exports. More specifically, when it comes to the newly included variables, the results indicate that most of the variables included capturing the effect of historical and cultural ties between trading partners have the expected sign, as is frequently reported in the literature, and are statistically significant. Besides, sharing a shared border and official language between exporters and importers has also been demonstrated to have a favorable and significant impact on African International exports, which supports our hypothesis. As far as the policy variables are concerned, common membership in regional trading blocs is positive as expected and significant.

The standard Poisson estimator (PPML) suggested by Santos Silva and Tenreyro (2006) addressed the unobserved heteroskedasticity, however, the PPML model might bias the parameter estimates in the presence of excess zero values and overdispersion problem. The Poisson distribution's assumption of equal mean and variance is one of its drawbacks. There are cases in which the conditional variance exceeds the conditional mean that causes overdispersion. According to Richard Williams (2021), if there is overdispersion, ordinary

Poisson models do not produce efficient estimates since standard errors are biased downward, resulting in erroneously big z-values.

Table 1: Basic Results

VARIABLES	(1) PPML	(2) PPML	(3) PPML	(4) NB
lngdp_o	0.842***	0.814***	0.815***	0.987***
	(0.210)	(0.219)	(0.214)	(0.0497)
lngdp_d	0.802***	0.837***	0.848***	0.523***
	(0.137)	(0.142)	(0.140)	(0.0474)
lndist	-1.241***	-1.233***	-0.901***	-1.718***
	(0.102)	(0.101)	(0.121)	(0.0301)
linder		-0.00601	-0.00394	-0.00517***
		(0.00643)	(0.00646)	(0.00156)
contig			1.006***	1.392***
			(0.222)	(0.0776)
comlang_off			0.379*	0.351***
			(0.200)	(0.0378)
comcol			0.130	0.236***
			(0.214)	(0.0416)
col45			0.531*	1.567***
			(0.312)	(0.144)
WTO			-0.309	0.306***
			(0.238)	(0.0676)
rta			0.266*	0.640***
			(0.161)	(0.0422)
Constant	-10.68***	-10.65**	-13.66***	-7.236***
	(4.130)	(4.142)	(4.034)	(1.171)
Observations	114,436	114,436	113,812	113,812
R-squared	0.494	0.492	0.503	
Exporter FE	YES	YES	YES	YES
Importer FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
AIC	8.15e+09	8.14e+09	7.76e+09	1250959
BIC	8.15e+09	8.14e+09	7.76e+09	1253273
overdespersion				9.879265***

Robust standard errors are shown in parenthesis. All models include dummies for importer, exporter, and year. The panel spans the years 2000 through 2018. Significance is as follows: *** p<0.01, ** p<0.05, * p<0.1

The choice between PPML and NB, on the other hand, is based on the overdispersion test. The NB model is used to re-estimate the model, and the results are displayed in column (4). As demonstrated in the result, the likelihood ratio test of $\alpha = 0$ strongly rejects the null hypothesis that the errors do not display overdispersion As a result, the Poisson regression (PPML) model is rejected in favor of its generalized counterpart, the NB regression model. The coefficients in the two models are similar, and the NB estimates are comparable to those from Poisson with robust standard errors.

4.2. The effect of the African Trade Network on the flow of African International Exports

In this section, we continue with the preceding section's analysis by focusing on the explanatory role of trade networks in capturing multilateral trade resistance and firm heterogeneity and their impact on African international export. We can see from the preceding discussion that the PPML model is rejected in favor of the NB model; so, the next discussion is based on the outcomes of the NB model (Table 2). Table 2 shows the estimated panel data findings utilizing the NB estimation technique. The fixed effect for the year and country are also included. Column (1) displays the estimated standard gravity model results without network measures, allowing us to assess the model's stability when network statistics are incorporated. Besides, standard gravity variables that have been demonstrated to be essential in the literature of the gravity equation are included as control variables in each model.

The estimated parameters are as expected and consistent with gravity literature. Following HMR specification, country and year fixed effects are included to capture unobserved heterogeneity and in line with Bruyne et.al, (2013) multilateral trade resistance is included in this study only to the extent these fixed effects capture the unobserved third country dependence. To capture different aspects of multilateral trade barriers, the network indicators are added both separately and jointly to the regression model to analyze the influence of each indicator on African exports. Second, we investigate whether and how these factors reinforce or cancel each other out. Column (2) contains the degree centrality measures represented by the exporters' weighted out-degrees and importers' weighted in-degrees. The third column, likewise, provides clustering coefficients for both importers and exporters. Finally, both network statistics are presented in column (4). The estimated result indicates that following the inclusion of the degree centrality indices, we see that the control variables remain stable; as expected, the weighted degrees of exporters and importers have a positive and highly significant impact on African international trade. An increase of 1% in an exporter's weighted-out degree increases bilateral trade by 1.34 percent per partner on average. This appears to be a significant increase: if total African exports to all importer countries increase by 10%, each existing export destination will induce 13.4% extra African international exports. A similar logic applies to the import partner's weighted in-degree: a 1% increase in weighted in-degree increases African export by 0.609 percent per partner on average. As can be seen, the network effect is found to high for exporters than for importers. The concept of the network effect in international trade is that having additional trading partners, in general, will improve trade in a specific destination. This could be a reflection of their export experience, as they learn from overcoming trade barriers, including all costs associated with exporting. The positive and significant coefficient of weighted out-degree of the exporter shows exporters with high out-degree centrality are more competitive in the international market while the positive and significant in-degree of the importers reveals importers with high value of in-degree are more open to import. In this regard, Bruyne et.al, (2013) argue that exporter out-degrees signal a noble global name as it could signal the exported items are of high quality and or the exporter can be competitive cost-wise, whereas importer-in degree signals the importers are an attractive destination for suppliers. The origin and destination clustering coefficients were then added to the model in column (3). In our study, the clustering coefficient is used to directly capture third-country dependence or multilateral trade barriers. The logic behind including the clustering coefficient as a determinant of African international exports is obvious: intensely connected trading partners trade more among themselves than trading with their initial trading partners.

Table 2: NB and PPML gravity panel estimation of Network Indicators on African Export

VARIABLES	(Basic) NB	(Degree Centrality) NB	(Clustering coefficients) NB	(All) NB	(All) PPML
lngdp_o	0.987***	-0.256***	0.851***	-0.281***	-0.0137
	(0.0497)	(0.0477)	(0.0502)	(0.0478)	(0.192)
lngdp_d	0.523***	0.0577	0.534***	0.0537	-0.00279
	(0.0474)	(0.0499)	(0.0474)	(0.0500)	(0.159)
lndist	-1.718***	-1.661***	-1.794***	-1.672***	-0.888***
	(0.0301)	(0.0274)	(0.0300)	(0.0274)	(0.121)
linder	-0.00517***	-0.00258*	-0.00240	-0.00240*	-0.00283
	(0.00156)	(0.00142)	(0.00156)	(0.00142)	(0.00668)
contig	1.392***	1.638***	1.452***	1.649***	1.039***
	(0.0776)	(0.0710)	(0.0771)	(0.0711)	(0.234)
comlang_off	0.351***	0.439***	0.326***	0.446***	0.379*
	(0.0378)	(0.0343)	(0.0375)	(0.0342)	(0.199)
comcol	0.236***	0.254***	0.212***	0.249***	0.151
	(0.0416)	(0.0381)	(0.0411)	(0.0381)	(0.216)
col45	1.567***	1.611***	1.682***	1.613***	0.529*
	(0.144)	(0.132)	(0.144)	(0.132)	(0.311)
rta	0.640***	0.629***	0.634***	0.632***	0.264*
	(0.0422)	(0.0385)	(0.0419)	(0.0385)	(0.159)
WTO	0.306***	0.347***	0.188***	0.322***	-0.401
	(0.0676)	(0.0608)	(0.0697)	(0.0615)	(0.277)
lnwod_o		1.342***		1.340***	0.932***
		(0.0173)		(0.0171)	(0.0949)
lnwid_d		0.609***		0.596***	1.126***
		(0.0399)		(0.0401)	(0.136)
cluster_o			-18.71***	-5.021***	-0.411
			(0.412)	(0.380)	(0.489)
cluster_d			-1.815***	-1.108***	-0.178
			(0.307)	(0.291)	(0.552)
Constant	-7.236***	-9.321***	12.35***	-3.620***	-17.71***
	(1.171)	(1.086)	(1.288)	(1.193)	(3.275)
Observations	113,812	99,970	111,831	99,970	99,970
R-squared					0.587
Exporter FE	YES	YES	YES	YES	YES
Importer FE	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
AIC	1250959	1207979	1239716	1207800	6.19e+09
BIC	1253273	1210224	1241997	1210064	6.19e+09
Overdespersion	9.879***	7.23***	9.52***	7.22***	

Robust standard errors are shown in parenthesis. All models include dummies for importer, exporter, and year. The panel spans the years 2000 through 2018. Significance is as follows: *** p<0.01, ** p<0.05, * p<0.1

To put it another way, countries having higher clustering coefficients are expected to have fewer export flows. Looking at the results in the third column, the clustering coefficients are found to be negative as expected, and both destination and origin countries' coefficients are statistically significant.

Because the clustering coefficient is a measure ranging from 0 (zero concentration) to 1 (full concentration) and the variable is not in log form, the most simple approach to interpret it

requires an exponential transformation and rescaling the coefficient on a scale ranging from 0 to 100. Accordingly, the result indicates that the coefficients of the clustering coefficients are found to adversely affect African international trade flows. More specifically, while a unit percentage increase in the clustering coefficients of the origin countries decreases African international export by about 21%, the African international export decreases by 1.8% for a unit increase in clustering coefficients of the destination countries. The intuition is that if the destination countries trade more among themselves, the demand for imports decreases. Similarly, if African countries are highly clustered, they trade more among each other instead of exporting. This clearly shows how bilateral trade is affected by multilateral trade barriers.
Lastly, in column (4), all the network indicators are incorporated. The signs and significance of the degree centrality and the control variables, as well as the control variables, remain stable. Taking the degree centrality and the clustering coefficient into account, the result shows that while densely clustered countries confront intense competition inside their trade network, hammering trade with the original trading allies, the positive result of the degree centrality shows that countries benefit from exporting to and importing from other countries. Columns (5) present the estimation results using the PPML model as sensitivity analysis. When the sign and significance of network statistics are compared, the sign remains unchanged while the clustering coefficients become insignificant.

4.3. Robustness checks

We re-estimated the gravity model with the Heckman selection model with fixed effects to test the robustness of our results. We control for entrance cost index (cdb) estimated from Principal Component Analysis using three (costs and time to start business, procedures) ease of doing business factors in exporter countries. Business entry is utilized as an exclusion criterion. According to Helpman et.al, (2008), the exclusion variable is included in the selection equation but excluded from the outcome equation since the variable affects the likelihood of trade between the trading countries. We employ clustering with robust standard errors to compensate for probable heteroscedasticity and correlation of the same country pair across years. The regression results are shown in Table 3. The first column shows the estimation results from the fixed effect NB model whereas the second and the third are results from the fixed effect Heckman selection model. The second column shows the second stage estimation of the African international export flows whereas the third column reports the first stage probit estimation equation.

The results clearly show that the likelihood of countries to participate in trade is found to be negatively affected by the exclusion restriction variable (cdb). The inclusion of this variable is based on the assumption that countries having huge entrance costs to the market are less likely to trade. As expected, the estimated coefficient of this variable is negative and statistically significant at a 1% level of significance. The estimated coefficient is convincing since to get stable results the exclusion restriction factor should have the expected and significant result. When the findings of the Heckman and NB models are compared (as shown in appendix 1), the signs and significances of virtually all variables, including the basic gravity variables and Network indicators, remain sound. More importantly, all network results are consistent: the effect of weighted degrees on African international export is statistically significant and positive, and the influence of clustering is significant and negative in the Hekman selection model as well, implying the results' robustness.

5. Conclusions and policy implications

The conventional gravity literature extensively documents the influence of bilateral trade costs on bilateral trade flows. However, it has lately been clear that the driver of bilateral trade goes beyond the simple decision of the bilateral trading countries, and that the interaction with third countries is also an important predictor of these bilateral trade flows. since the AVW model introduced the effect of other countries other than the trading countries on bilateral trade as multilateral trade resistance, recent empirical works have focused that the multilateral trade barriers can be captured using the network indicators since the positions of countries in the world trade network highly determines the trade flows. Nevertheless capturing third-country effects from the perspective of the network is not that much abundant in general and lacking in African studies in particular. The current study estimates an augmented gravity equation to explain African international exports using traditional gravity variables as well as network indicators using data collected from different sources between 2000 and 2018. The clustering coefficient is utilized to capture the third-country effect, while the degree centrality (weighted out-degree and weighted in-degree centrality respectively) captures the international competitiveness of African exporters and import openness of destination countries. The regression results from varying specifications show that while an increase in degree variables increases African international trade flows on average, a higher clustering coefficient is found to have a negative and significant impact on African export- which is consistent with the theory and our expectation. It is therefore advisable that the attention of African country exporters and policymakers should be geared towards encouraging the degree centrality and plummeting clustering of African exporters within themselves to boost African international exports.

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Appendix 1: **Robustness checks**

Fixed Effects Estimation of Heckman and NB gravity Models

VARIABLES	(1) NB	(outcome) Heckman	(Selection) Heckman
lngdp_o	-0.281***	-0.329***	-0.119***
	(0.0478)	(0.0780)	(0.0116)
lngdp_d	0.0537	0.387***	0.177***
	(0.0500)	(0.0801)	(0.0174)
lndist	-1.672***	-1.537***	-0.685***
	(0.0274)	(0.0769)	(0.0250)
linder	-0.00240*	-0.0282***	0.00769***
	(0.00142)	(0.00404)	(0.00119)
contig	1.649***	2.092***	-0.0172
	(0.0711)	(0.215)	(0.184)
comlang_off	0.446***	0.707***	0.595***
	(0.0342)	(0.0926)	(0.0382)
comcol	0.249***	0.247**	0.186***
	(0.0381)	(0.101)	(0.0424)
col45	1.613***	1.465***	0.163
	(0.132)	(0.302)	(0.394)
WTO	0.322***	0.116	0.167***
	(0.0615)	(0.131)	(0.0313)
rta	0.632***	0.673***	0.392***
	(0.0385)	(0.0882)	(0.0498)
lnwod_o	1.340***	0.723***	0.194***
	(0.0171)	(0.0420)	(0.00572)
lnwid_d	0.596***	0.472***	0.168***
	(0.0401)	(0.0677)	(0.0182)
cc_o	-5.021***	-2.857***	-8.983***
	(0.380)	(0.656)	(0.212)
cc_d	-1.108***	0.0416	-0.338**
	(0.291)	(0.385)	(0.158)
cdb			-0.0695***
			(0.00913)
Constant	-3.620***	-0.393	6.702***
	(1.193)	(2.194)	(0.334)
Observations	99,970	81,983	81,983
Exporter FE	YES	YES	YES
Importer FE	YES	YES	YES
Time FE	YES	YES	YES
Mills		.1079521***	

Robust standard errors are shown in parenthesis. All models include dummies for importer, exporter, and year. The panel spans the years 2000 through 2018. Significance is as follows: *** p<0.01, ** p<0.05, * p<0.1

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