



# Macroeconomic Determinants of Forest Trade between China and ECOWAS Member States: Income Disparity Approach

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## Abstract

China's relationship with Africa has grown at a breakneck pace following the 1978's economic reform. This paper focuses on analyzing the macroeconomic determinants of forest product trade between China and ECOWAS member states based on the panel data from 2000-2019. Specifically, the study employs a panel-gravity model by sub-grouping the ECOWAS member states into different income groups per the World Bank classification. Whilst other forest trade studies deal with the controversies surrounding ECOWAS-China resource trade, this study emphasizes the volume of forest trade. This provides fresh insight into the ongoing discussions and existing misconstrued literature on this trade agreement. Per the FMOLS estimation of the panel-gravity model, the study establishes that, apart from GDP and Population which enhances both low income and low middle-income states (ECOWAS), institutional quality plays a vital role in shaping forest trade flows from Middle-income countries. Nevertheless, China's rapid Economic growth (GDP) and the rising population remain core with regard to exports of forest products. As a result, strengthening and sustaining win-win forest trade deals should be emphasized by both parties since the determinants uncovered in this study may foster continuity for a long time.

## Subject Areas

Forest Resource Economics, International Trade

## Keywords

China, ECOWAS Member States, Forest Trade, Gravity Model, Exports

## 1. Introduction

The purpose of this study is to evaluate the drivers of forest products trade engagements between the Economic Community of West African States (ECOWAS) and China. Since 1978, when China began its forest sector reforms by halting major logging activities, the country has increased its volume of forest product imports from both existing and emerging trade partners across the globe becoming the highest importer and user of wood products [1] [2]. Apart from Oceania, the US, Canada, and Russia which have dominated china's wood imports, about 75% of African timber ends up in the Chinese market with a high volume of trade concentrated in central, southern, and eastern Africa [3]. Conversely, due to the high demand for unique forest species (African rosewood, etc.) native to most ECOWAS regions, the value of forest exports to China has increased steadily from the year 2000 reaching the highest peak in 2014 at a tune of \$815 million with active engagement of 6 African states: Ghana, Nigeria, Liberia, Sierra Leone, Gambia and Mali [4] [5]. Moreover, as trade cooperation platforms such as the Forum on China-Africa Cooperation (FOCAC) and China-Africa Forest Governance Project (CAFGP) improve over time, the possibility of forest trade intensification is indubitable [6] [7] [8] [9].

Owing to these assumptions and claims regarding trade flows between China and Africa, follow-up findings have raised concerns as to what lays behind the curtains of the China forest product trade. [10] asserted that though GDP and population are the main cause of high exports of raw materials from Africa to China, bilateral trade agreements that do not foster the development of export products major driving factors. In the case of China's paper and pulp trade [11] noted that although the size of China's economy plays a major role, distance and resource endowments, the level of economic cooperation are fundamentals to the level of both exports and imports. Similarly, [12] reported that regardless of the type of forest products, the distance which accounts for the cost of trade is significant in regulating China's trade volume however for big economies such as China and the US, the economic gains from trade still merits the potential cost that may arise due to distance. Some authors [13] [14] have also concluded that although the size of China's economy affects the volume of trade, World Trade Organization (WTO) has shaped both the structure and geography of China's trade with many developed and developing countries. In terms of forest trade, there has been limited research focusing on Africa which has lead unreliable facts and myths apart from China-Africa forest products trade engagement [15]. Existing literature has mainly focused on global forest trade and China's imports from larger economies [13] [16] [17]. However, because wood has already become an important commodity between China and the African continent a better insight into the importance of the Africa-China trade in forest products and the determinants of exports is necessary.

The main purpose of this paper is to analyze the factors affecting ECOWAS-China forest product trade based on the gravity model hypothesis for under-

standing future forest trade policies given the growing exports of timber resources from the West African States to China. The gravity model of international trade is grounded on Newton's law of gravitation and assumes that economies will trade based on economic size and distance [18] [19]. Today, the model has been widely employed in analyzing determinants of a diverse route of trade engagements in Africa [20], Asia [21], Europe [22] and other trade partners [23] [24]. In this paper, we model the gravity model of international trade based on previous and current literature to analyze China-ECOWAS forest products trade engagement.

Compared with previous studies, this paper first considers the income classifications of exporter countries and analyses its influence on the volume and determinants of forest products trade. At the same time, this paper also analyses the trade impact of the size of forest (natural resource endowments) while considering other vital elements such as institutional quality, infrastructural development, and China's population among other economic variables. The analysis is conducted grounded on the widely held gravity model technique, which has been evidenced due to its potency in elucidating diverse cases in international trade, predominantly bilateral trade.

The fully modified least square (FMOLS) estimation technique employed based on the assertion of [25] [26] helps to provide optimal estimates for the cointegrated variables. To our knowledge, no studies have focused on ECOWAS-China forest trade using FMOLS estimator. Therefore, the findings of this paper will provide a better understanding of the bilateral forest product trade and ways to improve the present status. The results are important for recent African's bilateral trade direction with China and reduction of uncertainty. The contribution of this paper is two-fold: contribute to previous pieces of literature on forest product trade between China and Africa, and through a dynamic gravity model approach, provide suggestions for improving the ECOWAS-China trade. The next section introduces the status of the trade between ECOWAS and China and the main commodities that are traded. Section 3 introduces the method and data used in this study. Section 4 presents the model estimation results and discussion and presents the limitations of the paper. Section 5 presents the policy implications. Section 6 summarizes and concludes.

## **2. Literature Review**

### **2.1. Theoretical Literature and Empirical Literature**

This work employs the gravity model of international trade as our theoretical lens in analyzing China-Africa forest product trade determinants. Though the basic gravity model focuses on economic mass and distance as the motivating factors for trade, there are contrasting views regarding trade-GDP-population-distance nexus.

[12] employed the fixed effect vector decomposition in analyzing China's forest imports and exports of various forest products groups and realized the paramount role of economic sizes of countries (GDP and GDPC) in predicting the

volume and magnitude of trade flow between China and major forest trade partners. Ordinary Least Squares (OLS), Fixed Effects (FE), Poisson Pseudo-maximum estimation in the study of Zhang & Li, (2009) also proved that logging restriction and exporters forest resources endowments have valid influence in determining both the direction and volume of forest products trade. moreover, a global analysis of individual forest products trade based on the application of Maximum Likelihood (ML), Poisson Pseudo-Maximum Likelihood (PPML), and fixed Effects Estimator (FE) also unravel the positive role of economic growth and size of trading partners in forest trade in addition to forest products consumption status [23] [24].

In analyzing China-Africa trade, [27] found out that, although the GDP's of trading partners deliver positive effect on trade, the combined effect of population and economic growth population are major determinants of continuous trade engagements. Elsewhere trade openness among 33 African countries was traced to the rapid population growth in addition to the quest for economic growth by these countries [28]. This shows how population growth in most developing economies could pivot bilateral engagement with wealthier nation and therefore should be accounted for in examining trade flows. Also [29] noted that because population drives income growth it more likely to enhance trade than trade agreements. The study which examined total and sectorial trade between Columbia and South Korea also revealed that distance and limited sea routes decrease the likelihood of trade. Similarly [30] [31] found negative significant relationship between trade volume and distance barrier.

Additionally, FDI [32] [33] exchange rate [34] [35] and natural resources among other economic indicators have been applied in understanding trade flow and openness [28] [36] [37].

The economic situation of African states (GDP) and the growing Chinese language investments remain a backbone anchoring forest trade between African-China. Based on the literature assessment above, it is clear that the growing forest trade relations between ECOWAS and China merits further scholarly and practical attention.

Despite the polemics surrounding Chinese presence in Africa, forest trade remains paramount in China-Africa engagements, and as China continues to tighten anti-logging policies, demand for forest products is expected to increase [38]. Numerous studies have labeled China's forest products import growth as a way of satisfying the quest for industrial raw materials since the country now assumes the position of global producer and exporter of finished wood products [38]. However, after the conclusions of [39] on "Who will meet China's forest product import demand", attention has been drawn to Africa-China trade because the region plays a potential role in supplementing China's ever-increasing forest product imports. Furthermore, the uniqueness of wood products emanating from the forest zones of Africa (African rosewood) on the Chinese market renders African forest exports more valuable regardless of the quantities traded [40]. Again, following the reports of the 2020 forest resource assessment which

unraveled the devastating loss of most African forests due to man-made deforestation and uncontrolled logging of logs, the need for sustainable and controlled forest products removal has been awakened [41]. This calls for the role of major log importers and stakeholders in African wood products trade and since China has remained a hot spot and leading importer of most wood products from Africa over the years, the need to understand the rationale behind China's interest in Africa's wood products remain crucial due to the alarming global environmental and social concerns raised in literature from a diverse school of thoughts [42]. The question here however is what backs the Chinese growing presence in the African forest products market? To answer these questions, we draw inferences from various China forest trade relations with both Africa and other trade partners in other parts of the world as well as global forest trade trends based on the unique gravity model of trade (popularly adapted in trade studies) to analyze the current situation with regards to the study countries (ECOWAS-China).

Although there has been a steady stream of research on China-Africa forest trade, reports on the determinants of forest products exports remain scarce in the literature. Thus, this study contributes significantly to the literature by examining the forest products trade with particular reference to ECOWAS forest export to China and the associated economic drivers.

## 2.2. Research Hypotheses

Studies [43] [44] have revealed both direct and indirect relationships between Income and trade. For instance, in analyzing the role of income on trade openness in sub-Saharan African countries [45] asserted that in countries such as Tanzania the level of income plays a significant part in the level of trade openness. Additionally, an increase in the volume of trade between BRIC countries and South Africa was observed based on fiscal economic growth. [46] also revealed that wood product imports from china by major trading partners have also improved as a result of income growth. Similarly some studies [47] [48] found evidence of income and volume of Agricultural products trade. Based on the above literature assertions the studies proposed the following hypotheses:

- 1) The volume of forest products exports from low-income ECOWAS countries is higher than from middle-income ECOWAS countries.
- 2) The volume of forest products exports from middle-income ECOWAS countries is lower than that of low-income ECOWAS countries.

The economic situation of African states (GDP) and the growing Chinese language investments remain a backbone anchoring forest trade between African-China. Based on the literature assessment above, it is clear that the growing forest trade relations between ECOWAS and China merits further scholarly and practical attention.

## 3. Method

### 3.1. The Panel, Data Source, and Variables Description

The study examines the forest trade relationship between China and ECOWAS

countries in the ECOWAS economic zone. Further, the ECOWAS panel is subdivided by the income level classification per the World Bank. Therefore, lower-middle-income and lower-income level countries are estimated differently.

**Table 1** and **Table 2** details the panel, data sources, and description. The data is collated from the FAO from 2000 to 2019. Although there are 15 countries in the ECOWAS, per the available data, only 12 countries (Liberia, Togo, Senegal, Sierra Leone, Guinea Bissau, Guinea, Gambia, Benin, Cote d'Ivoire, Mali, Nigeria, and Ghana) are included in the sample due to their active engagement in forest trade and the consistency of available data.

The total trade volume (Volume) represents the total amount of forest trade between China and the ECOWAS sub-region. The export represents the total annual export volume of the ECOWAS forest products. Gross domestic product (GDP<sub>i</sub> and GDP<sub>j</sub>) represents the annual economic growth of China and the ECOWAS members. Population growth (POP<sub>i</sub> and POP<sub>j</sub>) also represents the total annual population growth of China and the ECOWAS countries. Infrastructure (INFR<sub>j</sub>) represents the annual infrastructural development in individual ECOWAS countries. Institutional quality (INSTQ<sub>j</sub>) also represents the annual institutional quality improvement efforts of ECOWAS members. Finally,

**Table 1.** Panel groups and coding.

Panel Classification	Country Code	Country
LMI (low middle income)	GHA, NIR, IVC, BEN, SEN	Ghana, Nigeria, Cote d'Ivoire, Benin, Senegal
LI (low income)	LIR, TOG, SIL, GBS, GUI, GAM, MLI	Liberia, Togo, Sierra Leone, Guinea Bissau, Guinea, Gambia, Mali
ECOWAS	GHA, NIR, IVC, BEN, SEN, LIR, TOG, SIL, GBS, GUI, GAM, MLI	Ghana, Nigeria, Cote d'Ivoire, Benin, Senegal Liberia, Togo, Sierra Leone, Guinea Bissau, Guinea, Gambia, Mali

**Source:** Authors (New World Bank Country Classifications by Income Level: 2021-2022) [49].

**Table 2.** Panel and data description.

Variables	Description	Source
Tvolume	Trade volume ECOWAS-China	Authors computation based
Export	Export volume of ECOWAS members	Resource trade. Earth
GDP <sub>i</sub>	Economic size of importing country (China)	World Bank
GDP <sub>j</sub>	Economic size of ECOWAS members	World Bank
POP <sub>i</sub>	Annual population importing country (China)	World Bank
POP <sub>j</sub>	Annual population ECOWAS members	World Bank
INFR <sub>j</sub>	The infrastructure of ECOWAS members	WGI
INSTQ <sub>j</sub>	Institutional quality of ECOWAS members	FAO
NR <sub>j</sub>	Forest resources of ECOWAS members	FAO

natural resources (NR<sub>j</sub>) represent the forest natural resources of the ECOWAS members.

### 3.2. Model Specification

Similar to existing studies, [50] [51] [52] [53] we build on the extended version of the gravity model of trade to analyse the determinants of forest trade between China and the FOCAC members by segregating members into different income levels (IMF middle-income and low-income classifications). Specifically, the Fully Modified Ordinary Least Square (FMOLS) approach was employed to examine the determinants of China-ECOWAS forest products trade engagements. This approach was chosen over other econometric models due to its reliability in estimation for small sample sizes [36]. Moreover, the FMOLS mitigate endogeneity, heteroscedasticity, and correlation problems in the data and also estimates the long-run relationship between the selected series [36] [54] [55]. Accordingly, the model is specified as follows:

$$Tvolume_{it} = f(GPDi_{it}, GDPj_{it}, POPi_{it}, POPj_{it}, INFRj_{it}, INSTQj_{it}, NRj_{it}) \quad (1)$$

Since econometrically there could be potential issues of heteroscedasticity, the variables employed in the models must be presented as a linear arrangement of the parameters then transformed into natural logarithms. This is significant because variables in their natural logarithms deliver direct elasticities simplifying clarification and interpretation. Therefore, the upgraded multivariate model function in a transformed log-linear model based on a panel specification is formulated as:

$$\begin{aligned} \ln Tvolume_{it} = & \delta_0 + \delta_1 \ln GDPi_{it} + \ln GDPj_{it} + \delta_3 \ln POPi_{it} + \delta_4 \ln POPj_{it} \\ & + \delta_5 \ln INFRj_{it} + \delta_6 \ln INSTQj_{it} + \delta_7 \ln NRj_{it} + \mu_{it} \end{aligned} \quad (2)$$

Here,  $\ln Tvolume$  represents forest trade volume between China and the ECOWAS partners;  $\ln GDPi$ ,  $\ln GDPj$ ,  $\ln POPi$ ,  $\ln POPj$ ,  $\ln NRj$ ,  $\ln INSTQj$ ,  $\ln INFRj$ , are economic size of China and ECOWAS partners, the population of China, population of ECOWAS countries, forest natural resource, institutional quality, and infrastructural development. Further,  $\delta_0$  is the constant term whereas  $\delta_1$ ,  $\delta_2$ , ...  $\delta_7$  are slope coefficients measuring the elasticities of forest trade volume with the respect to the model repressors;  $i$  denotes the individual countries within the study panel, and  $t$  is the study period 2000-2019.

### 3.3. Analytical Roadmap

The Study follows rigorous econometric procedures to estimate the relationship between China's trade potential with the different ECOWAS members section per the income level classification of the IMF. Specifically, the analysis begins with the descriptive analysis to determine the shape of the data. Next, we perform the correlation and multicollinearity test to ensure that the variables under consideration do not have a higher correlation between themselves. After these issues are resolved, we move to the cross-sectional dependency test. Here since

these countries are basically from the same continent and trade amongst themselves, there could be issues of cross-sectional connectedness. Therefore, we need to ensure the non-existence of this issue to avoid erroneous residual interpretation. Again, there is the need to determine the integration order of the variables, thus we employ the panel unit root test to determine if the variables are cointegrated at their level form or first level. Next, we estimate the model using the FMOLS to determine the relationship between the trade volume and the regressors.

## 4. Results and Discussion

### 4.1. Descriptive Statistics

From **Table 3** we observe a description of the data set based on the selected variables; Trade volume of exporter country ( $j$ ), GDP ( $i, j$ ) and Population ( $i, j$ ) of both partners, natural resource endowment, Institutional quality, and Infrastructural development of exporter ( $i$ ) of different groups.

### 4.2. Correlation Analysis

To determine the link between the response variable and the model's independent variables, a correlation analysis is used. The results of the analysis are shown in **Table 4**. GDP and population of both partners (ECOWAS and China) are highly correlated with trade volume (Tvolume) and Exports (0.68, 0.91, 0.67, and 0.74). Natural resource endowment (NR $j$ ) was positively correlated (0.55) with trade volume and negatively correlated (-0.05) with exports. Moreover, the quality of institutions (INSTQ $j$ ) also had a negative correlation (-0.47) with the volume of forest trade and a positive correlation (0.06) with Exports. Finally, the infrastructural development (INFR $j$ ) also assumed a positive correlation between (0.55 - 0.66) across all panels (LMI, LM & ECOWAS). In brief, the magnitude and direction of the relationship between variables presented via the model had unique variations. Irrespective of the variances in the dependent variables, the bond between the independent variables remains constant, with some variables exhibiting positive and negative associations in all panel groups.

### 4.3. Cross-Sectional Test

Before the empirical analysis, cross-sectional reliance tests as mentioned in the earlier section are being performed on the panel data employed. The results are based on three different tests of cross-sectional dependence which include the Breusch and Pagan LM test, Pesaran scaled LM and Pesaran CD tests are there reported in **Table 5** and fail to reject the null hypothesis of cross-sectional independence at a 10% level of significance. Thus, cross-sectional residual reliance across country groups cannot be considered.

### 4.4. Unit Root Tests

We examine the existence of long-run affiliations amid variables employed for



**Table 3.** Descriptive statistics.

Panel	Variable	Mean	Std. Dev	Skewness	Kurtosis	JB
LMI Countries	Tvolume	44.23	1.76	0.18	2.51	2.23 <sup>a</sup>
	Export	14.96	2.79	-0.31	2.20	3.58 <sup>a</sup>
	GDPi	29.35	0.78	-0.52	1.88	8.36 <sup>a</sup>
	GDPj	24.25	1.32	0.72	2.48	8.39 <sup>a</sup>
	POPi	21.01	0.02	-0.25	2.04	4.13 <sup>a</sup>
	POPj	17.11	1.02	0.88	2.43	12.24 <sup>a</sup>
	NRj	8.90	0.71	0.53	1.96	7.82 <sup>a</sup>
	INSTQj	29.75	21.39	0.04	1.51	7.80 <sup>a</sup>
	INFRj	63.21	42.11	-0.03	1.85	4.65 <sup>a</sup>
LI Countries	Tvolume	42.08	1.22	-0.18	2.52	1.40 <sup>a</sup>
	Export	14.93	2.61	-0.51	2.12	7.12 <sup>a</sup>
	GDPi	29.61	0.60	-1.09	3.38	19.49 <sup>a</sup>
	GDPj	21.91	0.86	0.19	1.99	4.57 <sup>a</sup>
	POPi	21.02	0.02	-0.42	2.50	3.86 <sup>a</sup>
	POPj	15.48	0.78	-0.23	1.88	5.75 <sup>a</sup>
	NRj	46.23	4.65	0.90	3.63	13.31 <sup>a</sup>
	INSTQj	27.94	14.46	-0.30	1.89	6.22 <sup>a</sup>
	INFRj	61.88	36.09	0.21	2.35	2.38 <sup>a</sup>
ECOWAS Countries	Tvolume	43.10	1.84	0.48	2.99	6.89 <sup>a</sup>
	Export	14.94	2.69	-0.40	2.18	9.91 <sup>a</sup>
	GDPi	29.49	0.70	-0.84	2.51	22.84 <sup>a</sup>
	GDPj	23.02	1.60	0.66	3.00	13.37 <sup>a</sup>
	POPi	21.02	0.02	-0.42	2.35	8.35 <sup>a</sup>
	POPj	16.26	1.21	0.53	3.24	9.10 <sup>a</sup>
	NRj	70.21	6.67	1.47	4.36	79.18 <sup>a</sup>
	INSTQj	28.80	18.05	0.01	1.84	9.92 <sup>a</sup>
	INFRj	62.51	38.96	0.07	2.08	6.44 <sup>a</sup>

Note: <sup>a</sup> and <sup>b</sup> mean significance at 1% and 5% levels.

**Table 4.** Correlation matrix.

Panel		Tvolume	Export	GDPi	GDPj	POPi	POPj	NRj	INSTQj	INFRj
LMI Countries	Tvolume	1								
	Export	0.58	1							
	GDPi	0.68	0.71	1						
	GDPj	0.91	0.34	0.32	1					

## Continued

	POPi	0.67	0.69	0.98	0.31	1				
	POPj	0.74	0.16	0.04	0.94	0.05	1			
	NRj	0.55	-0.05	-0.10	0.77	-0.10	0.87	1		
	INSTQj	-0.47	0.06	0.05	-0.66	0.05	-0.71	-0.45	1	
	INFRj	0.60	0.65	0.94	0.24	0.92	-0.02	-0.18	0.09	1
	Tvolume	1								
	Export	0.34	1							
	GDPi	0.73	0.55	1						
	GDPj	0.88	0.11	0.34	1					
LI Countries	POPi	0.71	0.49	0.97	0.33	1				
	POPj	0.76	0.03	0.14	0.95	0.15	1			
	NRj	0.52	-0.13	0.07	0.67	0.05	0.65	1		
	INSTQj	-0.26	0.16	-0.01	-0.35	-0.03	-0.35	-0.55	1	
	INFRj	0.63	0.44	0.82	0.32	0.83	0.11	0.15	-0.05	1
	Tvolume	1								
	Export	0.39	1							
	GDPi	0.45	0.62	1						
	GDPj	0.92	0.17	0.08	1					
ECOWAS Countries	POPi	0.45	0.59	0.97	0.10	1				
	POPj	0.54	0.08	-0.05	0.96	-0.03	1			
	NRj	0.65	-0.05	-0.10	0.77	-0.10	0.82	1		
	INSTQj	-0.29	0.10	0.02	-0.35	0.01	-0.39	-0.54	1	
	INFRj	0.50	0.55	0.87	0.20	0.87	0.03	-0.06	0.03	1

Table 5. Cross-sectional dependence test.

Panel	Test	Statistic	Prob.
LMI Countries	Breusch-Pagan LM	134	0.61
	Pesaran Scaled LM	27.73	0.67
	Pesaran CD	11.51	0.71
LI Countries	Breusch-Pagan LM	50.62	0.78
	Pesaran Scaled LM	4.57	0.72
	Pesaran CD	4.55	0.63
ECOWAS Countries	Breusch-Pagan LM	767.17	0.82
	Pesaran Scaled LM	61.02	0.65
	Pesaran CD	27.54	0.74

Note:  $H_0$  of cross-sectional independence is rejected at a 10% level of significance.

the study, the study investigates the integration properties of these variables [56] [57]. The panel unit root tests are commonly used as reported in Table 6. The Augmented Dickey-Fuller Fisher (ADF-Fisher), and Lm, Pesaran, and Shin (IPS) test. The test results reveal the variables are not stationary at their level forms but rather become stationary when differenced in the first order. Therefore, the study of the variables is integrated in the same order (I (1)).

**Table 6.** Panel unit root test.

Panel	Variables	ADF I (0)	Im Pesaran & Shin I (0)	ADF I (1)	Im Pesaran & Shin I (0)
LMI Countries	Tvolume	0.47	3.40	31.84 <sup>a</sup>	-3.72 <sup>a</sup>
	Export	3.86	1.64	33.85 <sup>a</sup>	-4.77 <sup>a</sup>
	GDPi	0.25	4.01	12.67 <sup>a</sup>	-1.01 <sup>a</sup>
	GDPj	5.96	0.77	28.99 <sup>a</sup>	-3.29 <sup>a</sup>
	POPi	0.40	3.55	7.87 <sup>a</sup>	-0.09 <sup>a</sup>
	POPj	68.44	-13.46	50.30 <sup>a</sup>	-5.16 <sup>a</sup>
	NRj	36.99	-75.15	24.37 <sup>a</sup>	-53.65 <sup>a</sup>
	INSTQj	12.78	-0.91	35.04 <sup>a</sup>	-4.25 <sup>a</sup>
	INFRj	15.94	0.07	21.81 <sup>a</sup>	-2.24 <sup>a</sup>
LI Countries	Tvolume	1.30	38.01	3.81 <sup>a</sup>	-3.62 <sup>a</sup>
	Export	12.31	15.68	1.07 <sup>a</sup>	-0.30 <sup>a</sup>
	GDPi	0.35	17.74	4.75 <sup>a</sup>	-1.20 <sup>a</sup>
	GDPj	7.95	48.03	1.06 <sup>a</sup>	-4.71 <sup>a</sup>
	POPi	0.57	11.02	4.20 <sup>a</sup>	-0.45 <sup>a</sup>
	POPj	55.01	99.09	-8.29 <sup>a</sup>	-16.39 <sup>a</sup>
	NRj	18.42	19.40	-46.19 <sup>a</sup>	-176.70 <sup>a</sup>
	INSTQj	30.09	32.33	-2.45 <sup>a</sup>	-2.99 <sup>a</sup>
	INFRj	18.42	19.40	-46.19 <sup>a</sup>	-176.70 <sup>a</sup>
ECOWAS Countries	Tvolume	1.78	69.89	5.11 <sup>a</sup>	-5.17 <sup>a</sup>
	Export	16.17	49.53	1.73 <sup>a</sup>	-2.14 <sup>a</sup>
	GDPi	0.61	30.41	6.22 <sup>a</sup>	-1.57 <sup>a</sup>
	GDPj	13.91	77.03	1.31 <sup>a</sup>	-5.72 <sup>a</sup>
	POPi	0.97	18.89	5.50 <sup>a</sup>	-0.14 <sup>a</sup>
	POPj	123.45	149.39	-15.03 <sup>a</sup>	-15.85 <sup>a</sup>
	NRj	55.41	43.78	-84.78 <sup>a</sup>	-166.67 <sup>a</sup>
	INSTQj	41.46	65.55	-2.34 <sup>a</sup>	-4.86 <sup>a</sup>
	INFRj	22.36	65.13	1.86 <sup>a</sup>	-4.62 <sup>a</sup>

Note: <sup>a</sup> and <sup>b</sup> means significance at 1% and 5% level.

#### 4.5. Results (FMOLS Estimation)

Based on the FMOLS estimation, we found out that 99% of the variation in the volume of forest exports by the low middle-income group (LMI) was explained by the predictor variables. Both importer and exporter (GDP<sub>i</sub> and GDP<sub>j</sub>) were both significant at 0.00a which is the case of most import and Export trade studies [20] [22] [58] [59] [60]. At 0.01a and 0.02a, this implies that all things being equal the economic size of the two partners is likely to propel the volume of forest trade. Again, the population of china showed significance on the volume of forest product trade which explains the assertion that increased population leads to the quest for industrial raw materials to feed the dynamic increasing demands, and since China export of finished wood products is constantly rising there is more possibility to increase trade partners and the export volume [60] [61] [62]. However, in the case of the aggregate ECOWAS group, the population was negative and significant on the volume of exports. This does not come as a shock as other trade studies have similarly reported this finding [20] [63]. Most African states (LMI) are still wallowing in the infantry stage of economic development hence key institutional structures are porous in regulating the flow of exports as expected [64] [65] [66]. The quality of institution per our findings was negative but significant (−1.51 at 0.01a) for low-income countries (LMI) whereas the other variables; infrastructural development and Natural resource endowments of LMI ECOWAS countries (INFR<sub>j</sub>, and NR<sub>j</sub>) were insignificant. Among the Low-income ECOWAS group, all the variables were insignificant except for GDP<sub>i</sub>, GDP<sub>j</sub>, and POP<sub>i</sub> which were significant and positive at 0.00a, 0.00a, and 0.05b respectively. Lastly, in analyzing the ECOWAS group and the associated economic variables, the results showed that GDP (GDP<sub>i</sub>, GDP<sub>j</sub>) and Population (POP<sub>i</sub>, POP<sub>j</sub>) are both highly significant and positive determinants for both partners as indicated in **Table 7**.

#### 4.6. Diagnostic Tests

We test for the residual terms: serial correlation and heteroscedasticity test. **Table 8** presents the results. The diagnostic check for the models used in this study indicates that the models are valid for interpretation with no serial correlation and heteroscedasticity in residuals. The null hypothesis of no serial correlation and no heteroscedasticity are not rejected since the corresponding probability values are above 1%, 5%, and 10% levels of significances.

### 5. Policy Implication

While it is evident that the presence of China's wood trade investments has grown in recent years in key forest regions of Africa such as central Africa, there are still prospects for enhancing forest trade cooperation particularly in marginalized regions where forest trade is certain on value rather than volume. To realize this, ECOWAS countries must seize the development opportunities provided by the China-Africa Forest Governance Platform, and build sustainable

**Table 7.** Panel Fully Modified Least Squares (FMOLS).

Panel	Variables	Coeff.	Std. err	Prob.	
LMI Countries	Export	1.34	1.41	0.34	Adj. R <sup>2</sup> 0.99
	GDPi	1.00	2.13	0.00 <sup>a</sup>	
	GDPj	1.00	1.01	0.00 <sup>a</sup>	
	POPi	2.96	1.21	0.01 <sup>a</sup>	
	POPj	-5.31	2.24	0.02 <sup>a</sup>	
	INFRj	-2.13	4.63	0.64	
	INSTQj	-1.51	6.22	0.01 <sup>a</sup>	
NRj	-1.14	6.76	0.86		
LI Countries	Export	2.52	1.87	0.18	Adj. R <sup>2</sup> 0.98
	GDPi	1.00	4.37	0.00 <sup>a</sup>	
	GDPj	1.00	3.45	0.00 <sup>a</sup>	
	POPi	3.33	1.75	0.05 <sup>b</sup>	
	POPj	-5.24	3.76	0.16	
	INFRj	-1.03	1.61	0.52	
	INSTQj	1.24	7.32	0.88	
NRj	-2.87	2.04	0.88		
ECOWAS Countries	Export	6.93	4.02	0.08	Adj. R <sup>2</sup> 0.99
	GDPi	1.00	8.26	0.00 <sup>a</sup>	
	GDPj	1.00	4.25	0.00 <sup>a</sup>	
	POPi	1.05	3.72	0.00 <sup>a</sup>	
	POPj	-1.51	6.82	0.02 <sup>a</sup>	
	INFRj	-2.43	2.64	0.92	
	INSTQj	-1.07	1.59	0.50	
NRj	-5.86	1.70	0.97		

Note: <sup>a</sup> and <sup>b</sup> means significance at 1% and 5% level.

**Table 8.** Diagnostic tests.

Panel	Tests	Test statistic
LMI Countries	Serial correlation	F = 0.69 (0.74)
	Normality test	$\chi^2$ (Chi-square) = 5.23 (0.25)
	Heteroskedasticity	F = 0.91 (0.531)
LI Countries	Serial correlation	F = 0.77 (0.55)
	Normality test	$\chi^2$ (Chi-square) = 6.75 (0.45)
	Heteroskedasticity	F = 0.88 (0.66)

**Continued**

ECOWAS Countries	Serial correlation	F = 0.76(0.33)
	Normality test	$\chi^2$ (Chi-square) = 5.11 (0.26)
	Heteroskedasticity	F = 0.58 (0.24)

Note: Numbers in the parenthesis are probability values.

forest trade relations that foster win-win benefits for both sides whilst focusing on achieving the sustainable development goal 15.

Furthermore, since most ECOWAS forest exports are raw wood products (wood logs), value-added exports of specialized wood products will generate additional income, promote local industrial growth, and increase employment avenues for the rural populace in logging areas where initial forest operations have only left indelible negative footprints on livelihoods. The Mozambique forest trade modification experience offers a perfect road map for leaders of other African states [3].

Moreover by strengthening logging restrictions and illegalities associated with the wood products trade, full benefits from the industry can be realized. ECOWAS nations should make greater efforts to work with the Chinese government to evaluate and strengthen bilateral trade agreements, ensuring that these accords have a meaningful positive impact on forest trade thus the value and cost of forest removal and trade should correspond to economic, environmental gains. Again for LMI with weak institutional structures attention should be focused on sustainability rather than the personal gains by lead actors in the forest trade industry.

Although several forest-related partnership arrangements between China and some African countries are underway, some countries are yet to benefit fully from China in terms of forest investments. Whilst these countries await a call from Chinese investors, lessons from the ongoing China-Africa forest cooperation member countries remain vital footing in drafting beneficial policies and negotiations. Furthermore, based on the United Nations' development goal projection, Africa's forest remains core in preserving the last habitat of existing native species in the world hence its sustainability is of major concern. However, the 2020 FAO forest assessment report raises a red flag on the rapidly deteriorating state of most African states, therefore, considerations towards the aforementioned situation should be made by stakeholders of ECOWAS members in their forest trade, investment, and policy relations with China (FAO, 2020).

## 6. Conclusions

Africa-China trade partnership has experienced exponential transformation and diversification since the deepening of bilateral relations between the two sides over the years. However, analysis of forest trade activities between China and key economic regions of Africa is still scarce. Following the assessment that china's

forest products imports from Africa are smaller in value than anticipated in literature, the answers to why China still engages in such perceived insignificant forest trade remain paramount to forest trade literature and since this form of trade varies across the various African regions, this article employed modified gravity model of trade with panel data of 12 ECOWAS nations over 19 years (2000-2019) to examine the factors regulating forest product trade flow of key ECOWAS countries with China. Again, the study utilized the Income Disparity Approach based on the IMF classification of countries in drawing clear comparisons across the classified groups. The findings demonstrate that the factors that influence forest exports differ depending on ECOWAS members' income groups. Apart from China's GDP and population, which were both positive and significant predictors, the GDPs of both low middle income and low-income ECOWAS partners were also positive predictors, whereas the population of ECOWAS states was a negative predictor of forest exports to China. Furthermore, institutional quality plays a role (negative) in defining forest trade volume flow from low middle-income groups. This implies that, as low-income countries tighten forest regulations fueled by strong legislative structure among other regulatory bodies, the tides of trade volume and direction will be unfavorable to China's expectations.

Finally, although forest resource endowment is frequently cited as a factor in determining forest exports, their effects and significance in our study were not valid. It is not surprising that the region per China's trade deals contributes little compared with that of other regions within the African region. These results presented here are vital in shaping the continuity and drafting of China-ECOWAS future forest trade policies and since these results focused on unilateral forest products trade (exports), the need to explore a multilateral flow of forest products from both sides is needed to further enrich literature. Also, regional level comparative analysis of Africa and China forest trade will be beneficial.

### Conflicts of Interest

The authors declare no conflicts of interest.

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