

# The study of impact factors on timber trade between Ghana and China

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## Abstract

**Purpose** – Timber export is an important economic development pillar in Ghana, which has a direct effect on Ghana's domestic forestry industry development, local communities' income and sustainable forest management and deforestation. China, as the Ghana's largest timber export destination, brought significant impacts on Ghana's timber export. However, there is a lack of quantitative analyses on impact factors of timber trade between the two countries in the past, which this paper sought to do.

**Design/methodology/approach** – The authors first collected Ghana's timber exports to China from 1997 to 2017, and then based on the literature review and trade theories, the authors set up a least squares estimate (LSE)-based multiple linear regression (MLR) model to analyse the specific impact factors. In addition, multi-collinearity, autocorrelation and heteroscedasticity issues of the impact factors were checked to guarantee the accuracy of the results.

**Findings** – The results showed China timber import volume, Ghana cedi (GHC)/US\$ exchange rate, Ghana's gross domestic product (GDP) and China timber consumption volume in construction sector had positive impacts; Ghana timber production volume and Ghana average timber export price had negative impacts. The results confirmed that China's timber consumption had a positive linkage with Ghana's timber export. The article also reviewed possible impacts caused by change in timber trade policies, which proved important but was hardly directly quantified. The authors pointed out the importance of optimizing these impact factors to make sure Ghana's timber export to China went on the sustainable track.

**Originality/value** – There is no literature about timber trade and its impact factors between Ghana and China, which used econometric models. This paper provided new perspectives on the impact factors in timber trade between the two countries.

**Keywords** Timber export, Ghana, China, Impact factors

**Paper type** Research paper

## 1. Introduction

### 1.1 *Forest resources in Ghana*

According to the Food and Agricultural Organization (FAO), Ghana has around 9.3 million hectares of forested land in 2014, which constitutes 41.0% of the total land area (FAO, 2015). Around 9.0 million hectares are primary or otherwise naturally regenerated forest with major tree species of ceiba, bamboo, rosewood, Gmelina, etc., and around 325000 hectares are planted forest with over 70% consisting of *Tectona grandis* (teak) (Forestry Commission, 2016a). The country is endowed with bamboo also, which grows naturally in the wild. *Vulgaris* species is the most prevalent. The Western part of Ghana has the highest stock of natural bamboo reserves estimated to be over 60% (Kuudaar, 2016). The annual change rate per year estimated over 25 years (from 1990–2015) is 0.3% (FAO, 2015), indicating some increase in forest land area as a result of plantation development in forest and non-forest



lands. But, the density of forest cover is reducing giving way to a reducing close forest cover and an increasing open forest cover, the net result being an expanded forest land area, but a low density forest in terms of canopy formation (Kuudaar, 2016).

From 1990 to 2015, the forest degradation rate had been 45,931 ha per year (Kuudaar, 2016). According to the Global Forest Watch (GFW), Ghana is losing its rainforest at a faster rate in the world than any other country. GFW reported that Ghana’s primary rainforest loss increased by 60% in 2018 compared to 2017, the highest in the world (Global Forest Watch, 2019).

The key drivers of deforestation and forest degradation in Ghana include agricultural expansion, mining and infrastructural development. Since 1990, nearly 80% of Ghana’s forest resources under state control have been lost due to illegal logging and forest conversion, according to a study released by the Ministry of Lands and Natural Resources (MLNR) in 2016 (MLNR, 2016). Illegal small-scale mining, known in Ghana as “galamsey”, has wreaked havoc on the country than anything, with the government estimating that it would cost US\$29 bn to restore (Forestry Commission, 2016a; Global Forest Watch, 2019).

The Ghana Forest Plantation Strategy 2016–2040, which is the current framework for the implementation of the National Plantation Development Programme, is aimed at halting deforestation and forest degradation by providing a sustainable supply of timber and other non-timber forest products and environmental services by means of establishment and management of forest plantations, using selected species (Forestry Commission, 2016b; Kpelle, 2018). Table 1 summarized the main features of Ghana’s forest resource.

### 1.2 The timber industry and timber trade in Ghana

Timber in the article refers to round wood log and sawn wood. According to the Forestry Commission (FC) of Ghana’s Timber Industry Development Division (TIDD) classification, round wood consists of poles and billets and can also be referred to as primary products which made up 5.91% by value and 10.07% by volume of all wood exports in 2017. Sawn wood include air dried lumber, kiln dried lumber and overland lumber; which is a component of secondary products, made up 90.11% by value and 86.73% by volume of all wood products exports in 2017. Timber trade between Ghana and China is being dominated by sawn wood. For example, sawn wood made up 86.92% by volume and 86.88% by value of all secondary product exports, in 2017, according to the TIDD statistics (TIDD, 2017a).

The forestry sector significantly contributes to the gross domestic product (GDP) of Ghana and remains the third largest contributor in foreign exchange earnings for the country, according to the Ghana Statistical Service (Kpelle, 2018). The Ghanaian exports are sold to all regions of the world. Besides overland export routes to other African countries, most timber is exported via the main ports (GPHA, 2015) in the south: the Port of Tema and Port of Takoradi.

Ghana export 15 different wood products, with the top five in export volume being lumber (air dried), lumber (kiln dried), billet, plywood (overland) and sliced veneer with respect to manufactured volumes. There are totally around 42 species involved in the timber export, with the top five in terms of export volume in 2017 being rosewood (34.88%), teak (33.25%),

Land surface	22.8 million hectares
Forest cover	9.3 million hectares (41%)
Production forest	1.5 million hectares designated for production
Forest ownership	100% publicly owned
Annual change rate	0.3% per year; over 25 years (1990–2015)

Source(s): FAO (2015)

Table 1.  
Ghana forest resources

wawa (6.97%), ceiba (4.39%) and Gmelina (2.91%). Ghana export timber to 38 different countries, and the top five timber shipping destinations with regards to volume in 2017 are China, India, Germany, Vietnam and Italy (TIDD, 2017a).

Ghana's timber production area has been declining over the years from 1.6 million ha in 1990 to about 762,400 in 2015, about 52.35% decrease for the period. Harvesting of timber is regulated by the FC through the implementation of the Annual Allowable Cut (AAC), which has been set at 0.5 m cubic metres per year. But, due to inadequate management capacity to ensure effective enforcement of this regulation, it has always been exceeded by more than 200% (Kpelle, 2018).

Timber products export is one of the most important economic pillars in Ghana (TIDD, 2017a), creating more jobs, especially for the unemployed rural labour (Pepke *et al.*, 2016).

Meanwhile, intensive timber harvest caused environmental issues like deforestation and biodiversity loss. From 1990 to 2010, Ghana lost an average of 125,400 ha per year (1.68% per year), representing 33.7% of its forest cover, or around 2,508,000 ha lost for the entire period (Mongabay, 2020). GFW reported a 60% increase in Ghana's primary rainforest loss as at 2018 due to logging and mining activities (Global Forest Watch, 2019).

Ghana sells timber with the aim of continuing to supply only legal timber from sustainable sources in accordance with the guidelines of the European Union (EU) and the International Tropical Timber Organization (ITTO). The Ghanaian government is seeking further investment in design and technical assistance and international cooperation. For the development of the export industry, the country is striving for more efficient use of wood and the production of high-quality products, such as moulded and processed castings, floors, furniture components, dowels and similar value-added items (Timber Trade Portal, 2020).

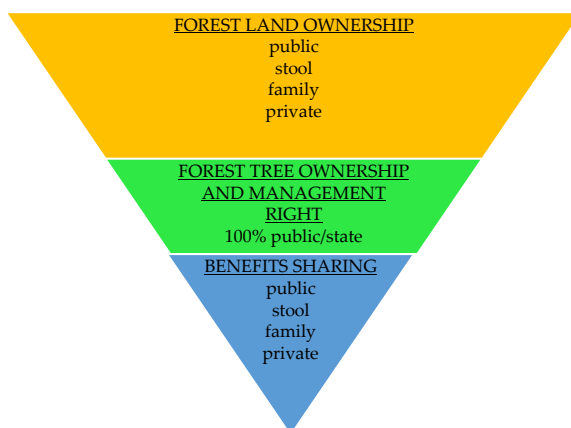
### *1.3 Forest ownership and benefit sharing*

As showed in Figure 1, the ownership of the Ghanaian forest area can be divided into public land, stool land (this is similar to a dynasty), family land and private land. However, the management of all forest resources including timber harvesting rights are administered by the FC for the benefit of the land owners through sharing of benefits according to the benefits sharing agreements and Social Responsibility Agreements (SRAs) in the FC's logging manual (Forestry Commission, 2016b). Timber royalties paid to land owners, chiefs, communities and all stakeholders are calculated based on the stumpage rate for the harvested species set in timber utilization contracts, as prescribed by the Timber Resource Management Regulations in 1998 (ITTO, 2020).

The 1962 Concession Act provides for naturally regenerated trees to be vested in the state for care and management. As such, all forests, naturally regenerated, in and outside forest reserves are owned by the state on behalf of the people of Ghana (Kuudaar, 2016).

The FC generates funds through fees charged for forest management activities and ecotourism. The FC retains 50% of the amount realized, and the Administrator of Stool Lands is allocated 10% of the amount. The rest of the 40% (considered 100% again) is distributed to key stakeholders such as traditional authorities (20%), district assemblies (55%) and stool lands (25%) (Forestry Commission, 2016b; Kpelle, 2018). For example, in October 2020, the government of Ghana paid around US\$4.69 m in timber royalties to traditional authorities for logs harvested in their localities as part of a disbursement of US\$53.84 m from the Minerals Development Fund and Stool Lands Administration to traditional authorities, metropolitan, municipal and district assemblies, the Minerals Commission and the sector ministry (ITTO, 2020).

In addition, logging companies also have some social responsibility roles to play on the forest adjacent communities. A permit holder (a company given the right to harvest timber by the FC) engaged in logging must sign an undertaking to provide social facilities and amenities



**Figure 1.**  
Ghana forest  
ownership structure

for the inhabitants of the forest area: communities 5 kilometres within the timber harvesting operational area. This should be at a cost of 5% of the value of the stumpage fee of timber that is harvested, according to the revised guidelines for SRA in 2016 (Forestry Commission, 2016b).

Also, the state can allocate degraded reserves to private entities for the creation of forest plantations. This is encouraged by giving 90% of the proceeds from the timber harvest to the private entity, and the remaining 10% is paid to the state. But this system does not allow the conversion of forest land by the private owner (Kuudaar, 2016).

Furthermore, the state, through the modified Taungya system (MTS) can reforest degraded forests and share the benefits with the farmers (Kuudaar, 2016; Forestry Commission, 2016b).

#### 1.4 Timber trade between Ghana and China

China and Ghana have recently developed close ties. China's economic presence on the African continent takes the form of infrastructure finance and trade. China's policy towards Africa has emphasized mutual benefit and equality. Competition from countries with the prices and resources of African products increases with the presence of China and has a positive impact on debt financing. In general, the presence of China receives positive support from Ghanaian leaders in the past and present (Ibrahim, 2018). In relation to Ghana, trade, aid and investment are the basis of engagement. However, business remains the main pillar of engagement. Ghana imports more products and exports fewer raw materials and agricultural products to China (Ibrahim, 2018).

China's economy is now second to the USA (GDP standard), and the interaction of the country with other nations, especially Africa, is increasing. In Africa, there is now a shift from the north-south co-operation with western countries such as the USA, United Kingdom (UK) and Germany as it was to new south-south co-operation with China as one partner to consider first. Many countries, such as Ghana, welcome China as an alternative partner for development (Ibrahim, 2018).

China's forest product imports have grown dramatically in recent years pushing the country into a leading global role in the sector. China has moved from a close economy in the 1970's and transformed to a major economic player and one of the largest trading nations in the world. China now has bilateral and multilateral trade agreements with most countries in the World, and Ghana is not an exception (Frimpong, 2012).

China is a net importer of wood products, and timber import is growing faster, adding to the supply pressure from growing global demand (Pepke *et al.*, 2016). The combination of scarce domestic forest resources, low-cost production and rapidly increasing external demand has made China a hub for remanufacturing and redistributing wood products (Liu *et al.*, 2020).

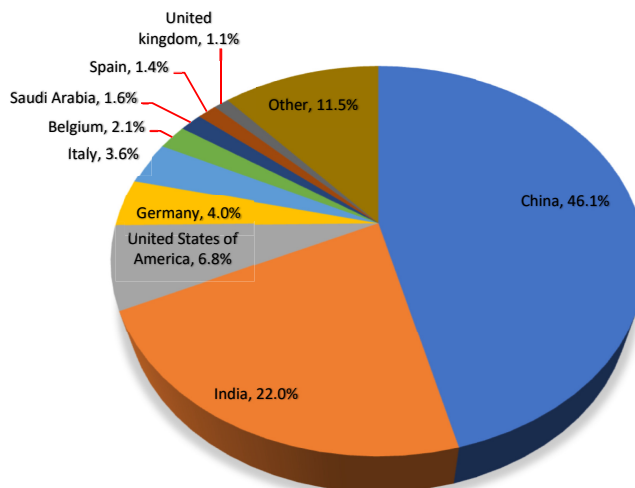
Figure 2 showed that according to the TIDD in 2017, Ghana exported 75.43% in volume of all wood products to Asian countries; of which, China was the major destination followed by India, compared to 11.14% to European markets, 7.63 to Africa and 3.09% to America. Lumber (air dried), billet, furniture parts, lumber (kiln dried) and sliced veneer dominate timber exports to Asia (TIDD, 2017a).

Most of Ghana’s timber products (46.1%) is exported to China followed by India (22%) and the rest of the world (Timber Trade Portal, 2020), showing how important China is to Ghana in terms of timber trade.

Ghana’s timber exports to China kept increasing since 1997, both in volume and value though, and the sustainability of the trade flow between Ghana and China also faced a lot of challenges influenced by several factors as discussed earlier including government policy.

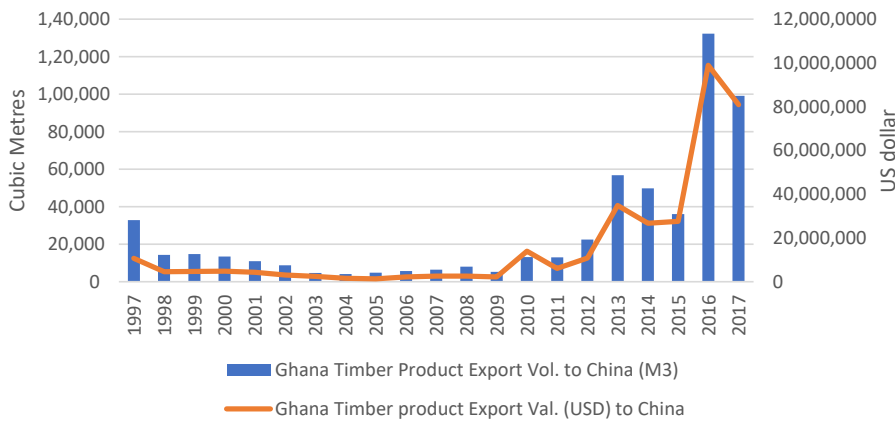
The export trends in Figure 3 below from the TIDD annual reports (TIDD, 2017b) is divided into three stages by the authors.

- (1) First stage: from 1997 to 2002, a slightly stable increase period, bedevilled with log export ban impositions.
- (2) Second stage: from 2003 to 2011, a decrease and rebound period so much inflicted by the raw log export ban and then an exemption for teak and Gmelina at some point in 2006.
- (3) Third stage: from 2012 to 2017 was a quick increase period but with fluctuations and partly influenced by the reduction of timber exports to the EU and the US markets due to their environmental sensitivity, an export ban on raw log exports and even a new ban imposition on the harvesting and export of rosewood in 2019.



**Figure 2.**  
Top 10 timber export  
markets of Ghana  
in 2017

**Source(s):** Timber Trade Portal, 2020



**Figure 3.**  
Ghana timber product  
export volume and  
value to China  
(roundwood and  
sawn wood)

### 1.5 Problem statement and research aim

The economy of Ghana is one of the most promising in sub-Saharan Africa, endowed with natural resources, such as gold, cocoa, diamond, forest and backed by stable political environment, that are essential for the country's development and its future prosperity. Ghana is an open economy, and Ghana Investment Promotion Centre (GIPC) welcomes trade and investment from all countries, including China. A major source of financial inflow by which the economic performance of the forestry sector is measured is the foreign exchange the country earns through the export of timber and other wood products from the forest. Timber from the high tropical forests has traditionally been the third largest source of foreign exchange, while fuelwood, bushmeat, medicinal plants and other natural products have played a significant role in the well-being of most Ghanaians (Kpelle, 2018).

China is currently the largest destination market for African timber exports, and timber trade with Ghana has grown significantly over the past decade. As of 2015, about 10% of China's total import of timber comes from Africa of which Ghana is one of the important partners. This has important implications for the sustainable development of forests and trade in exporting countries such as Ghana (Andrade *et al.*, 2018).

Trade in timber between Ghana and China is becoming very important and getting more attention from all over the world because timber trade and the industry in Ghana have contributed significantly to the domestic economic development of the country; meanwhile, it has also raised serious concerns on the impacts to deforestation and community livelihood (Ibrahim, 2018). The trade in timber between Ghana and China has not been much studied, and there is little literature on this, especially, from the angle of quantitative analysis. The research problems the authors tried to address are the features of forestry product trade between Ghana and China, what factors impact the trade flow and how the trade flow could better support the forestry industry upgrade and improve community livelihood in Ghana.

This article reviewed Ghana's timber export to China and identified the influencing factors and challenges, with the discussion on how to improve the trade flow and structure to benefit Ghana's domestic industry and local community. We recognized that Ghana's timber export to China not only had impacts on Ghana but also had impacts on China. Like the timber trade, volume and value change could impact China forestry industry's production size and cost on major trade tree species. Besides, it also had impacts on China timber sourcing structure. Given the limited space, this manuscript is more focused on impacting factors analysis and the impacts on Ghana's side.

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Last but not least, timber traded between Ghana and China should come from legal and sustainable source to help address deforestation and improve the forest governance in Ghana.

This article will provide help, through the results and suggestions, to the Ghanaian government through the FC and the timber industry as a whole on how to optimize timber exports to China to the benefit of the country through economic growth and improvement in community livelihood.

## 2. Materials and methods

### 2.1 Research design and data collection

The study used data from Ghana's timber exports to China from 1997 to 2017 from the TIDD of the FC of Ghana; data from FAOSTAT and China Forestry Publishing House's forestry statistics books. We also collected and examined useful documents and publicly available data from other relevant sources including, but not limited to scholarly articles, international organizations, such as the World Bank.

### 2.2 Data analysis

The statistical analysis of the data was conducted using mainly STATA 14.1 and Excel. The analysis was conducted mainly by employing the Least Squares Estimate (LSE) based Multiple Linear Regression (MLR) model.

The study planned to use historical data of Ghana's round wood log and sawn wood exports from 1997 to 2017, but we found that round wood log data from public official sources was not complete. In addition, data on Ghana timber product exports to China from the TIDD of the FC of Ghana showed that, per the entire historical public official data from 1997 to 2017 of Ghana timber product (round wood and sawn wood only) exports to China, sawn wood cumulatively accounted for 98.58% by volume and 99.36% by value of the entire export data for these two timber export products. Round wood log accounted for 1.42% by volume and 0.64% by value of exports to China for these two timber products for the entire period, suggesting that, deleting round wood log will not actually impair the quality of the study results and interpretations. So, we used sawn timber as the data base to run the modelling. We applied LSE-based MLR to measure the degree at which identified factors influences Ghana timber exports to China.

### 2.3 Multiple linear regression model (MLR)

The study used the following MLR model to examine the impacts factors identified. Based on the literature reviewed, impact factors related to international trade theories include factor endowment theory, competitive advantage theory and gravity theory. Based on the above theories and related researches, we selected the following variables to conduct the analysis.

Ghana's sawn wood export to China (Y): this is the monetary value in US dollar of Ghana's annual sawn wood exports to China.

Ghana's timber product production volume (X1): this is the annual domestic log production volume in Ghana. We expected a positive effect.

China's sawn wood product import volume (X2): this is the total volume of China's annual imports of sawn wood. We expected a positive effect.

Ghana cedi (GHC)/US\$ exchange rate (X3): this is the exchange rate between Ghana cedi and US dollar. We expected a positive effect.

Ghana's timber unit export price (X4): this is the annual Ghana's timber export price per cubic metre. We expected a positive effect.

Ghana gross domestic product, GDP (X5): This is the monetary measure of the market value of all final goods and services produced in Ghana annually. We expected a positive effect.

China consumption in construction sector (X6): This is the total annual timber product consumption in Chinese construction sector. We expected a positive effect.

Besides the above impact factors, time could be another important factor to be considered through the introduction of a dummy variable, but in this article, we are more focused on solid economic impact factors. Policy is also an impact factor, but instead of including it directly into the model which increases the complexity of the modelling, we chose to illustrate it more in the discussion part.

The equation of MLR used is as follows:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + \beta_6 X_{6t} + \varepsilon_t \quad (1)$$

$$\varepsilon \sim N(0, \sigma^2), \quad (2)$$

where

$Y$  = Ghana's sawn wood product export to China ( $m^3$ ),

$\beta_0$  = the y-intercept (value of y when all other parameters are set to 0),

$X_{1t}$  = Ghana timber product production volume ( $m^3$ ),

$X_{2t}$  = China sawn wood product import volume ( $m^3$ ),

$X_{3t}$  = Ghana cedi (GHC)/USD exchange rate,

$X_{4t}$  = Ghana's timber unit export price (US\$),

$X_{5t}$  = Ghana GDP (US\$),

$X_{6t}$  = China timber consumption in construction sector and

$\varepsilon$  = model error, distributed with 0 mean and a variance of  $\sigma^2$ .

To ensure quality of the modelling, we tested how suitable the data are for the model of the study by employing Kaiser–Meyer–Olkin (KMO). It measures the proportion of variance among variables that might be common variance. Overall KMO value through the test is 0.8352, more than 0.5, showing good result. We also ran multi-collinearity test to identify potential multi-collinearity. The mean variance inflation factor (VIF) calculated is 17.95, larger than 10 and showed multi-collinearity among the independent variables ( $X$ 's). To address it, we applied principal component analysis (PCA) to prove the correlation between  $Y$  and the six variables ( $X_1$  to  $X_6$ ). The PCA test results showed that PC1 which include  $X_1$ ,  $X_2$ ,  $X_3$ ,  $X_5$  and  $X_6$ , and PC2 which include  $X_4$  are all significantly related to  $Y$ .

Heteroskedasticity was also found to be an issue with the data, and White's robust standard error was applied through LSE-based MLR. Through the LSE-based MLR analysis, the study identified how much (in percentage) Ghana's timber exports to China,  $Y$  changes when, say, Ghana's timber production,  $X_1$  changes by 1%, and also how much percentage change  $Y$  responds to a 1% change in  $X_2$ ,  $X_3$ ,  $X_4$ ,  $X_5$  and  $X_6$ .

### 3. Results

#### 3.1 LSE-based multiple linear regression analysis

In order to check the degree of impact from each influencing factor, MLR was run based on the data collected. Given the large nature of annual changes in the data and the instability of



the data collected, LSE-based MLR was applied. The data were checked for heteroscedasticity issues and White correction applied to solve the heteroskedasticity issue, and to find the estimators of heteroskedasticity-robust standard error.

The final result of the LSE-based MLR is presented in the following [Table 2](#). The regression analysis yielded an F-value of 34.94, with a  $p$ -value of 0.0000, indicating that the model result is statistically significant. [Table 3](#) summarized factors affecting Ghana timber export to China, the coefficient of determination ( $R^2$ ) was 0.9474 meaning that approximately 94.74% of the variation of the dependent variable, Y (Ghana's timber export to China) was accounted for by the explanatory variables in the model.

The new linear relationship between Ghana timber exports to China and the factors affecting the timber trade between the two countries is given by

$$\begin{aligned} \text{Lg}Y_t = & -0.473 - 7.703\text{Lg}X_{1t} + 2.188\text{Lg}X_{2t} + 1.941\text{Lg}X_{3t} - 0.950\text{Lg}X_{4t} + 1.818\text{Lg}X_{5t} \\ & + 1.396\text{Lg}X_{6t} + \varepsilon \end{aligned} \quad (3)$$

Based on this, the study found that when X1(Ghana timber product production volume) increases by 1%, Y (Ghana swan wood product export volume to China) decreases by 7.703%; when X2 (China sawn wood import volume) increases by 1%, Y increases by 2.187%; when X3 (Ghana cedi/USD exchange rate) increases by 1%, Y increases by 1.941%; when X4 (Ghana timber unit export price) increases by 1%, Y decrease by 0.950%; when X5 (Ghana gross domestic product) increases by 1%, Y increase by 1.818%. China timber consumption in the construction sector (X6) had a lag effect. After running one time period lag, it positively related, implying that when in the previous period, X6 (China timber consumption in construction sector) increases by 1%, current Y will increase by 1.396%.

Ghana timber product production volume, though was expected to have a positive effect on Ghana sawn wood export volume, that is, when there is an increase in Ghana's sawn wood production, we expect an increase in Ghana's sawn wood exports to China, but the modelling result is otherwise. We applied the LSE and White's correction to recheck, but they still showed a reverse relation. Policy changes, especially log export ban polices Ghana had few times, could contribute to this unexpected negative relation by interrupting the normal relation with government administrative instruments. When log export ban is implemented, even domestic timber production increase will not lead to increase in timber exports as expected. Ghana started log export ban since 1995, modified in 2014, 2015 and 2019, which for sure impacted on timber export and could led to this unexpected reverse relation.

China's sawn wood import volume had a significant and positive influence on Ghana sawn wood exports to China. This is in line with the expectation of this research as the study of [Liu et al. \(2020\)](#) concluded China has become a hub for wood product remanufacturing and redistribution due to its ability to efficiently combine scarce forest resources to produce other products, hence causing a surge for foreign demand for wood products, including from Ghana.

Ghana cedi (GHC)/US\$ exchange rate also had a positive and significant relationship with Ghana sawn wood exports to China, in line with expectation. A depreciation of the Ghana cedi rate, or when more Ghana cedi (GHC) are need to buy a US dollar, it becomes an incentive for exports, which triggers capital accumulation to produce tradable goods ([Twanugize et al., 2017](#)). The exchange rate contributed significantly to the increases in Ghana's timber exports to China ([TIDD, 2017b](#)). The result is also in line with the assumption that when Ghana cedi depreciate to the US\$, it helps increase Ghana's timber export to China.

Unit export price had a negative influence on Ghana sawn wood export volume to China. This could be ascribed to the premium prices paid on some Ghanaian timber species,

Year	Ghana swan wood export vol. To China (m <sup>3</sup> )	Ghana timber product export val. To China (10000USD)	Ghana timber production volume (10000 m <sup>3</sup> )	China swan wood import volume (10000 m <sup>3</sup> )	Ghana cedi (GHC)/USD exchange rate	Ghana timber unit exp. Price (USD/m <sup>3</sup> )	Ghana's GDP (billion USD)	China timber consumption in construction sector (10000 m <sup>3</sup> )
1997	32786.42	1071.9303	2581.0762	133.1473	0.20	696.67	6.89	5435
1998	14203.208	446.8325	2667.7359	169.03	0.23	411.35	7.48	5980
1999	14633.574	459.2844	2733.7907	275.64	0.27	401.26	7.72	6200
2000	13411.334	474.5495	2819.8457	361.37	0.54	351.3	4.98	7668.2
2001	10905.035	424.4529	2940.9105	403.41	0.72	354.68	5.31	7846.4
2002	8652.861	303.7254	3029.6088	548.37	0.79	376.49	6.17	8838.01
2003	4613.938	235.6142	3166.4142	559.81	0.87	454.81	7.63	8381.03
2004	4020.498	151.4664	3265.9033	605.17	0.90	475.68	8.88	10984.12
2005	4771.439	128.4379	3364.4547	605.42	0.91	469.74	10.73	9438.48
2006	5552.876	210.0313	3488.0530	615.31	0.92	474.58	20.41	8748.68
2007	5351.709	225.7764	3602.2900	655.78	0.94	477.36	24.76	9392.53
2008	2985.248	128.8740	3727.8400	718.18	1.06	461.47	28.53	8287.6
2009	5241.863	213.7130	3839.5781	993.52	1.41	451.27	25.98	11664.16
2010	13073.359	1392.2549	4025.3966	1481.22	1.43	471.74	32.17	10221.21
2011	12529.596	592.9904	4143.8647	2160.67	1.51	510.55	39.57	12801.08
2012	22427.725	1076.3514	4275.4470	2066.97	1.80	513.13	41.94	14347.39
2013	56202.859	3456.1587	4429.6188	2404.3	1.95	601.43	63.28	16283.29
2014	49367.239	2658.7064	4543.2574	2565.2	2.90	473.36	53.6	16566.62
2015	35896.147	2756.7160	4716.2427	2659.77	3.67	572.32	49.18	16768.96
2016	132022.13	9877.5260	4807.7347	3153	3.91	595.35	55.01	17315.25
2017	98913.898	8085.5480	4933.3768	3740	4.35	660.8	59	17273.68

Source(s): TIDD statistics, FAOSTAT statistics, China Forestry Publishing House statistics, World Bank data and China Forestry Statistics Book

Table 2. Original data set used for model analysis

lgY	Coef	Robust std. err	T	P> t	(95% conf. interval)	
lgX1	-7.702972	1.256985	-6.13	0.000	-10.50371	4.902243
lgX2	2.187953	0.4195742	5.21	0.000	1.253083	3.122822
lgX3	1.940968	0.7654385	2.54	0.030	0.2354652	3646472
lgX4	-0.9496447	0.2422473	-3.93	0.003	-1.489405	0.4098841
lgX5	1.81793	0.4105253	4.43	0.001	0.9032222	2.732637
lgX6 L1	1.396218	0.4480015	3.12	0.011	0.3980079	2.394427
_cons	-0.4734552	0.3434507	-1.38	0.198	-1.238711	0.2918007
Number of obs. = 21						
F(6,10) = 34.94						
Prob > F = 0.0000						
R-squared = 0.9474						
Root MSE = 0.4384						

**Table 3.**  
Factors affecting  
Ghana timber export  
to China

rosewood for example, making the average price factor not really a challenge. Besides, rosewood species as a “natural resources” had natural limitation in terms of supply. For certain precious rosewood species, once it was over harvested and run out, it could not be recovered through plantation in short time period. This could also cause the price factor not to be positively related as we expected. This is also probably being influenced by the big data fluctuations.

Ghana’s GDP is also significant and has a positive relation with Ghana timber exports to China as expected. An increase in GDP will increase the country capacity to produce and export goods and services as an increase in Ghana’s gross domestic product will result in an increase in sawn wood exports to China.

China timber consumption in the construction sector also showed that an increase in the previous year’s consumption will result in Ghana exporting more timber products to China in the current year. Ghanaian timber product exporters will increase or decrease their supply to the Chinese market based on the previous year’s China construction sector consumption statistics. It means that China’s timber consumption has a certain positive pull force to Ghana’s timber export, and this is in line with assumption.

#### 4. Discussions

##### 4.1 Analysis of the impact factors on Ghana’s timber export to China

4.1.1 *Ghana timber production.* The abundance of forest resources and the rapid prosperity of plantations are important reasons for the increase in the timber harvest (O’Brien and Bringezu, 2018). Knowing the production level of timber as a country will help to know if a country is under or over producing. This helps the country to know the amount harvested, amount to export and local consumption (Asamoah et al., 2020).

Figure 3 shows Ghana sawn wood and round wood production from 1997 to 2017. Ghana’s sawn wood and round wood production have generally been increasing steadily since 1997. For example, in 1997, timber production was around 25.8 million m<sup>3</sup> and increased to over 49.3 million m<sup>3</sup> in 2017 (TIDD, 2017b).

The regression analysis showed Ghana timber production volume negatively correlated with Ghana sawn wood exports to China. This implies that, a percentage increase in Ghana timber production volume will result in Ghana timber export volume to China decreasing by 7.703%. This can be explained by the export data fluctuations influenced mainly by policy. Figure 4 showed Ghana’s timber production change.

4.1.2 *China timber import volume.* Consumption and demand of timber in the developing world has grown rapidly from 770 million m<sup>3</sup> in 1998 to 1.2 billion m<sup>3</sup> in 2018, a compound

annual growth rate (CAGR) of 2.3% over the past 20 years, driven by China through its rapid GDP growth and a substantial rise in urbanization led construction (Richard, 2020).

China is the biggest importer of timber in the world, which in 2018 accounted for US\$ 20 bn (34.9% of total global imports) by value and 109 million m<sup>3</sup> (22.9%) by volume (Liu *et al.*, 2020). China has become a hub for efficient wood product remanufacturing and redistribution, increasing foreign demand for wood products in China. The demand in the Chinese market for some Ghanaian timber species was quite stable (ITTO, 2020).

There is a positive and a significant relationship between China timber import volume and Ghana timber export to China, in the MLR analysis. A one percentage increase in China timber import volume will result in an increase of around 2.188% in Ghana's timber export to China. Figure 5 below shows China's sawn wood imports from 1997 to 2017 (State Forestry Administration, 2018), which kept rising and projected to rise further. This indicates an increasing market demand, and this therefore would increase Ghana's timber imports to the country hence, increasing revenue from timber exports.

4.1.3 *Ghana cedi (GHC)/USD exchange rate.* The issue of exchange rate risk has assumed strong prominence in international economics, and this is best understood by the incessant debates about the level and scope of how damaging it is. The tendency for currency exchange rates to fluctuate unpredictably has been blamed for limiting gains from international trade and lowering welfare. Generally, a weaker domestic currency stimulates exports and makes imports expensive, thus decreasing the country's trade deficit depending on the sector (Twamugize *et al.*, 2017).

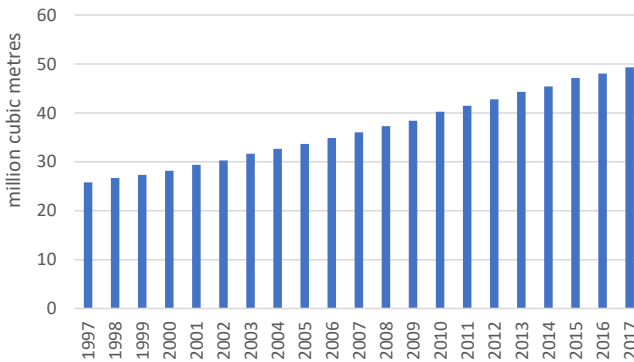


Figure 4.  
Ghana's timber  
production change

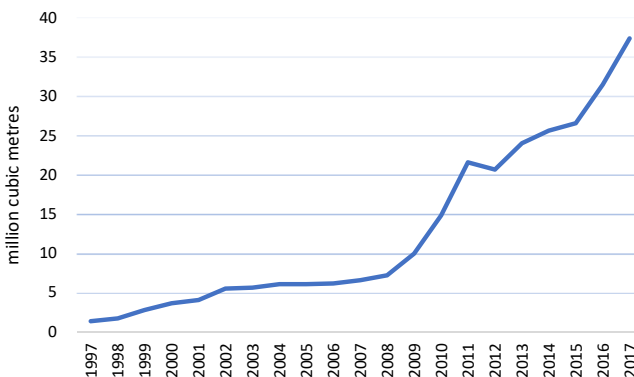


Figure 5.  
China sawn wood  
imports – 1997 to 2017

There is a positive correlation between the Ghana cedi (GHC) exchange rate to the US\$ and Ghana timber export volume to China in the analysis. A percentage change in the Ghana cedi (GHC) exchange rate will result in a substantial increase in the quantity of timber product exported to China, around 1.941% increase. This is because Chinese importers would need fewer US dollars to buy a substantial volume of wood in the Ghana cedi (GHC), all things being equal. On the other hand, Ghanaian exporters become richer when export proceeds in dollars are being changed to the Ghana cedi (GHC) back in Ghana.

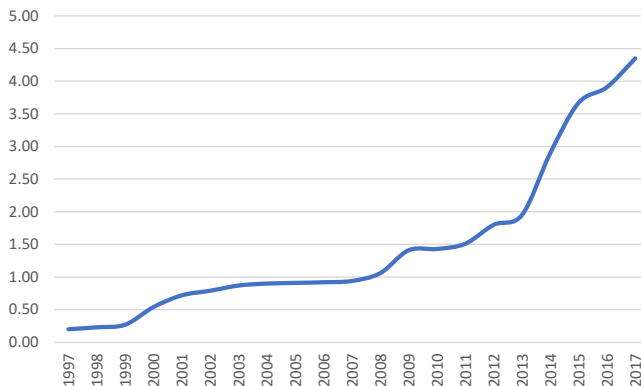
Zhang *et al.* (2019) concluded that the growth of imports is closely related to exchange rate as can be seen in this study. The Ghana cedi (GHC) kept depreciating against the US\$ in the past decades, hence having a positive impact on the country's propensity for exportation rather than importation. The Ghana FC in its TIDD 2016 report said the currency exchange rate contributed significantly in the increases in exports and some exporters and buyers shifting to premium species like rosewood (TIDD, 2017b). The following Figure 6 shows the annual currency exchange rate of USD1 to the Ghana cedi (GHC) (World Bank, 2022).

4.1.4 *Timber export price.* Though trade is principally littered with investment fundamentals factors such as the price factor, Ghana timber export price did not yield the expected result. It showed a negative relationship with Ghana timber exports to China.

This could be ascribed to the premium prices paid on some Ghanaian timber species, rosewood for example, making the average price factor not really a challenge. The TIDD in 2015 reported that, the demand for some premium species, such as teak, papao, mahogany, rosewood, etc. is inelastic. This signifies that price of timber products export change faster than product volumes demanded, resulting in more value earned for the same volume exported (TIDD, 2015). It is also probably being somehow influenced by the big data fluctuations in the data collected.

Ghana's round wood and sawn wood prices kept fluctuating in the past decades. The average unit price of exported timber products during the reported period has fallen from US\$696.67/cubic metre in 1997 to US\$660.80/cubic metre in 2017 (TIDD, 2017b). The following Figure 7 shows average Ghana's round wood and sawn wood prices from 1997 to 2017.

4.1.5 *Ghana gross domestic product (GDP).* The regression result shows that GDP is an important factor in Ghana timber exports to China as they positively relate with each other in the LSE-based MLR analysis. From the previous literature, it is also clear that the main factors affecting foreign trade includes GDP, and an increase in GDP will increase the country capacity to produce and export goods and services (Zhang *et al.*, 2019).



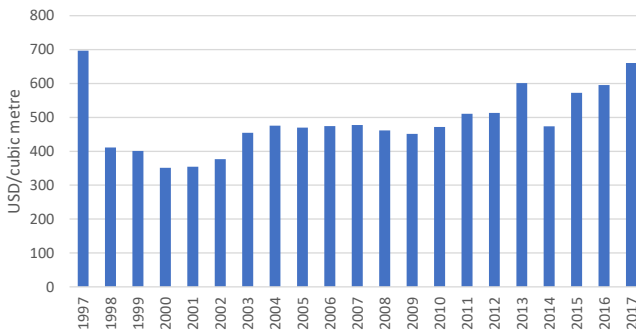
**Figure 6.**  
Ghana cedi (GHC)/USD  
exchange rate from  
1997 to 2017

Figure 8 below shows Ghana’s GDP which generally has been increasing since 1997 from US\$6.89 bn to US\$59.00 bn in 2017.

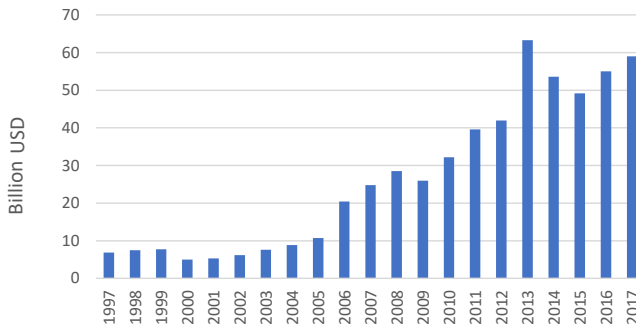
4.1.6 *China timber consumption in the construction sector.* Total global demand for forest products continues to rise as population and developing countries increase, increasing the ability of many countries to increase consumption levels. Global economic growth is a major determiner of demand for timber products because of its impacts on housing, construction activity and consumer wealth and spending (ITTO, 2018).

Richard, in his “*Global Timber Outlook*” published by Gresham House in 2020 asserted that, over the past 20 years, global timber consumption increased by 1.1% yearly, and this was driven by increasing urbanization and global housebuilding requirements. He projected that, over the next 30 years, timber consumption is expected to rise by 3.1% per annum, which will be driven by urbanization, decarbonization and increased housebuilding; of which, China’s demand is very important to look out for. China has set significant targets to reduce carbon emissions towards net zero by 2060, and timber will play a significant part in this transformation. As a result of the combined effects of urbanization and decarbonization, more new homes will be constructed, as well as cleaner, low-carbon buildings made of timber. As a result, wood will gradually take the place of carbon-intensive steel and concrete (Richard, 2020).

The LSE-based MLR with a one-time period lag showed that Ghana will increase its timber exports to China in the current year based on how favourable was China’s timber consumption in the construction sector in the previous year. China consumption and demand of timber is growing rapidly through its economic growth and substantial rise in urbanization (96% increase in urban dwellers over the past 20 years) led construction, a trend expected to continue (Richard, 2020), which is impacting positively on Ghana timber exports.



**Figure 7.**  
Ghana’s average  
timber export price  
from 1997 to 2017



**Figure 8.**  
Ghana gross domestic  
product from 1997  
to 2017

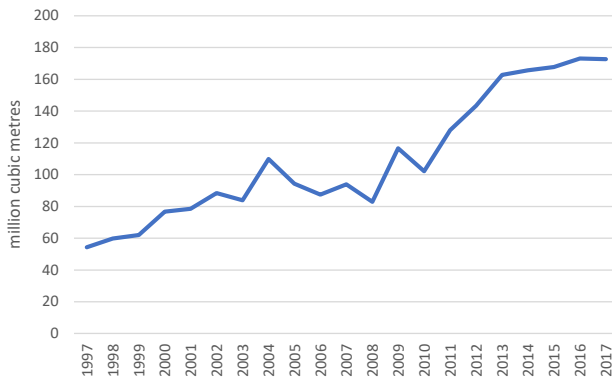
Figure 9 shows the timber consumption in the Chinese construction sector from 1997 to 2017, which increased about 3.18 times for the period.

#### 4.2 Timber trade-related policies

Economic and environmental policies in underdeveloped countries, such as Ghana, are important factors influencing logging practices (O'Brien and Bringezu, 2018). In view of the expansion and development of the timber trade market, government policies, particularly legal regulations and export bans, can play an important role in timber trade flows. International trade policy and regulation can have an impact on the volume of timber harvest, level of trade and countries' choice of trading partners (Liu et al., 2020; Nzayisenga and Zhu, 2020).

In terms of trade policies for wood products, China has maintained an open market and low tariffs on bilateral trade since joining the World Trade Organization (WTO) in 2001, which has brought more benefits and opportunities to countries to export to China. Zero import duties on logs and a reduction in value added tax and customs duties on logs and sawn timber (7% on logs and 13% on lumber), combined with relatively low wages and high productivity have created a competitive advantage for China in the markets and world trade of forest products. At the same time, China has signed bilateral-free trade agreements with many forest products partner countries (including Ghana), which has led to the growth and expansion of China's import and export trade and developed mutually beneficial markets with these countries (Liu et al., 2020).

The logging ban policy which started from year 2000 to now limited China's domestic timber supply and derived the increase of round wood and sawn timber import in recent decades. The import of more timber has enabled China to meet the growing demand for domestic and international forestry products market. The Chinese government has taken steps to combat illegal timber trade, including signing of an Memorandum of Understanding (MOU) with timber producing countries to combat illegal logging and associated trade like Indonesia, Myanmar, Gabon, etc. China is developing timber legality verification system to trace the timber legality traded and issued policies like green public procurement policy, green consumption policy and green finance policy to increase the market for forest products that come from legal and sustainable sources. China also set up a national forest certification system (CFCC) which is already adopted by Programme for the Endorsement of Forest Certification (PEFC), one of international forest certification system. Companies in China can choose Forest Stewardship Council (FSC), an other popular international forest certification system, CFCC or PEFC COC certification to ensure the sustainability of the timber products



**Figure 9.** China construction sector timber consumption from 1997 to 2017

they sourced. Timber supply and trading companies are now using voluntary certification systems such as FSC and PEFC to identify their legal and sustainable products. All the work has had a positive effect on the sustainable trade in wood products. The share of illegal wood sources has decreased, and the share of certified wood products is increasing (Liu *et al.*, 2020).

Meanwhile, Ghana also supports the fight against illegal logging and trade. In Ghana, all logs, except teak, are not approved for export. There was an export ban on the export of logs since 1995. However, around 2005/2006, an exemption was granted for teak, and later Gmelina was also exempted. Since January 1, 2014, the harvest and export of rosewood (*Pterocarpus erinaceus*) from Ghana has been banned due to uncontrolled and indiscriminate harvesting. The current export ban has been partially lifted for some exporting companies though there was a fresh ban on the harvesting and export of rosewood in 2019 (Timber Trade Portal, 2020).

Many supplier countries, including Ghana, have adopted protective trade policies on round wood log export and would like to attract more investment to develop timber processing industry, which can provide more value-added products and more jobs. Most of the round wood and sawn wood produced in Ghana in 2014 were processed domestically due to an export ban on raw log from natural forests. EU was once a big market for round wood and sawn wood log export from Africa including Ghana, but given the increased environmental sensitivity, the EU timber regulation (EUTR) in 2012 enacted a legislation, which banned illegally sourced timber and timber product from entering the EU market. As a result, Ghana's timber export to EU is declining (Timber Trade Portal, 2020; Global Forest Watch, 2019).

Following the signing of the Forest Law Enforcement, Governance and Trade (FLEGT) Voluntary Partnership Agreement (VPA) between Ghana and the European Union in November in 2009, Ghana became the first country to sign a VPA with the European Union, which ensures that timber and timber exported to the EU are sourced from legitimate sources. With the final assessment, Ghana will begin issuing FLEGT license. Ghana adopted the Timber Resources Management and Legality Licensing Regulation of 2017, LI 2254, which amended the legal framework of Ghana to comply with the VPA. The new law specifies the procedure for issuing special permits and includes granting access to wood for small logging. Ghana has already established the Legality Assurance System (LAS) to monitor, control and verify the management and use of Ghana's forest resources to ensure that only legal timber is logged, sold and exported. Within the FC, a Timber Validation Department has been set up to verify compliance with legal standards for each batch. The TIDD of the FC has been designated the national licensing authority under the VPA, which will issue FELGT licenses for the export of forest products to the EU market and to markets outside the EU. EU border control officials will only allow imports if the supplies are under such a license. This agreement will reduce conflicts in the forest sector, diminish forest degradation and support rural livelihoods. The policy seeks to stimulate sawmills to supply at least 40% of their production to Ghana's domestic market, with a wood tracking system implemented to eliminate illegal timber production and trade (Timber Trade Portal, 2020).

#### 4.3 Timber trade economic impacts on the Ghanaian economy

The effects of international trade on economic growth have been largely studied in the literature for both developed and developing countries such as Ghana. Through the reduction of tariffs and institutional trade barriers, countries that are more open to trade like Ghana tend to perform remarkably better than less open economies. This is so not only in terms of economic growth but also in relation to poverty alleviation, control of inflation, reduction in unemployment, crime reduction and in many other areas in the country (Sun, 2014; Wang, 2016; Ibrahim, 2018; Hyeon-Seung and Cyn-Young, 2019).

Timber is one of the backbones of the Ghanaian economy, supporting the livelihood of several Ghanaians through creations of jobs in the domestic and export sector. In 2017, the



country earned close to US\$99.6 million from round wood and sawn wood exports to China only, according to the FAO (FAOSTAT, 2020). Ghana earned around US\$345.91 m for the export of only round wood and sawn wood timber to China for the entire period under investigation (1997–2017) (TIDD, 2017b).

Ghana is considered one of the countries in West Africa having a large number of sawmilling industries dominated by Chinese operators, with a high volume of timber and the export of timber has been a key economic activity in the country generating income for the economy and employment for a lot of people. The industry is made up of many wood-processing units and other enterprises, dominated by Chinese operators that focus on furniture production and other value-added products (Asamoah *et al.*, 2020).

According to the Ghana FC, in 2016 for example, Ghana earned almost US\$267.75 m from close to 397,000 m<sup>3</sup> of all wood products, a significant improvement on 2015 exports. In terms of the direction of trade, Asian markets accounted for around 73% of the volume of exports in 2016 with the top markets being China, followed by India. Comparing this to the revenue generated from the European imports from Ghana, the country made approximately US\$27.3 m or 12% of all 2016 exports (TIDD, 2017b). This is an evidence of how the Chinese timber imports from Ghana have helped build the Ghanaian economy, increasing the GDP.

Revenue from wood products increased by close to 260% year-on-year during the first two-months of 2021 against that in 2020 (ITTO, 2021). The Asian market of which China is the favourite destination has been the major contributor to Ghana foreign exchange earnings from timber exports recently. The share of exports to the Asian market has increased sharply from 2012 and has overtaken the EU and Africa to become the leading export destination of Ghana's wood products. In 2007 to 2014 for example, according to TIDD reports, Ghana's timber exports to the Asian market grew annually by 10.47% and 3.40% in value and volume, respectively, while all other destinations including the EU and Africa grew at a negative rate, shifting focus to this destination (TIDD, 2017b). This is an evidence and suggestive of how China as the leading destination to Ghana's timber has been key to Ghana's economic growth.

#### *4.4 Timber trade impact on local community income*

As a result of inequities, the government has resolved to significantly increase the contribution of the forest industry, other forest-based businesses and forest environmental services to social, economic and environmental development (Owusu, 2008). Therefore, for forest-dependent citizens, the government established a forest plantation fund and a micro-financing scheme (MLNR, 2019).

These include, but not limited to:

- (1) The government has set up a Timber Industry Plantation Development Fund with a 0.5% share of the 1.5% export tax paid by the exporters of timber products for the development of timber plantations. These export taxes are largely generated from exports to China.
- (2) Access to agricultural financing inputs that include low-cost credit to forest-dependent individuals and organizations, as well as business strategies tailored to the needs of rural forest-dependent communities (Microsere Micro-Finance operates in the Kakum National Park and Ankasa Conservation Area).

Local communities can now enter into SRAs with forestry companies and other forest-based companies dominated by Chinese exporters to fund community development initiatives since the government has developed an encouraging policy and legislative framework (MLNR, 2019). With increased proportion of timber export income in recent decades, the impact of timber export on local communities also surged in Ghana.

Many types of Chinese actors are active in the timber industry in Ghana. A noticeable characteristic of the timber exports to China by Ghana is the high frequency of dealings between Chinese-owned companies and small-scale loggers. Chinese timber demand represents an important source of cash income for families in rural areas. Cash payments are made by Chinese buyers to Ghanaian rural loggers of timbers, which are used to pay for subsistence household activities, providing much-needed cash income to the impoverished communities (MLNR, 2019; Weng *et al.*, 2014).

## 5. Conclusions and recommendations

### 5.1 Conclusions

China has recently become Ghana's favourite partner in timber exports, overtaking the European Union and the African markets, and it is important to identify and examine the impact factors of the timber trade flow and improve the economic, social and environmental benefits for stakeholders in Ghana.

Based on related trade theories and literature review, we identified six impact factors and then used the LSE-based MLR model to run the impact factors for examination. Modelling results showed that all six factors had outstanding impacts in which China timber import volume, Ghana cedi/USD exchange rate, China timber consumption in the construction sector and Ghana's GDP positively influenced Ghana timber exports to China, and Ghana timber production volume and Ghana timber export price related negatively. Based on the modelling results, we made further analysis on each impact factor. As a timber importer, China's timber import volume and China timber consumption in construction sector positively relating to the timber trade flow means that China's timber purchasing power change could bring substantial impacts to Ghana's timber export. It is necessary for Chinese policymakers and the business sector to use more market incentives like lifting market requirements on timber legality and sustainability and adopt environment friendly business purchasing policy to help address illegal logging and deforestation threats Ghana faces. Meanwhile, as the timber exporter, Ghana could also improve forest governance, revenue allocation to provide livelihood safeguard to local community and improve sustainable forest management practices to support legal and sustainable timber supply.

It is evident that China as the leading destination to Ghana's timber currently has been key to Ghana's economic growth. It is the major source of Ghana's foreign exchange earnings from timber products exports, and there is an incentive to sell timber products to the Chinese market due to its openness to trade and wiliness to pay premium prices on high value species like rosewood, wawa, teak and so on.

Ghana's timber trade with China as a major destination is responsible for increased activities like chainsaw activities, log transportation, wood processing activities, machine operation and so on at communities where logging and processing take place, involving both Ghanaian and Chinese operators in the value chain. This does not only create employment for those communities and the country as a whole, but landowners, communities and individuals are also being paid royalties and sometimes tip-offs in the form of money which is a source of livelihood income improvement.

State or international policy interventions have also been responsible for Ghana's increased or decreased timber product exports to China at some time points in the period under study.

### 5.2 Recommendation

Based on the modelling results and impact factors analyses above, the authors raised following recommendation to improve the benefits of Ghana's timber export to China.

- (1) Improve statistic database in Ghana to better track the timber trade flow: Authors noted that Ghana's timber export data were not fully complete, and some data were missing in certain category. On the one hand, it puts challenges on scientific research and on the other hand, it could damage policy-making process, which could be more accurate with high quality science-based research.
- (2) Enhance Ghana's sustainable timber production capacity: The Ghana FC could invest more and increase timber production on the existing and new plantations containing high value species, like rosewood, wawa, mahogany, teak and which are the favourites of the Chinese market and also will release the pressure on intensive commercial harvest on primary forest. In addition, Ghana forestry authority could more strictly require that all forest concessions adopt and implement sustainable forest management plan to make sure of the sustainable use of the forest resources.
- (3) Set up major timber export price monitoring system: Ghana FC could set up the timber export price monitoring system and publish it regularly. With accountable and easier access of timber export price information, the domestic timber producers and timber traders could better plan their business behaviour and avoid unexpected losses caused by unusual changes of the timber export market.
- (4) Strengthen the bilateral coordination with China on timber trade policy: Both sides have recognized the important economic, environmental and social roles timber trade played. As one of important forest product import and consuming market, China is lifting the standard of the timber legality and sustainability both for domestically produced timber and imported timber. Along with increased domestic construction steps, shaping impacts brought by China's global timber purchase has been discussed by stakeholders and policymakers in China. It's important that Ghana and China strengthen the bilateral policy dialogue on timber trade to make sure the trade flow will favour the legal and sustainable timber from Ghana, which could avoid the risk of deforestation and guarantee the benefits on local communities.

## References

- Andrade, E., F., Ren, P., Zhang, J., Júnior, E.U. and Siteo, E.C. (2018), *Tackling Discrepancies in Timber Trade Data: Comparing China and Mozambique*, IIED.
- Asamoah, O., Kuittinen, S., Danquah, J.A., Quartey, E.T., Bamwesigye, D., Boateng, C.M. and Pappinen, A. (2020), "Assessing wood waste by timber industry as a contributing factor to deforestation in Ghana", *Forests*, Vol. 11, p. 939.
- FAO (2015), "Global forest resources assessment 2015: country report - Ghana", Global Forest Resources Assessment 2015.
- Faostat (2020), *Forest Products Statistics*, FAOSTAT.
- Forestry Commission (2016a), *Ghana Forest Plantation Strategy: 2016-2040*, Forestry Commission, Ghana.
- Forestry Commission (2016b), *Revised Guidelines for Social Responsibility Agreement*, Collaborative Resource Management Department, Forestry Commission of Ghana, Ghana.
- Frimpong, S.K. (2012), "Research on relationship between China and Ghana: trade and foreign direct investment (FDI)", *Journal of Economics and Sustainable Development*, Vol. 61, pp. 51-61.
- Global Forest Watch (2019), *The World Lost a Belgium-sized Area of Primary Rainforests Last Year*, World Resources Institute, Vol. 29.

- GPHA (2015), "Ghana ports and harbours authority port report", Ghana Ports and Harbours Authority, available at: <https://ghanaports.gov.gh/>.
- Hyeon-Seung, H. and Cyn-Young, P. (2019), "A new index of globalization: measuring impacts of integration on economic growth and income inequality", Asian Development Bank, Manila, Philippines.
- Ibrahim, I. (2018), "China Africa relations: trade or gold rush in Ghana?", *International Journal of Economics, Commerce and Management*, Vol. VI, pp. 391-409.
- ITTO (2018), "ITTO annual report (2017)", International Tropical Timber Organization (ITTO).
- ITTO (2020), "Tropical timber market report, 16th – 31st october 2020", International Tropical Timber Organization (ITTO), p. 24.
- ITTO (2021), "Tropical timber market report, 1st – 15th april 2021", International Tropical Timber Organization (ITTO), p. 25.
- Kpelle, D.G. (2018), "Development of a system for monitoring progress toward sustainable forest management: an inventory of existing forest-related data and mapping gaps on national reporting on the United Nations strategic plan for forests 2017-2030", United Nations Forum on Forests.
- Kuudaar, E. (2016), "Ghana case study", Prepared for FAO as part of the State of the World's Forests 2016 (SOF0).
- Liu, F., Wheeler, K., Ganguly, I. and Hu, M. (2020), "Sustainable timber trade: a study on discrepancies in Chinese logs and lumber trade statistics", *Forests*, Vol. 11, pp. 1-22.
- MLNR (2016), *Forestry Development Master Plan (2016-2036)*, Ministry of Lands and Natural Resources, Accra.
- MLNR (2019), *Voluntary National Report to the United Nations Forum on Forests*, Ministry of Lands and Natural Resources, Ghana.
- Mongabay (2020), "Ghana forest information data", Mongabay Forest Information, available at: <https://rainforests.mongabay.com/deforestation/2000/Ghana.htm>.
- Nzayisenga, E. and Zhu, Y. (2020), "The import trade forecasting model based on PCA: evidence from Rwanda", *Open Journal of Statistics*, Vol. 10, pp. 678-693.
- O'Brien, M. and Bringezu, S. (2018), "European timber consumption: developing a method to account for timber flows and the EU's global forest footprint", *Ecological Economics*, Vol. 147, pp. 322-332.
- Owusu, J.H. (2008), "New trends in Ghana's domestic & international timber trade: some implications for local livelihoods and sustainable forest management", *Workshop on Forest Governance & Decentralization in Africa*, April 2008, Durban, pp. 8-11.
- Pepke, E., Brusselen, J.V. and Tegegene, Y.T. (2016), "Timber trade flows and investments between China and six voluntary partnership agreement signatory countries", EFI Report.
- Richard, R. (2020), *Global Timber Outlook*, Gresham House.
- State Forestry Administration (2018), *China Forestry Statistical Yearbook*, China Forestry Publishing House.
- Sun, X. (2014), "Forest products trade between China and Africa: an analysis of import and export statistics", *Forest Trends Report Series*, pp. 12-19.
- TIDD (2015), "2015 cumulative export performance – fourth quarter", Forestry Commission.
- TIDD (2017a), "Report on export of timber and wood products", Forestry Commission, December 2017.
- TIDD (2017b), "Report on export of wood products 1997-2017", Forestry Commission.
- Timber Trade Portal (2020), "Gateway to international timbertrade", *Timber Trade Portal*, available at: <https://www.timbertradeportal.com/countries/ghana/>

- Twamugize, G., Xuegong, Z. and Rmadhani, A.A. (2017), "The effect of exchange rate fluctuation on international trade in Rwanda", *IOSR Journal of Economics and Finance*, Vol. 8, pp. 82-91.
- Wang, J. (2016), "Analysis of the factors influencing Japan's soybean import trade: based on gravity model", *American Journal of Industrial and Business Management*, Vol. 6, pp. 109-116.
- Weng, X., Putzel, L., Kandulu, M.M., Ekman, S.M.S., Zafinikamia, M.L.B., Assembe-Mvondo, S., Cerutti, P.O. and Lescuyer, G. (2014), "The Africa-China timber trade: diverse business models call for specialized policy responses", Center for International Forestry Research, CIFOR.
- World Bank (2022), "Official exchange rate - Ghana", World Bank Exchange Data base, available at: [https://data.worldbank.org/indicator/PA.NUS.FCRF?locations=GH&name\\_desc=true](https://data.worldbank.org/indicator/PA.NUS.FCRF?locations=GH&name_desc=true).
- Zhang, S., Dai, Y. and Lai, Y. (2019), "Empirical analysis on the influencing factors of China's total foreign trade", *Journal of Applied Mathematics and Physics*, Vol. 7, pp. 1421-1428.

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