Export Efficiency and Diversification in Ghana

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Export Efficiency and Diversification in Ghana

By

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Abstract

Ghana needs to expand its export base in order to generate sufficient foreign exchange earnings for economic transformation. There is, therefore, a need to examine the efficiency of the existing export basket and explore new products to add to it. This study employs the stochastic frontier gravity model to investigate the efficiency of bilateral exports of Ghana using a panel of 44 export destination countries for the period 2000 to 2018. In addition, a product space analysis is carried out to ascertain which other products Ghana has to diversify into in order to engender the transformation required for the attainment of Sustainable Development Goal 8. As a third objective, the study investigates the extent to which Ghana can leverage the African continental free trade area for its diversification agenda. The study finds that Ghana's bilateral export trade is inefficient, implying huge potential exists. It further reveals that Ghana's economic complexity is low, leading to the production and export of primary commodities. Moreover, the African continental free trade area offers an opportunity for Ghana to crystalise its export diversification drive. It is recommended that Ghana takes advantage of its membership of trade blocs to negotiate access to foreign markets, improve on logistics, enhance macroeconomic stability, step up vocational and technical education, and increase investment in land and reliable, cheap electricity in order to grow its exports.

Keywords: Export diversification, export efficiency, product space, Ghana

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1. Introduction

1.1 Background to study and research problem

Exports have become one of the channels through which most countries have integrated into the international market. Along with providing direct employment, income and foreign exchange for the exporting countries, exports allow countries to ameliorate the impact of the developmental challenge of small domestic markets on productivity by exposing these countries to the global market with huge economies of scale, increased capacity utilisation, transfer of technology, managerial skills, productivity gains and greater product variety. Thus, harnessing export potential could offer countries the opportunity to attain Sustainable Development Goal (SDG) 8; economic growth and decent jobs (International Trade Centre, 2018). The downsides of openness, however, are that countries become vulnerable to external shocks and suffer terms-of-trade shocks with adverse implications for macroeconomic targets and economic growth (UNCTAD, 2012; Cavalcanti et al., 2011).

With the support of the IMF and the World Bank, Ghana carried out economic reforms in the early 1980s. Pivotal to the economic reforms was trade liberalisation and tariff reforms. The trade and tariff reforms took the form of gradual removal of quantitative restrictions and reduction of the level and range of tariffs. In addition, the exchange rate was transformed from a fixed regime through auction to the current managed-floating regime. Furthermore, diversification of the export base was vigorously pursued with the introduction of a wide range of non-traditional exports. International competitiveness improved as a result, and exporters of non-traditional exports took advantage of it by expanding exports (Jebuni et al., 1992).

In addition to having one of the most liberalised economies in Africa (ECA, 2004), Ghana has also signed the interim Economic Partnership Agreement (iEPA) with the EU and the African, Caribbean and Pacific (ACP) countries, as well as the African Continental Free Trade Area (AfCFTA) agreement. Ghana is also a member of the Economic Community of West African States (ECOWAS) and the West African Monetary Zone (WAMZ). This illustrates Ghana's subscription to regional and multilateral trade agreements. The AfCFTA, the most recent trade agreement in Africa, has a potential market of 1.2 billion people, and a cumulative GDP of more than US$3.4 trillion. It is projected to lead to increased growth of 52% in intra-Africa trade from 2020 to 2022 (Cazares, 2018). It would be interesting to find out how these trade blocs, especially the AfCFTA, affect export growth and the products for export diversification in Ghana.

In spite of all these developments, Ghana has not made much progress with exports over the years. In fact, Ghana's export intensity has decreased continuously from 2013 as captured in Table 1. The trade balance has been in deficit over the years, with the exception of 2017 and 2018 as shown in Table 1. Moreover, Ghana was unable to meet the US$5 billion target set for non-traditional export earnings in the 2012 National Export Strategy Programme (Ministry of Trade and Industry, 2012). Available evidence shows that earnings from non-traditional exports increased from US$2.44 billion in 2013 to US$2.8 billion in 2020. The new National Export Development Strategy, which is set to run from 2020 to 2029 is envisaged to raise non-traditional export earnings to U$25.3 billion in 2029 (GEPA, 2020). It is evident that the old export structure dominated by primary commodities is not sustainable. Ghana needs scalable export transformation to promote sustainable growth, but the question is how must this be approached? That is, must Ghana continue with the diversification taking place within the old export structure, that is, adding value to existing raw materials or primary products, or should entirely new products (and markets) be found?

Table 1: Trends in merchandise exports and imports for Ghana, 2010–2018 (US$ million)

Year	Merchandise exports	Merchandise imports	Trade balance	Export/GDP (%)
2010	7977.29	10769.79	-2792.50	34.2
2011	12772.73	15837.74	-3065.01	43.7
2012	13552.34	17752.46	-4200.11	44.7
2013	13751.92	17600.37	-3848.43	39.8
2014	13216.77	14600.20	-1383.43	34.3
2015	10321.32	13465.16	-3143.82	28.0
2016	11138.37	12920.10	-1781.77	25.8
2017	13835.01	12647.36	1187.65	23.5
2018	14942.71	13134.06	1808.65	22.8

Source: Author's computation using data from Bank of Ghana, 2021.

It is an established fact that export growth emanates from expansion in the existing export basket (Helpman et al., 2008; Besedes and Prusa, 2007) as well as the introduction of new export products (Hummels and Klenow, 2005; Amurgo-Pacheco and Pierola, 2008). Unravelling the mystery surrounding Ghana's poor export performance requires taking a critical look at the efficiency of the existing export structure and also scouting for new products to augment the export basket. Export efficiency refers to how much of the export potential of a country is being exploited (Deluna and Cruz, 2013) while export diversification involves either exporting new products to existing markets or new markets, or an existing product to a new destination (Amurgo-Pacheco and Pierola, 2008). For the purpose of this study, export diversification encompasses identifying and exporting new products, with high potential for transforming an economy, to the same or new markets.

To the best of the author's knowledge, no country-specific study has been done for Ghana. Related export efficiency studies identified include Kumah (2017) and

Adam and Tweneboah (2009), while Chandra and Osorio-Rodarte (2007) carried out a product space analysis (PSA) for Ghana. Kumah (2017) studied the level of trade integration in the WAMZ zone. The author employed the Stochastic Frontier Gravity Model (SFGM) to investigate the export efficiencies of the member countries of WAMZ, which included Ghana. In the case of Adam and Tweneboah (2009), the authors employed the traditional gravity model to predict the trade potential of Ghana's trading partners. Chandra and Osorio-Rodarte (2007) carried out a PSA for Ghana and identified agro-processing as short to medium term, and wood and metal manufacturing as long-term diversification strategies. The difference between these studies and the current study is that the current study utilises current datasets to estimate the efficiency of the bilateral exports of 44 major export destination countries for the period 2000–2018 and explores new export products that Ghana can diversify into using the SFGM and the PSA, respectively. It is worth noting that the SFGM is more efficient than a traditional gravity model because it addresses internal and external frictions to export, and the product space analysis gives an indication of the potential of new products a country can add to its export basket given the current export structure. This study filled the gap in the empirical literature by answering the following research questions: First, what is the level of efficiency of Ghana's bilateral exports? Second, what new products must Ghana diversify towards? Third, what role can the AfCFTA play in Ghana's export diversification drive? The uniqueness of this study lies in the fact that it is the first to combine export efficiency with an actual determination of products for diversification for Ghana.

1.2 Objectives of the study

The main objective of the study is to analyse the efficiency and diversification of Ghana's exports. The specific objectives of the study are to:

i. estimate the efficiency levels of bilateral exports of Ghana relative to each destination country;
ii. conduct a product space analysis for Ghana; and
iii. investigate how Ghana can leverage the AfCFTA in its export diversification drive.

2. Literature Review

The SFGM has been used for country-specific, regional, trade agreement, bilateral and counterfactual studies as seen in the examples below.

In a study on the bilateral export efficiency and potential of the Philippines and its trading partners over the period 2009–2012, Deluna and Cruz (2013) used the SFGM. The results indicate that export performance is influenced by income, market size of the trading partner, and distance. The level of efficiency between the Philippines and its trading partners ranged from 38% to 42%, indicating that inefficiency in the former's exports is quite high. The results further show that the Philippine's membership of trading blocs like the Association of Southeast Asian Nations (ASEAN), the Asia-Pacific Economic Cooperation (APEC) and the World Trade Organization (WTO), reduction of corruption with freer labour market conditions in the importing country, and using a common language reduce export inefficiency.

Other country-specific studies only looked at the determinants of export performance and efficiency. Much as these studies can determine how well a country is doing in terms of reaching its optimum, they do not provide information on the determinants of the inefficiency. An example is Hassan (2017), who examined the determinants of export performance and level of efficiency of Bangladesh's bilateral trade with 40 trading partners. Using panel data for the period 2008–2011 and the SFGM and likelihood estimation technique, the author found that GDP, population, trade agreements and exchange-rate depreciation positively affect exports, but the distance between Bangladesh and its partner countries and tariff levels negatively influence trade. The results further show that socio-political-institutional "behind-the-border" constraints, such as customs procedures, port inefficiencies and corruption, reduce trade. Finally, the results show that there is a high level of untapped export potential that can be realized by removing the behind-the-border constraints and by integrating more efficiently into the international market.

In a related country-specific study, Miankhel et al. (2009) used the SFGM and disaggregated trade panel data for the period 2007–2008 to estimate the trade potential of Australia with 65 of its trading partners. The results show wide variations in Australia's attainment of its trade potential with the various countries.

The SFGM has also been employed for commodity/service-specific country studies, such as those by Barma (2017), Nasir and Kalirajan (2014) and Atif et al. (2017). Barma (2017) investigated the efficiency of India's agricultural bilateral exports to 112 trading

partners for the period 2000–2013. Using panel data and the stochastic frontier gravity model and maximum likelihood estimation, the author found that India's bilateral agricultural exports are positively influenced by GDP, population and business freedom but it is negatively affected by distance and being landlocked, the real exchange rate and trade freedom, and freedom from corruption. Finally, agricultural export efficiency was shown to vary widely between trading partners, regions and trading blocs. Nasir and Kalirajan (2014) employed the stochastic frontier gravity model and maximum likelihood estimation technique to estimate the performances of emerging and developed Asian economies in selected modern services. The results show that emerging economies in South Asia and the ASEAN trailed the developed economies in North America and Europe in terms of export efficiency, and that the number of graduates and quality of ICT infrastructure are the drivers of efficiency. Atif et al. (2017) also used the stochastic frontier gravity model and maximum likelihood estimation technique to estimate the determinants and potential of agricultural exports of Pakistan to its trading partners from 1995 to 2014. The results indicate that exchange rate, tariff rates, common border, common culture, colonial history and preferential trading agreements were the drivers of agriculture exports and that great potential exists between Pakistan and the neighbouring Middle Eastern and European countries. These studies only consider the trade potential of the countries, but they are silent on the causes of the level of inefficiencies observed.

Boonyakunakorn et al. (2018) used a copula-based stochastic frontier gravity model that allows the inefficiency of the previous period to influence current inefficiency to investigate the effects of the ASEAN trade area on Thailand's exports. The results indicate that Thailand was not taking full advantage of the ASEAN trade area.

Studies on regional blocs within the framework of the SFGM have also been undertaken. An example is the study by Stack et al. (2018), who researched the efficiency of bilateral trade from 18 Western European countries to 13 new European Union (EU) member countries. Using a panel of actual bilateral trade from EU members to new EU members over the period 1995–2016 and projected data for 2017 - 2022 and using a stochastic frontier gravity model and maximum likelihood estimation technique, the results show that income, per capita income differential, common border, common language, colonial ties and regional integration influenced trade positively, but distance and being landlocked reduced trade. The results further show a high trade integration of new member states. In an earlier, related study, Ravishankar and Stack (2014) used the SFGM approach and maximum likelihood estimation technique to investigate the efficiency of exports from 17 Western European countries to the 10 new EU member countries for the period 1994–2007. The high efficiency scores show that there is high trade integration among the EU member countries and their Western Europe counterparts with the exception pf Greece, Iceland, Norway and the United Kingdom.

In a related regional trade area study, Bhattacharya and Das (2014) employed the SFGM and panel data for the period 1995–2008 to estimate the trade efficiency

levels among the six countries forming the South Asian Association for Regional Cooperation (SAARC): Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. The results showed that Pakistan exploited the greatest portion of its trade potential with the other countries, while India had taken advantage of the least of its trade potential with the other countries.

Kalirajan and Paudel (2015) used the SFGM and export panel data for the period 1995–2010, the maximum likelihood estimation technique and a counterfactual approach to analyse a free trade agreement for India and China. The results show that at the prevailing tariff and exchange rates, India achieved 68% of its export potential with China, while China covered 86% of its export potential with India. Complete removal of the tariff raised the export potential of China and India by 20% and 28%, respectively. Earlier, Drysdale at al. (2000) carried out a study on the bilateral trade efficiency of China. Using a panel data of exports and imports of China and 57 of its trading partners, and the SFGM framework and the maximum likelihood estimation technique, the authors found that China's trade efficiency was lower than the average for the group. The study also revealed that economic freedom in China and its trading partner countries enhance trade efficiency.

A recent study by Hong and Ngoc (2017) on the effect of the ASEAN Free Trade Agreement on Vietnam's trade efficiency indicates that ASEAN membership contributes positively to Vietnam's trade efficiency, tariffs negatively influenced trade efficiency and that the trading partners' economic freedom significantly raised trade efficiency, diminishing the gap between actual and potential trade. The study further identified varying trade efficiencies for both the EU and the North American Free Trade Agreement (NAFTA), and concluded that Vietnam's trade with those countries surveyed could grow substantially if man-made barriers to trade could be removed.

In their study on the impact of competitiveness on Asian countries' trade efficiency, Demir et al. (2017) used the stochastic frontier gravity model. Their results indicate that gross domestic product (GDP), population, distance, contiguity, common official language, common colonizer, free trade agreements, global financial crisis and competiveness significantly influence trade. The authors suggest that countries should improve their production technology by increasing research and development expenditures and human capital to obtain stronger comparative advantages in their exports.

For the West African sub-region, Kumah (2017) used the SFGM to investigate the trade efficiency of the West African Monetary Zone (WAMZ). He specifically examined the level of trade integration between member counties of the WAMZ. Using panel data of exports for 45 countries over the period 2000–2014 and employing the Battese and Coelli (1988) and Kumbhakar (1990) models, the author found that trade between member countries of the monetary zone is very low, implying that there is huge trade potential within the zone.

The trade literature suggests that a better logistics system reduces trade costs and promotes international trade. Recent studies that used the World Bank logistics performance index, such as those by Martí et al. (2014), Gani (2017) and Çelebi

(2019), have confirmed the positive effect of logistics on trade flows. Similarly, macroeconomic instability (inflation) makes exports uncompetitive and so reduces trade flows (Irshad et al., 2018).

Studies using the SFGM framework for Ghana are scarce. The closest study is the one by Adam and Tweneboah (2009), where the authors used the traditional gravity model estimated with ordinary least squares (OLS) to predict the trade potential of Ghana with its major trading partners. The results show that high potential for trade exists between Ghana, Nigeria and Guinea. The weaknesses of this study are that the trade potential was estimated using the mean effect of the determinants of trade included in the gravity model, and that unobserved trade resistance and multilateral trade resistance between Ghana and its trading partners were not controlled for. These challenges raise doubts about the efficiency of their results (Kumah, 2017).

With the exception of the study by Deluna and Cruz (2013), none of the studies reviewed looked at the drivers of bilateral export inefficiency. In addition, none of the studies focused on Ghana. The current study will, therefore, contribute to the empirical literature by estimating the level of bilateral export efficiency using current bilateral export panel data and the SFGM framework. An advantage of the SFGM over the traditional gravity model is its ability to make the empirical estimation of trade potential more consistent with the theoretical conceptualization of trade potential (Kumah, 2017).

The application of the product space methodology is manifold in the extant literature. While in some instances it has been used directly to study the export diversification potential of countries, in other cases it has been applied to analyse economic transformation through export diversification. As an example of the former, Jankowska et al. (2012) compared Asian and Latin American export experiences. Hausmann et al. (2010) studied export diversification in Algeria, Hausmann et al. (2014) examined export diversification in Uganda and Hausmann and Chauvin (2015) explored export diversification in Rwanda. Bogetic et al. (2013), De La Cruz and Riker (2012) and Chandra and Osorio-Rodarte (2007) employed the framework in studying export diversification in Montenegro, Brazil and Ghana, respectively. Baah-Boateng and Twum (2019); Oira et al. (2091); Golub et al. (2019) and Bhorat et al. (2019) utilised the economic complexity framework to identify products that Ghana, Kenya, Senegal and South Africa, respectively, should diversify towards to create jobs for women and the youth. In a recent study, Tou (undated) employed the product space framework to assess the potential benefits of the East African Community to the member countries.

Hausmann and Klinger (2006, 2007, 2008 and 2009) studied structural transformation through export diversification in South Africa, Chile, Colombia, and several Caribbean nations. Similarly, Hidalgo (2011) studied the industrial opportunities of five countries in eastern and southern Africa. Abdon and Felipe (2011) studied the opportunities for growth and structural transformation in sub-Saharan Africa. Felipe, Kumar, and Abdon (2013) and Singh et al. (2018) applied the methodology to exports and industrial policy in India, and Felipe, Kumar, Usui, and Abdon (2013) applied the methodology to China.

3. Methodology

This section of the study focuses on the methods that were employed. In order to address the first objective of the study, a theoretical framework and an empirical model with a detailed description of the variables of interest are presented. This is followed by a description of the framework that was employed to implement objectives two and three.

3.1 Methodology for Export Efficiency

Export flows between countries are constrained mainly by three factors: (a) natural constraints, which are geographical distance and transport cost; (b) "behind-the-border" constraints, which are institutional and infrastructural rigidities that exist in exporting countries; and (c) "beyond-the-border" constraints, which are institutional and infrastructural rigidities that exist in importing countries. The impact of the beyond-the-border constraints can be divided into two groups, namely, "explicit beyond-the-border" constraints and "implicit beyond-the-boarder" constraints. Beyond-the-border constraints which are explicit are mainly tariffs and exchange rate. Conversely, it is very difficult to identify and measure implicit beyond-the-border constraints that emanate from institutional and policy rigidities of importing countries; they are usually considered as a "given" and generally not country-specific. In the absence of these constraints, exporting countries will reap their export potential (Khan and Kalirajan, 2011; Bhattacharya and Das, 2014).

The formal presentation of the above theoretical structure following Kalirajan (2007), which is an adoption of the SFGM developed by Aigner et al. (1977) and Meeusen and Broeck (1977) is as follows:

$$\mathbf{Exp_{ijt}} = f(\chi_{ijt}, \beta)\exp(-\varepsilon_{ijt} + v_{ijt}) \quad (1)$$

where $\mathbf{Exp_{ijt}}$ is bilateral exports between the country and trading partners; χ_{iit} is the arguments of potential bilateral exports; v_{ijt} is the random error term and $-\varepsilon_{ijt}$ = (0, 1) is the level of inefficiency in bilateral exports. It is assumed that ε_{ijt} follows a truncated (at 0) normal distribution, with mean "mu" and constant variance. When $-\varepsilon_{ijt}$ = 0, bilateral export is optimal. When $-\varepsilon_{ijt} > 0 < 1$, it means actual bilateral

export is less than potential export, implying that behind-the-border factors are hindering exports from attaining export frontier.

Employing the definition of exports efficiency as the ratio of realised exports and the potential export, we are able to measure efficiency as follows:

$$EE_{it} = \frac{\ln f(lnx_{ijt};\beta)exp(-\varepsilon_{ijt}+v_{ijt})}{lnf(lnx_{ijt};\beta)exp(v_{ijt})} = exp(-\varepsilon_{ijt}) \quad (2)$$

where EE_{it} is export efficiency and all other variables are as defined earlier. Following from that, the export inefficiency is expressed as:

$$\varepsilon_{ijt} = f(\Omega_{ijt}, \partial) + \mu_{ijt} \quad (3)$$

In Equation 3, ε_{ijt} is the inefficiency in exports; Ω_{ijt} is the behind-the-border constraints; ∂ refers to parameters to be estimated; and μ_{ijt} is the error term.

To test for the robustness of the stochastic frontier model, we estimated the gamma coefficient as specified in Equation 4.

$$\gamma = \frac{\sigma_\varepsilon^2}{(\sigma_\varepsilon^2+\sigma_v^2)} \quad (4)$$

The gamma coefficient (γ) indicates whether behind-the-border constraints are one of the determinants of Ghana's bilateral exports, and also serves as a robustness test for the stochastic frontier gravity model given in Equation 1. When γ is significant, it means that behind-the-border constraints are important determinants of Ghana's bilateral exports. In other words, the significant gamma signifies that the effect of behind-the-border constraints are responsible for the gap between potential and actual exports. In addition to the gamma serving as a robustness test, we estimated the likelihood ratio test statistics as suggested by Kumbhakar et al. (2015). The statistics of the likelihood ratio test were determined from Equation 5.

$$\lambda = -2\{ln[L(H_o)] - ln[L(H_1)]\} \quad (5)$$

where $L(H_0)$ is the restricted model computed from OLS, and $L(H_1)$ represents the unrestricted model estimated from the stochastic frontier. $L(H_0)$ and $L(H_1)$ are the values of the log-likelihood under the null and alternative hypotheses, H_0; there are no export inefficiencies and with H_1: there are export inefficiencies. The computed value of lambda (λ) was then compared with the mixed distribution of critical values obtained from Kodde and Palm, 1986.

3.2 Empirical Model

The implementation of objective one of the study required estimating concurrently the empirical stochastic frontier gravity model (Equation 6.1) and the export inefficiency model (Equation 6.2).

$$InExport_{ijt} = \alpha_0 + \alpha_1 lnGDP_{it} + \alpha_2 lnGDP_{jt} + \alpha_3 lnPopulation_{jt} + \alpha_4 lnDistance_{ijt} + v_{ijt} - \varepsilon_{ijt} \quad (6.1)$$

The combined effects of the behind-the-border constraints can be modelled as a random variable, 'ε', which is added to Equation 6.1. 'ε' takes values between 0 and 1 and it is usually assumed to follow a truncated (at 0) normal distribution, with mean "mu" and constant variance. When ε takes the value 0, it means that the influence of behind-the-border constraints are not important and the actual exports and potential are the same, assuming there are no statistical errors. When ε takes a value other than 0 (but less than or equal to 1), it means that the influence of behind-the-border constraints are important and that they constrain actual exports from reaching its potential level. Thus, the term 'ε', which is bilateral and observation-specific, represents the influence of the combined effects of behind-the-border constraints. A double-sided error term v, which is usually assumed to be with zero mean and constant variance, is added to gravity Equation 6.1 to capture the influence on export flows of implicit beyond-the-border constraints and other left out variables, including measurement errors that are randomly distributed across observations in the sample.

$$EInef = [\gamma_1 ECOWAS_{jt} + \gamma_2 EU_{jt} + \gamma_3 WTO_{jt} + \gamma_4 LANG_{jt} + \gamma_5 Landlocked_{jt} + \gamma_6 Logistics_{ijt} + \gamma_7 (1 + Tariffs_{ij}) + \gamma_8 Inflation + \gamma_9 \ Economic\ Freedom + w] \quad (6.2)$$

where $\mathbf{Export_{ij}}$ represents the disaggregated bilateral exports of Ghana to its trading partners, $EInef$ is export inefficiency, $\mathbf{GDPit}$ is the GDP of Ghana while $\mathbf{GDPjt}$ is the GDP for country j at time t; $Population_{jt}$ is the population of country j at time t and $Distance_{ijt}$ refers to geographical distance between the capital cities of country i and j measured in kilometers, ω_{ijt} is the random error term, and ℓn denotes natural logarithm. ECOWAS, iEPA, WTO indicates importing country belongs to a trade bloc. LANG shows that importing country speaks the same official language as Ghana. Landlocked means importing country is landlocked; tariff is the ad valorem tariff imposed on imports by the importing country , Logistics is the Logistic Performance Index of the World Bank, inflation represents macroeconomic instability, and economic freedom refers to the right to own and dispose of property in a country.

After the parameter estimates of the frontier model in Equation 6.1 have been obtained, we achieved objective one by predicting the point estimate of the export efficiency using the post-estimation command developed in Stata by Battese and Coelli (1988) as specified in Equation 2.

3.3 Methodology for Product Space Analysis

The Product Space (PS) methodology is the outcome of a number of studies by Hausmann, Hwang and Rodrik (2007), Hausmann and Klinger (2006, 2007) and Hildalgo et al. (2007). The framework hinges on the interconnectedness between pairs of products. Countries that produce and export advanced products continue to produce and export modern products and they grow faster than those that produce and export less sophisticated products. Due to the similarities in the skill set, and institutional, infrastructural and technological demands, related products are easier to produce and export. Countries with the ability will, therefore, produce and export a wide variety of sophisticated products that will not be common (Hidalgo and Hausmann, 2009).

For the formal presentation of the theory and mathematical equations of the product space analysis refer to Hausmann and Klinger (2007).

3.4 Data Sources

The data for the export efficiency are a balanced panel of 44 countries (Annex D) Ghana traded with for the period 2000–2018. Data availability informed the choice of the study period. Yearly disaggregated bilateral exports were used to avoid the problem of aggregation that earlier studies faced for using aggregate export data. The data on disaggregated bilateral exports of Ghana to trading partners based on the international standard industrial classification and ad valorem tariff rates were sourced from the World Integrated Trade Solution (WITS), while data on Ghana's GDP, GDP of the trading partners and population of the trading countries of the trading partners and inflation rate were obtained from the World Development Indicators database of the World Bank. Also, the data on distance, common language, colonial links, and being landlocked were sourced from Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). Data on economic freedom were obtained from the Heritage Foundation database (2020). Finally, data on logistics performance index were collected from the World Bank's Logistics Performance Index database.

For the product space analysis, an unbalanced world dataset of yearly disaggregated exports and imports as well as measures of the economic complexity index (ECI), product complexity index (PCI), revealed comparative advantage (RCA), distance, and opportunity gain at the Harmonized System (HS) 4-digit classification level for 1,240 products for the periods 2000 and 2018 were sourced from the MIT Observatory of Economic Complexity and the Harvard Atlas of Economic Complexity websites.

3.5 Estimation Strategies

Informed by the works of Kalirajan and Paudel (2015), Ravishankar and Stack (2014) and Atif et al. (2017) this study used the maximum likelihood estimation technique for the stochastic frontier analysis for the very reason that it is unique when the OLS residuals have the appropriate skewness. It is a well-known statistical technique used for fitting a mathematical model to reflect real world data. The maximum likelihood estimates of an unknown parameter can be described as the value of the parameter that maximises the prospects of randomly representing a specific sample of observations. The maximisation of the likelihood function involves an iterative optimisation procedure entailing the selection of starting values for the unknown parameters and comprehensively upgrading and revising them until the values that maximise the log-likelihood function are identified. A routine solution for the stochastic frontier estimates emerges that differs from, and is better than, OLS estimates. The estimation technique for the stochastic frontier gravity model provides superior estimates of efficiency because it helps to examine changes in export efficiencies over time in addition to underlying export potential.

The suitability of the stochastic frontier gravity analysis was tested by conducting a test on the least square residuals to confirm the presence or otherwise of negative skewness. A confirmation of negative skewness in the least square residuals indicated that the application of the stochastic frontier gravity analysis was appropriate. All the estimations were done using Stata.

With respect to the product space analysis, we first determined Ghana's current position in the product space using goods it exports for which it has an RCA of more than one. We then ascertained what products it has the potential to diversify towards given its current position in the product space and leveraging the AfCFTA.

4. Results

This section of the report presents the empirical results. The results discussed are the descriptive statistics, the frontier model, export inefficiency model, export efficiency scores, product space analysis, identification of potential products for diversification and the role of AfCFTA in the selection of Ghana's products for diversification.

4.2 Descriptive Statistics

The descriptive statistics of the variables used in this study are presented in Table A1 (Annex A). The table reveals that, on average, Ghana exported agriculture, forestry, and fishery commodities worth US$30,889.98 million with a minimum of US$0.044 million and a maximum of US$1,070,000 million over the study period.

Ghana exported an average of about US$43,903.32 million in mineral commodities. The mean amount of manufactured goods exported by Ghana is approximately US$23,230 million and that of manufactured goods not identified by kind is US$70,936.65 million. The average amount of other commodities exported by Ghana is worth US$638.652 million. This implies that, on average, manufactured goods not identified by kind were the most exported goods by Ghana. The various standard deviations of the commodities exported are greater than their means, which implies that the data points are spread over a wider range of values.

Moreover, the average GDP of Ghana for the period is about US$31.7 billion, while that of its partner countries stood at an average of approximately US$1.1 trillion. The minimum and maximum values of Ghana's GDP are approximately US$5 billion and US$65.6 billion, respectively. The minimum and maximum values of the partners' GDP are approximately US$487 million and US$2 trillion, respectively.

For the entire study period, Ghana's mean population was approximately 24.3 million people as compared to about 100 million people of its trading partners. Results show that the mean distance of all trading partners was about 5,864.057 km from Ghana. This implies that goods traded by Ghana travel an average distance of 5,864.057 km to its partner countries.

The descriptive results reveal that the mean score of Ghana's economic freedom is approximately 6.7 whiles that of its trading partners is approximately 7.2. This means that, on average, Ghana's trading partners are more economically free nations. Inflation in Ghana averages about 13.1, with minimum and maximum values of about

7.1 and 19.3, respectively. The mean logistics performance index of Ghana is 2.22 while the mean logistics index of its trading partners is 3.3. This implies that goods are easier and more efficiently moved to Ghana's partner trading countries.

Finally, the statistics revealed that the average tariff rate on agricultural, forestry and fishery commodities is about 8.1, with a lowest value of -90 and a highest value of 176.72. The mean tariff of mineral goods is valued at about 20.7, with a minimum of -21.99 and a maximum of 110. Also, the mean tariff of manufactured goods is 12.7, with a highest value of 28.3 and a lowest value of about -4.54. Manufactured goods not identified by kind, has a mean tariff of 8.1 with a minimum of -11.2 and a maximum of approximately 20 and 17.8. The mean tariff on other products is about 17.8 with a minimum of -28.3 and a maximum of 40. This implies that, on average, high tariffs are imposed on mineral goods whilst lower tariffs are imposed on agriculture, forestry, fishery commodities and manufactured commodities.

4.3 Estimation results for frontier model

The stochastic frontier gravity model and the inefficiency model (Equations 6.1 and 6.2) were estimated together using the maximum likelihood estimation (MLE). The model parameter estimates of the frontier and inefficiency are reported in Table B1 (Annex B). Generally, most variable estimates have the expected signs and are statistically significant.

As expected, the GDP of both the exporting country and the trading partners have a significant impact on the exports of Ghana. Except for export of agriculture, forestry and fishery products, the GDP of the exporting country has a significant effect on mineral commodities, manufactured commodities, manufactured commodities not identified by kind, and other commodities. In particular, manufactured commodities and manufactured commodities not identified by kind are highly significant and heavily dependent on the GDP of the exporting country. Also, the GDP of its trading partners has a greater impact on the exports of manufactured commodities, mineral commodities, and agricultural, forestry and fishery products. However, the exports of manufactured commodities and mineral commodities are more dependent on the GDP of its trading partners relative to agricultural, forestry and fishery products. This result confirms the findings of Deluna and Cruz (2013), Hassan (2017), Berma (2017), Nasir and Kalirajan (2014) and Atif et al. (2017).

Distance is statistically significant and negative as expected from the gravity model. The highly significant and negative coefficient for the distance variable suggests that the greater the distance between the two countries, the less likely they will trade. The distance variable proxies mainly for transportation costs where, due to higher transportation costs involved in the movement of goods and services, a country trades less with distant countries. From the results in Table B1, the exports of manufactured commodities not identified by kind, mineral commodities, and manufactured commodities are very responsive to the distance parameter. However, manufactured commodities not identified by kind are the most responsive to distance,

while agricultural, forestry and fishery products are less responsive to distance. The negative role played by distance in Ghana's exports to its trading partners validates the results of Deluna and Cruz (2013) and Hassan (2017).

The population of trading partners has a significant impact on all export categories except for other commodities. The impact of population of the trading partner has a positive impact on the exports of agricultural, forestry and fishery products, mineral commodities, manufactured commodities, and manufactured commodities not identified by kind. However, the impact of population is greatest on exports of agricultural, forestry and fishery products. Intuitively, a rise in the importing country's population engenders greater demand for imports to feed the growing population. This finding supports those of Barma (2017) and Hassan (2017).

4.5 Export Inefficiency Model

From the export inefficiency results presented in Table B1, membership of ECOWAS, WTO and the EU has a significant effect on some export categories. Ghana's membership of ECOWAS significantly reduces its inefficiency in the exports of agricultural, forestry and fishery products, mineral commodities, and manufactured commodities by 4.395, 2.786, and 9.295 units, respectively, at a 1 per cent level of significance. Similarly, Ghana's membership of WTO reduces its export inefficiency of agricultural, forestry and fishery products by 4.361 units at a 10 per cent level of significance. Relatedly, Ghana's exports to EU member countries reduce its export inefficiency of agricultural, forestry and fishery products, mineral products, and manufactured products not identified by kind by 3.518, 3.014, and 1.969 units, respectively. The coefficients are significant at 1 per cent for all three commodities. This result is consistent with the findings of Deluna and Cruz (2013) who find that Philippine's membership of a regional trade agreement decreases the export inefficiency of its export flow to trading partners.

The study also included specific characteristics of trading partners such as language and being landlocked. Language was found to be a significant factor that decreases export inefficiency of only manufactured commodities and manufactured commodities not identified by kind by 1.786 and 1.776 units, respectively, and is highly significant at a 1 per cent significance level. Language's negative and statistically significant coefficient implies that reduced barriers to communication between trading partners enhances efficiency of exports. This result supports the finding of Ravishankar and Stack (2014) who conclude that a common language significantly enhances bilateral trade flows, but contrasts with Deluna and Cruz (2013), for the Philippines.

As expected, the coefficient of the landlocked dummy is positive and significant in increasing export inefficiency of all export categories except for other commodities. The geographic feature of being landlocked lowers trade primarily because of lack of access to the sea, which tends to increase the cost of transportation. This finding confirms the findings of Ravishankar and Stack (2014).

The results in Table B1 further show that the logistics performance index of both exporter and trading partner has a statistically significant negative effect on the export inefficiency of agricultural, forestry and fishery products, manufactured commodities, manufactured commodities not identified by kind, and other commodities. The statistically negative effect of logistics performance index of both exporter and importer highlights logistics as an important determinant of export efficiency as improved trade related logistics facilitate more trade, thereby confirming the findings of Martí et al. (2014), Gani (2017) and Çelebi (2019).

As expected, the inflation rate of the exporting country has a positive effect on the exports of all export categories. However, the inflation rate has a statistically significant effect in increasing the export inefficiencies of only agricultural, forestry and fishery products, and manufactured commodities not identified by kind, with the latter more dependent on the rate of inflation. A unit increase in the rate of inflation would increase the export inefficiency of manufactured commodities not identified by kind by 0.160 units, and this coefficient is significant at a level of 1 per cent. For agricultural, forestry and fishery products, a unit increase in inflation raises its export inefficiency by 0.198, and it is statistically significant at a 5 per cent level of significance. This finding corroborates that of Irshad et al. (2018).

This study included an economic freedom index, which measures the degree of economic freedom that covers five major areas namely: size of government; legal system and security of property rights; sound money; freedom to trade internationally; and regulation. As expected, the coefficients for economic freedom in both exporting and importing countries have a negative impact on the export inefficiencies of all five export commodities. However, economic freedom appeared to be insignificant for some export categories. The exporting country's economic freedom has a significant effect in reducing the inefficiency of only the exports of manufactured commodities identified by kind. A unit improvement in the freedom score of the exporting country would reduce the inefficiency of its export of manufactured commodities not identified by kind by 2.877 units. The economic freedom of the importing country has a significant impact on reducing the export inefficiencies of four export categories, namely agricultural, forestry and fishery products; mineral commodities; manufactured commodities; and other commodities. However, the impact is greatest on the exports of manufactured commodities and other commodities. A unit improvement in the importer's economic freedom would result in a decrease in the export inefficiency of manufactured commodities and other commodities by 1.664 and 0.387 units, respectively. Both are highly significant at a level of 1 per cent. For mineral commodities and agricultural, forestry and fishery products, an improvement in the importer's economic freedom would reduce its export inefficiencies by 1.828 and 1.441 units, respectively, and they are significant at a level of 5 per cent.

Tariff rate is only significant in determining the export inefficiencies of mineral commodities and manufactured commodities. Specifically, a unit increase in the tariff rate on the export of manufactured commodities would increase the export inefficiencies of manufactured commodities by 0.135 units and is significant at a

level of 1 per cent. Also, for mineral commodities, a unit rise in tariff would result in a 0.0788 unit increase in its export inefficiency.

4.6 Post-estimation Tests

The results in Table B1 pass the sigma-squared (σ^2), the gamma (γ), and the likelihood ratio (LR) tests signifying that the use of the SFGM for this study is sufficiently justified.

4.7 Export Efficiency Scores

The results for the mean estimated export efficiency (in per cent) of Ghana's disaggregated bilateral exports for all trading partners selected for the study are presented in Table C1 (Annex C). From the table, the average export efficiency score for exports of agriculture, forestry and fishery products to all trading partners over the whole study period is 14.37%, which is generally low. The result reveals that exports of agriculture, forestry, and fishery products from Ghana to the Netherlands and Belgium are relatively efficient and closer to the frontier, with efficiency scores of 62.67% and 50.32%, respectively. This remarkable performance implies that Ghana is facing less resistance in terms of its exports of agriculture, forestry and fishery products to these two EU member countries compared to the rest of its partners. Despite the low efficiency score for the entire set, individual countries such as Togo, Côte d'Ivoire, Malaysia, Burkina Faso, South Africa, Ireland, Denmark, Spain, United Kingdom, France, Singapore, Italy, Turkey and Switzerland, respectively, have efficiency scores above the average score for the entire period. It also suggests that Ghana has a high unrealized export potential for agricultural, forestry and fishery products to the selected trading partners.

With respect to exports of mineral commodities, Table C1 reveals relatively high export efficiency scores and that most efficiency scores for individual countries are far above the average export efficiency of 41.86%. Most of the countries have recorded efficiency scores above 50 per cent, which is half of the frontier level. The countries with the highest efficiency scores are the Netherlands, United States and Switzerland with efficiency scores of 65.40, 63.45 and 62.73%, respectively. Others include Belgium (56.86), China (56.78), India (56.68), United Kingdom (55.59) and Singapore (50.37). This implies that Ghana's exports of mineral commodities to these countries is relatively efficient compared to its export efficiency score of 41.86% for the entire period, suggesting that the constraining impact of country-specific effects on potential exports (i.e., behind the border) is declining due to bilateral negotiations with these countries. Also, other EU member countries such as Italy, France, Greece, and Canada as well as ASEAN and East Asian (EA) member countries such as Indonesia, Hong Kong, Japan, Malaysia and Ukraine have efficiency scores above the overall average score. South Africa and Kenya also maintained efficiency scores above the average. It is interesting

to note that ECOWAS countries, such as Burkina Faso, Senegal, Sierra Leone and Togo, performed quite well by recording efficiency scores above the average.

In terms of export efficiency scores for Ghana's exports of manufactured commodities, the average efficiency score is 27.62%, implying that there are inefficiencies in this trade. It is interesting to note that all the countries that recorded high efficiency scores, above 50 per cent, are ECOWAS member countries, with the exception of South Africa and the Netherlands. The highest efficiency score of 75.01% is registered by Burkina Faso. This is closely followed by Niger, Senegal, Togo, Gambia and Côte d'Ivoire with efficiency scores of 67.47%, 63.87%, 62.00%, 54.55% and 53.76%, respectively. This overwhelming performance can be attributed to the shorter distance between Ghana and these countries, especially Burkina Faso, and also the fact that regional trade agreements among these countries has made it possible for members to trade in goods that they are more or less endowed with. Conversely, the low efficiency scores registered by other partners may be attributed to the fact that they are better producers of such commodities relative to Ghana. The other partners with high efficiency scores are South Africa and the Netherlands, with each registering efficiency scores of 52.94% and 51.86%, respectively. Some trading partners such as the United Arab Emirates, United Kingdom, United States, Spain, Singapore, India and two ECOWAS member countries, Liberia and Sierra Leone, have efficiency scores above the average score of 27.62%. In general, Ghana's exports of manufactured commodities to ECOWAS member countries are relatively efficient compared to the rest of the partners.

Regarding the exports of manufactured commodities not identified by kind, the export efficiency scores are generally very low for all individual countries and over the period as a whole. The average efficiency score for the entire period is 0.73%. This implies that the inefficiencies in Ghana's exports of these commodities to trading partners is about 99.27%, indicating a huge unexploited potential or export gap. Individually, none of the countries selected for the study have registered an efficiency score of 50%. Although all countries performed poorly, countries such as Switzerland, Singapore, United States, Hong Kong, Canada, Australia, Germany and South Africa have efficiency scores above the average score of 0.73%. Among these countries, the highest efficiency score is recorded by Switzerland (9.76%). This poor performance of exports of manufactured commodities not identified by kind may be because Ghana is not endowed with the potential to produce such goods. In a nutshell, Ghana has large untapped potential in the exports of manufactured commodities not identified by kind.

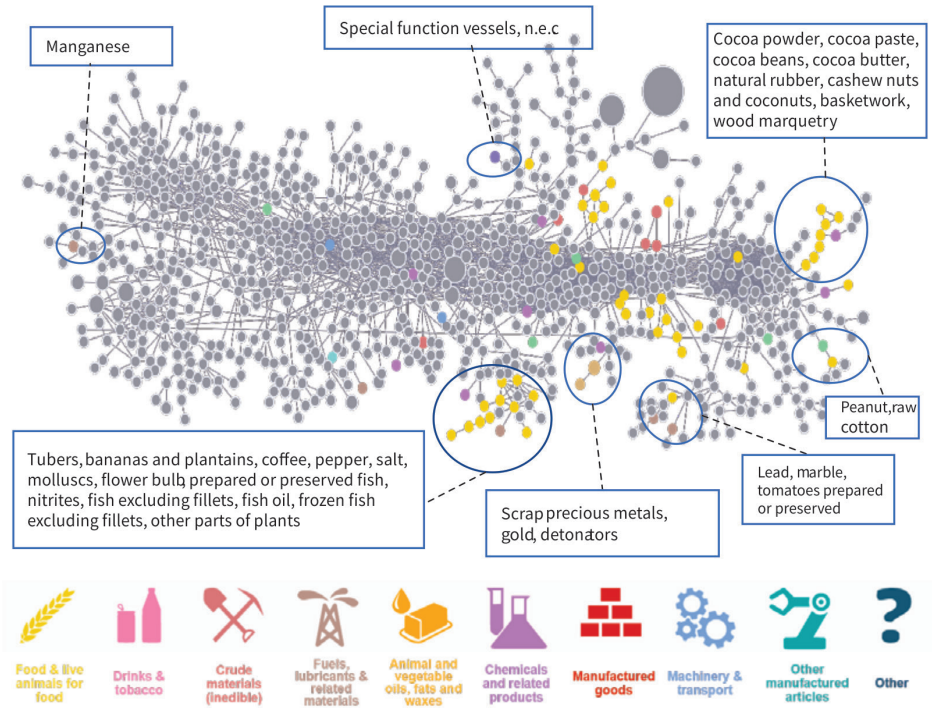
For the exports of other commodities, Table C1 shows that Ghana's export efficiencies for the selected trading partners over the period of the study is relatively low with an average efficiency score of 30.84%. This suggests a 69.16% inefficiency in the exports of other commodities. Also, all scores are below 50%. Specifically, countries such as Angola, Niger, France, China, Senegal, and Sweden have export efficiency scores of a little above 40%, while the efficiency scores of Norway, Sierra Leone, Togo, Canada, Indonesia, Italy, India, Denmark, South Africa, Saudi Arabia and Poland are a little above 30%. These countries' efficiency scores are higher than the average efficiency score of 30.84% for the entire period. Generally, there are

huge inefficiencies in the export of other commodities that Ghana must improve on. This suggests that there are huge behind-and-beyond-the-border constraints facing Ghana's exports of other commodities to its trading partners.

4.8 Product Space Analysis

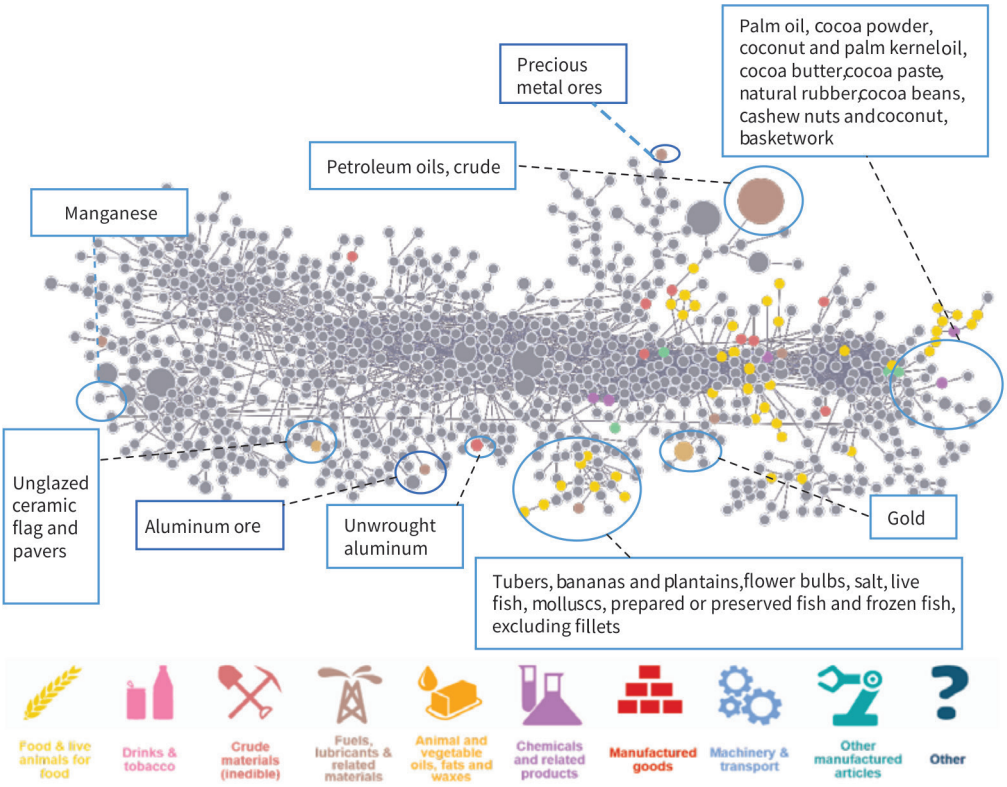
In this section, the evolution of Ghana's exports in the past decade is explored. Also discussed is the products Ghana should diversify towards, leveraging the AfCFTA. Using the product space visualization tool, the products Ghana exported in 2000 and 2018 are captured in Figures 1 and 2. The product space shows the connectedness of export products, with the most sophisticated and high know-how-required products situated at the centre and closely related to other products. Products located at the fringes are less sophisticated and less connected. The more products that are located at the centre and are well connected, the higher the level of economic complexity of the country. A critical examination of Figures 1 and 2, with the aid of the legend beneath each of them, shows that Ghana's export products (highlighted) are situated at the fringes and that they are less connected. The implication is that the level of economic complexity is very low. In fact, Ghana was ranked 110th complex country out of 133 countries in 2017 (Atlas of economic complexity, 2017).

Figure 1: Product space of Ghana, 2000



Source: Atlas of economic complexity, 2019.

Figure 2: Product space of Ghana, 2018



Source: Atlas of economic complexity, 2019.

The level of complexity of an economy has implications for the products it produces. For Ghana, the detailed specific products exported in 2000 and 2018 are shown in Table 2. The products are arrived at by considering only products with a revealed comparative advantage greater than one (RCA>1). RCA is the share of a particular product in the total exports of a country relative to the world. RCA>1 means that the product is important as far as the export basket of the country is concerned. It is important to note that the number of products with RCA> 1 exported by Ghana increased from 75 in 2000 to 93 in 2018. The value increased from about US$2.1 billion in 2000 to US$14.3 billion in 2018. This suggests that Ghana managed to double its share of global trade in value terms over the past 10 years. However, this was achieved on the back of increased export concentration exposing the country to potential vulnerabilities from changes in the world prices of these few products.

Table 2: Number of Ghana's exports with RCA (2000 and 2018)

		2000			2018	
Commodity community	Number of products Ghana has RCA>1	Value of Ghana's exports (US$' 000)	% of Ghana's merchandised exports	Number of products Ghana has RCA>1	Value of Ghana's exports (US$'000)	% of Ghana's merchandised exports
Animal and animal products	5	30,477	1.43	4	72,200,295	0.48
Vegetable products	14	70,313	3.30	22	743,585,949.7	4.99
Foodstuffs	11	578,527	27.16	17	2,677,248,224	17.97
Mineral products	6	163,029	7.65	10	4,216,123,886	28.30
Chemicals and allied industries	6	5,214	0.24	6	25,635,083.7	0.17
Plastics/ rubbers	2	17,056	0.80	3	159,600,000	1.07
Wood and wood products	12	200,869	9.43	8	272,805,430	1.83
Stone/glass	4	744,297	34.94	3	5,930,203,069	39.80
Metals	6	222,685	10.45	13	2,174,90,684.4	1.46
Miscellaneous	3	1,907	0.09	2	10,546,537.2	0.07
Textiles/ clothing	4	21,537	1.01	4	25,397,822.3	0.17
Footwear/ headgear	2	125	0.01	1	1,307,483	0.01
Total	75	2,056,034	96.53	93	14,342,155,937	96.26

Source: Author's construct based on 2018 export data, Atlas of economic complexity, 2019

Comparing the two periods, Ghana is generally diversified in the production and export of vegetable products, foodstuffs, mineral products, wood and wood products, and metals. Chemical and allied industries and textiles/clothing maintained their presence in the export mix for the two years while plastic/rubbers increased slightly from 2 to 3.

4.9 Identification of Potential Products for Diversification

In pursuit of objective 2 of the study, this section of the report is devoted to the identification of potential products that Ghana must diversify towards.

Knowing Ghana's export with RCA in 2018, the next logical thing to do is to identify those products with high potential developmental impact as candidates for the diversification drive. In selecting the products, emphasis is placed on the level of sophistication of the product (PCI), its ability to influence the development of other

products (opportunity gain, or OppGain), and its closeness (distance) to the existing knowledge capabilities of the country. However, it is impossible to concurrently fulfil these three conditions. For example, complex products are normally farther away from existing knowledge capabilities of countries (Hausmann and Chauvin, 2015).

Consequently, several product selection criteria have been proposed in the literature. This involves assigning different weights to distance, PCI and OppGain depending on the developmental objective of the country: creation of more jobs (parsimonious transformation) or better jobs (strategic bet) (Hausmann, et al., 2014 cited in Tuo, undated), market opportunities (Hausmann and Chauvin, 2015, cited in Tuo undated), and resource endowment and constraints on economic activities (Lin and Xu, 2016 and Hausmann, et al., 2005, cited in Tuo undated).

For the purpose of this study, the author relied on Hausmann and Chauvin (2015) and Tuo (undated) and followed the ensuing steps in the selection of the potential products for diversification in Ghana: First, all the export products of Ghana with RCA were removed from the dataset. Second, of the remaining set, products with product complexity index (PCI) greater than the mean PCI (-1.101014) of Ghana's exports with RCA were selected. Third, products with an OppGain greater than zero were included in the set. Fourth, products with a distance greater than the median distance (0.9373056) for all products that Ghana has with no RCA were eliminated. Finally, products with export values less than US$10,000 were excluded (Chandra and Osorio-Rodarte, 2007; Baah-Boateng and Twum, 2019).

About 232 products were identified using the criteria outlined above. However, the top 20 products (in terms of export value) selected for the diversification of Ghana's export set are shown in Table 3 (the full list of 232 products is available on demand from the author).

From Table 3 one can observe the PCIs of the products identified; their closeness to Ghana's export basket represented by the distance measure; the complexity outlook to be gained as reflected in the opportunity gain measure; the values of export of each product both within Ghana's export basket and that of the Africa; the corresponding values of each product in terms of Africa and world import; and, finally, the sectors for each product represented by the product community and the Lall classification, pointing to the level of technology embedded in each product.

Table 3: Top 20 frontier products for Ghana, 2018[1]

Product	Distance	OPPGAIN	PCI	Export values (US$)	Africa exports (US$)	Africa imports (US$)	World imports (US$)	Product community	LALL classification
Refined petroleum	0.8886	0.1770	-0.6606	91,000,000	27,200,000,000	68,500,000,000	20,500,000,000,000	Mineral products	RB2: Other resource-based products
Electrical transformers	0.9344	0.8319	0.5813	29,000,000	310,000,000	2,850,000,000	2,720,000,000,000	Machinery/ electrical	HT1: Electronics and electrical products
Plastic lids	0.8991	0.4661	-0.0673	25,800,000	828,000,000	2,250,000,000	1,520,000,000,000	Plastics/ rubbers	LT2: Other low technology
Industrial fatty acids, oils and alcohols	0.9287	0.8504	-0.4544	18,200,000	334,000,000	1,750,000,000	1,440,000,000,000	Chemicals & allied industries	Semi-processed
Raw plastic sheeting	0.9192	0.7179	0.4160	15,500,000	620,000,000	2,180,000,000	1,740,000,000,000	Plastics/ rubbers	MT2: Process industries
Electricity	0.8945	0.2575	-0.5204	14,700,000	1,370,000,000	1,980,000,000	1,140,000,000,000	Mineral products	Other
Flavoured water	0.8907	0.2105	-0.5571	10,000,000	365,000,000	1,080,000,000	496,000,000,000	Foodstuffs	Processed
Concentrated milk	0.8912	0.0794	-0.8571	9,114,172	177,000,000	3,860,000,000	649,000,000,000	Animal & animal products	Processed
Excavation machinery	0.9325	1.0214	0.8779	7,817,913	575,000,000	3,320,000,000	2,030,000,000,000	Machinery/ electrical	MT3: Engineering industries

Plywood	0.9040	0.2213	-0.7290	7,736,954	144,000,000	734,000,000	522,000,000,000	Wood & wood products	RB1: Agro/ forest-based products
Scrap iron	0.8962	0.3780	-0.5673	7,246,995	607,000,000	1,770,000,000	1,280,000,000,000	Metals	RB2: Other resource-based products
Hard liquor	0.8947	0.1431	-0.6150	6,963,237	249,000,000	1,290,000,000	922,000,000,000	Foodstuffs	Processed
Precious metal scraps	0.9040	0.3105	-0.4246	6,710,569	616,000,000	35,200,000	596,000,000,000	Stone/glass	RB2: Other resource-based products
Cleaning products	0.9113	0.5346	0.0647	6,637,320	674,000,000	1,900,000,000	971,000,000,000	Chemicals & allied industries	MT2: Process industries
Other small iron pipes	0.8993	0.2016	-0.3253	6,624,764	207,000,000	1,220,000,000	768,000,000,000	Metals	MT2: Process industries
Beauty products	0.9370	1.0420	0.6219	5,322,675	689,000,000	1,160,000,000	1,050,000,000,000	Chemicals & allied industries	MT2: Process industries
Aluminium bars	0.9141	0.4358	-0.0290	5,045,018	146,000,000	902,000,000	494,000,000,000	Metals	Other primary products
Light pure woven cotton	0.9252	0.0789	-0.9360	4,839,595	160,000,000	3,670,000,000	538,000,000,000	Textiles/ clothing	LT1: Fashion cluster
Other construction vehicles	0.9338	0.6333	-0.4848	4,266,332	170,000,000	931,000,000	382,000,000,000	Machinery/ electrical	MT3: Engineering industries
Baked goods	0.8940	0.2388	-0.4527	4,176,939	309,000,000	1,090,000,000	888,000,000,000	Foodstuffs	Processed

Source: Author's construct based on 2018 export data, Atlas of economic complexity, 2019.

It can be observed from Table 3 that the frontier products possess high strategic value and have the potential of enhancing the structural transformation of the Ghanaian economy if they are exploited and developed for export. The shift from focusing on foodstuffs and vegetable products to chemicals and allied industries, machinery/electricals, plastics and metals among others, which are more technology-intensive and have the complex network structures that can help to create further industries and wealth creation, is a welcome development.

4.9 Role of AfCFTA in Selection of Ghana's Products for Diversification

A major difficulty countries face when they introduce new export products is lack of access to international markets. It is often the case that the new entrant country is not competitive enough to gain a share of the established market. A continental free trade area that offers free access for goods and services to international markets could be an advantage in this respect. It is in this light that it is suggested that Ghana should take advantage of the AfCFTA to promote its export diversification agenda. The AfCFTA, which came into operation on 1 January 2021, is a single market for goods and services across 54 countries. It also has over one billion people and a combined GDP of more than US$3.4 trillion (https://au.int/en/ti/cfta/about).

In respect of objective three of this study, we created a dummy for the AfCFTA by combining and calculating import intensities for each of the imported products for the continent in 2018, using the RCA concept (Annex E) (Hausmann and Chauvin, 2015; Tuo, undated). We then apply the criteria that the import intensity for each product of the AfCFTA is greater than one (RCAm > 1) and the total import value is also greater than US$10,000. The resultant set of imports was matched with the identified frontier products of Ghana to select products it has to produce for the continental market. As a result, 67 frontier products were identified, as displayed in Table 4. From Table 4 it can be seen that, whilst the AfCFTA exports largely fruits and vegetables as well as primary products, their imports are mostly high technology goods, processed goods, and automotive products, among others. The suggestion is Ghana should develop and export these 67 products to the AfCFTA market. This will promote the spirit of continental trade and integration with the potential for enhancing industrialisation and job creation in Ghana.

Table 4: Frontier products for regional trade

Product	Distance	Opp gain	PCI	RCAm	Export values (US$)	Africa exports (US$)	Africa imports (US$)	World imports (US$)	Product community	Lall classification
Poultry meat	0.9292	0.5500	0.0418	1.9132	102,376	117,000,000	2,780,000,000	775,000,000,000	Animal & animal products	Processed
Concentrated milk	0.8912	0.0794	-0.8571	3.1723	9,114,172	177,000,000	3,860,000,000	649,000,000,000	Animal & animal products	Processed
Butter	0.9316	0.5492	-0.0397	1.0667	51,446	22,800,000	512,000,000	256,000,000,000	Animal & animal products	Processed
Potatoes	0.9089	0.1807	-0.8533	1.6001	125,135	311,000,000	423,000,000	141,000,000,000	Vegetable products	Horticulture
Processed cereals	0.8910	0.0923	-0.7122	1.6898	64,392	13,100,000	147,000,000	46,400,000,000	Vegetable products	Processed
Soya-bean oil	0.9083	0.0780	-0.9419	3.0140	23,273	124,000,000	1,910,000,000	338,000,000,000	Vegetable products	Semi-processed
Confectionery sugar	0.8884	0.1572	-0.5052	1.1209	501,312	248,000,000	704,000,000	335,000,000,000	Foodstuffs	Processed
Sauces and seasonings	0.8926	0.2279	-0.5754	1.2351	2,837,386	224,000,000	741,000,000	320,000,000,000	Foodstuffs	Processed
Soups and broths	0.8987	0.2945	-0.2989	1.8113	998,075	322,000,000	343,000,000	101,000,000,000	Foodstuffs	Processed
Flavoured water	0.8907	0.2105	-0.5571	1.1614	10,000,000	365,000,000	1,080,000,000	496,000,000,000	Foodstuffs	Processed
Other fermented beverages	0.9185	0.5889	0.0405	1.0457	517,899	70,800,000	74,700,000	38,100,000,000	Foodstuffs	Processed
Refined petroleum	0.8886	0.1770	-0.6606	1.7822	91,000,000	27,200,000,000	68,500,000,000	20,500,000,000,000	Mineral products	RB2: Other resource-based products

Asphalt	0.9154	0.3661	-0.6873	4.9016	28,031	37,600,000	329,000,000	35,800,000,000	Mineral products	Other primary products
Sulfuric acid	0.9176	0.2825	-0.0855	7.5509	20,005	204,000,000	487,000,000	34,400,000,000	Chemicals & allied industries	RB2: Other resource-based products
Nitric acids	0.9305	0.7140	0.3561	1.2127	102,319	2,961,704	24,100,000	10,600,000,000	Chemicals & allied industries	RB2: Other resource-based products
Sodium or potassium peroxides	0.9326	0.7100	0.2919	1.8079	190,621	99,900,000	522,000,000	154,000,000,000	Chemicals & allied industries	RB2: Other resource-based products
Hypochlorites	0.9078	0.2614	-0.5383	1.6448	64,921	21,100,000	58,900,000	19,100,000,000	Chemicals & allied industries	RB2: Other resource-based products
Sulfates	0.9254	0.4490	-0.2185	1.2384	213,020	269,000,000	228,000,000	98,200,000,000	Chemicals & allied industries	RB2: Other resource-based products
Nitrites and nitrates	0.9234	0.3750	-0.4377	1.6305	105,013	14,200,000	118,000,000	38,600,000,000	Chemicals & allied industries	RB2: Other resource-based products
Scented mixtures	0.9332	0.7776	0.4952	1.9910	1,075,833	395,000,000	2,460,000,000	659,000,000,000	Chemicals & allied industries	RB2: Other resource-based products
Dental products	0.9264	0.6114	0.0600	1.2282	788,297	160,000,000	350,000,000	152,000,000,000	Chemicals & allied industries	MT2: Process industries
Shaving products	0.9205	0.4933	0.0484	1.1136	698,790	153,000,000	760,000,000	364,000,000,000	Chemicals & allied industries	MT2: Process industries
Cleaning products	0.9113	0.5346	0.0647	1.0437	6,637,320	674,000,000	1,900,000,000	971,000,000,000	Chemicals & allied industries	MT2: Process industries
Detonating fuses	0.9058	0.2503	-0.6170	1.8516	312,445	66,100,000	159,000,000	45,800,000,000	Chemicals & allied industries	MT2: Process industries

Table 4: Frontier products for regional trade (continued)

Product	Distance	Opp gain	PCI	RCAm	Export values (US$)	Africa exports (US$)	Africa imports (US$)	**World imports (US$)**	**Product community**	**Lall classification**
Pesticides	0.9211	0.5973	0.0894	1.6901	1,402,944	403,000,000	3,080,000,000	972,000,000,000	Chemicals & allied industries	MT2: Process industries
Organic composite solvents	0.9096	0.4638	-0.0238	1.1642	773,698	55,400,000	129,000,000	59,100,000,000	Chemicals & allied industries	MT2: Process industries
Propylene polymers	0.9210	0.4075	0.2199	1.0369	269,496	690,000,000	2,430,000,000	1,250,000,000,000	Plastics/ rubbers	MT2: Process industries
Rubber tires	0.9281	0.6224	0.4359	1.0488	1,317,890	985,000,000	4,680,000,000	2,380,000,000,000	Plastics/ rubbers	RB1: Agro/forest-based products
Rubber inner tubes	0.9292	0.2698	-0.4960	2.2182	79,245	5,311,269	178,000,000	42,800,000,000	Plastics/ rubbers	RB1: Agro/forest-based products
Cigarette paper	0.9209	0.4833	-0.0001	1.1566	72,091	11,700,000	139,000,000	64,100,000,000	Wood & wood products	LT2: Other low technology
Paper notebooks	0.8967	0.1713	-0.5035	1.4288	166,939	120,000,000	442,000,000	165,000,000,000	Wood & wood products	LT2: Other low technology
Light pure woven cotton	0.9252	0.0789	-0.9360	3.6384	4,839,595	160,000,000	3,670,000,000	538,000,000,000	Textiles/ clothing	LT1: Fashion cluster
Other cotton fabrics	0.9350	0.5425	-0.1036	1.1156	42,557	3,879,170	73,000,000	34,900,000,000	Textiles/ clothing	LT1: Fashion cluster
Synthetic filament tow	0.9305	0.6256	0.1096	2.6505	46,665	15,600,000	243,000,000	48,900,000,000	Textiles/ clothing	MT2: Process industries
Non-retail synthetic staple fibers yarn	0.9236	0.2708	-0.3266	1.3013	49,493	34,000,000	527,000,000	216,000,000,000	Textiles/ clothing	LT1: Fashion cluster
Other synthetic fabrics	0.9194	0.0588	-0.5746	1.5898	867,384	84,800,000	465,000,000	156,000,000,000	Textiles/ clothing	MT2: Process industries

Twine and rope	0.9021	0.0879	-0.5897	1.1155	60,313	32,400,000	151,000,000	72,200,000,000	Textiles/ clothing	LT1: Fashion cluster
Netting	0.9027	0.1054	-0.7791	3.0702	253,938	20,300,000	274,000,000	47,600,000,000	Textiles/ clothing	LT1: Fashion cluster
Tulles and net fabric	0.9273	0.1995	-0.2146	1.2029	104,180	6,748,120	129,000,000	57,200,000,000	Textiles/ clothing	LT1: Fashion cluster
Bedspreads	0.9252	0.1202	-0.8941	1.3436	98,410	225,000,000	330,000,000	131,000,000,000	Textiles/ clothing	LT1: Fashion cluster
Ceramic bricks	0.9243	0.4907	-0.0541	3.8397	26,659	18,100,000	275,000,000	38,200,000,000	Stone/glass	RB2: Other resource-based products
Bathroom ceramics	0.9248	0.4128	-0.3336	1.7234	130,064	166,000,000	601,000,000	186,000,000,000	Stone/glass	MT3: Engineering industries
Coated flat-rolled iron	0.9240	0.5769	-0.0485	1.1201	3,685,214	1,110,000,000	3,360,000,000	1,600,000,000,000	Metals	LT2: Other low technology
Hot-rolled iron bars	0.9240	0.6596	0.2220	1.2218	398,441	307,000,000	969,000,000	423,000,000,000	Metals	LT2: Other low technology
Iron blocks	0.9050	0.2361	-0.3195	1.4675	2,749,936	1,220,000,000	1,450,000,000	527,000,000,000	Metals	LT2: Other low technology
Cast iron pipes	0.9312	0.5108	-0.2055	2.4793	280,508	9,340,109	304,000,000	65,400,000,000	Metals	MT2: Process industries
Iron pipes	0.9361	0.7200	-0.0486	1.0203	867,746	176,000,000	1,890,000,000	988,000,000,000	Metals	MT2: Process industries
Iron structures	0.9188	0.6332	0.3654	1.8327	1,450,635	665,000,000	4,570,000,000	1,330,000,000,000	Metals	LT2: Other low technology

Table 4: Frontier products for regional trade (continued)

Product	Distance	Opp gain	PCI	RCAm	Export values (US$)	Africa exports (US$)	Africa imports (US$)	World imports (US$)	Product community	Lall classification
Iron gas containers	0.9350	0.7217	0.0409	1.6260	264,825	27,400,000	314,000,000	103,000,000,000	Metals	LT2: Other low technology
Stranded iron wire	0.9274	0.4366	-0.0357	1.0187	56,898	126,000,000	403,000,000	211,000,000,000	Metals	LT2: Other low technology
Iron cloth	0.9173	0.5129	0.0235	1.2607	1,234,277	105,000,000	364,000,000	154,000,000,000	Metals	LT2: Other low technology
Iron nails	0.9075	0.3259	-0.5537	1.7641	839,927	41,700,000	299,000,000	90,400,000,000	Metals	LT2: Other low technology
Iron stovetops	0.9364	0.7501	0.3681	1.0280	58,395	112,000,000	584,000,000	303,000,000,000	Metals	LT2: Other low technology
Iron housewares	0.9322	0.1622	-0.7981	1.5109	1,125,843	55,800,000	966,000,000	341,000,000,000	Metals	LT2: Other low technology
Aluminium wire	0.9225	0.2522	-0.5062	1.6914	321,642	75,500,000	352,000,000	111,000,000,000	Metals	Other primary products
Aluminium structures	0.9258	0.7144	0.4221	1.1677	96,890	70,300,000	694,000,000	317,000,000,000	Metals	LT2: Other low technology
Aluminium cans	0.9061	0.4450	0.1436	1.2116	26,871	162,000,000	368,000,000	162,000,000,000	Metals	LT2: Other low technology
Stranded aluminium wire	0.9220	0.1899	-0.8902	4.8191	37,258	10,100,000	384,000,000	42,500,000,000	Metals	LT2: Other low technology
Flexible metal tubing	0.9370	0.6258	0.3223	1.4842	34,657	15,600,000	219,000,000	78,700,000,000	Metals	LT2: Other low technology
Metal stoppers	0.9225	0.6623	0.3023	1.2436	330,131	76,300,000	450,000,000	193,000,000,000	Metals	LT2: Other low technology
Coated metal soldering products	0.9280	0.8029	0.6527	1.2692	91,367	20,200,000	257,000,000	108,000,000,000	Metals	LT2: Other low technology

Other construction vehicles	0.9338	0.6333	-0.4848	1.2999	4,266,332	170,000,000	931,000,000	382,000,000,000	Machinery/ electrical	MT3: Engineering industries
Mill machinery	0.9290	0.6985	0.1638	3.7088	37,755	24,400,000	493,000,000	70,900,000,000	Machinery/ electrical	MT3: Engineering industries
Stone processing machines	0.9319	0.7277	0.2684	2.3398	922,305	436,000,000	2,540,000,000	579,000,000,000	Machinery/ electrical	MT3: Engineering industries
Buses	0.9294	0.5741	0.3286	1.5838	112,724	156,000,000	1,550,000,000	522,000,000,000	Transportation	MT1: Automotive products
Specialised vehicles	0.9231	0.5667	0.0331	1.9058	101,558	144,000,000	1,490,000,000	417,000,000,000	Transportation	MT1: Automotive products
Other floating structures	0.9223	0.6192	-0.1945	1.3139	43,623	13,300,000	101,000,000	41,000,000,000	Transportation	MT3: Engineering industries

Source: Author's construct based on 2018 export data, Atlas of economic complexity, 2019.

5. Conclusions and Policy Recommendations

5.1 Conclusions

Ghana's export promotion strategy has not led to much growth in exports. Information available on the website of the Atlas of Economic Complexity (2018) indicates that since 2003, only 10 products have been added to Ghana's exports basket, which contributed $129 to per capita income in 2018. There is the need, now, to diversify exports to generate more export revenue for economic transformation. Meeting this objective requires an appreciation of the performance of existing export products and what new products to introduce. This study, therefore, employed the stochastic frontier gravity model to investigate the efficiency of bilateral exports of Ghana using a panel of 44 of its export destination countries for the period 2000 to 2018. In addition, a product space analysis was carried out to ascertain which products Ghana has to diversify towards to engender the transformation required for the attainment of Sustainable Development Goal 8. As a third objective, the study investigated the extent to which Ghana can leverage the African continental free trade area for its diversification agenda. The study concludes that Ghana's bilateral export trade is inefficient, implying that huge potential exists for Ghana to further expand exports. It further reveals that Ghana's economic complexity is low, leading to the production and export of primary commodities. Moreover, the African continental free trade area offers an opportunity for Ghana to crystalize its export diversification drive. In conclusion, the promotion of Ghana's export growth requires enhancing the efficiency of existing products as well as discovering new ones.

5.2 Policy Recommendations

The following policy recommendations are drawn from the findings of the study. With respect to improving the efficiency of existing exports, Ghana's Ministry of Trade should continue to sustain Ghana's interest in trade blocs and strengthen negotiations to remove barriers to trade flows and thereby increase Ghana's exports to partner countries. In addition to negotiating tariff reductions, the Minister of Trade must pay specific attention to the time-consuming and inefficient border procedures, multiple

border crossings for goods to enter landlocked countries, and the construction of cross-country road, air and rail infrastructure. There is also the need for Ghana to, among other things, improve the performance of its trade logistics such as trade infrastructure, reduce the documentation and time spent at the border, enhance digitisation of trade and shipment, and to ensure an improvement in efficiency. Sustaining macroeconomic stability, the central bank will contribute to the competitiveness of exports to ensure efficiency in the existing export markets. Equally essential is for the country to improve on its economic freedom, which includes upholding property rights, an efficient legal system and liberalization of trade.

The product space analysis shows that Ghana has low economic complexity and therefore mostly agro-processing and light manufacturing activities such as textiles, pharmaceutical products, simple machinery and construction materials were identified for the private sector of Ghana to diversify towards by leveraging the AfCFTA. In addition to the above recommendations, the successful production of these products will require the development of required human capital with the necessary skills to produce the products. In this respect, the country's vocational and technical educational institutions need to be well resourced by the Ministry of Education to produce the mid-level manpower, much needed to produce these products. Existing firms must also be encouraged to increase their research and development expenditure for the production of these products. Government must encourage this through granting tax incentives and subsidies to both deserving domestic and foreign firms. Other constraints to investment in the country such as acquisition of land, regular and reliable supply of electricity and raw materials require attention for these products to be produced competitively. In this respect, Government will need to acquire land to lease to genuine investors. Also, regular and reliable cheap electricity must be produced using gas produced from the country's oil fields, and a constant and adequate supply of raw materials must be made available through strengthening the agriculture system ,from one dependent on rainfall and practiced for only a few months of the year to a year-round activity.

Notes

1 The median for the distance measure is 0.9373056, and the mean for the OP-PGAIN and PCI measures are 0.4726366 and -1.101014, respectively.

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Annexes

Annex A: Descriptive Statistics

Table A1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Agriculture, forestry, and fishery (SIC 0)	540	30889.98	75157.2	0.044	1070000
Mineral commodities (SIC 1)	540	43903.32	221000	0.002	4300000
Manufactured commodities (SIC 2)	540	23230.01	68289.28	0.016	833000
Manufactured commodities not identified by kind (SIC 3)	540	70936.65	344000	0.05	4190000
Other commodities (SIC 9)	540	638.652	4354.346	0.002	116000
GPD_i	540	31720894737	20792559024	4983000000	65560000000
GPD_j	540	1145066836608.19	2556598581231.81	487000000	20500000000000
$Population_i$	540	24284885.11	3227174.246	19278856	29767108
$Population_j$	540	100057114.2	261322141.5	1320000	1392730000
Distance	540	5864.057	3851.618	306.96	15472.97
Economic $freedom_i$	540	6.652491	0.1953403	6.25	6.92
Economic $freedom_j$	540	7.155583	0.8752686	4.59	9.11
Inflation $Inflation_j$	540	13.08631	3.767191	7.12635	19.25072
$Logistics_i$	540	2.22	.401	1.437	2.66
$Logistics_j$	540	3.3	.704	.64	4.437
Tariff on agricultural, forestry and fishery	540	10.54277	14.70953	-90	176.72
Tariff on mineral commodities	540	20.73501	26.84671	-21.99	110.18
Tariff on manufactured commodities	540	12.65068	4.36245	-4.546665	28.3
Tariff on manufactured commodities not identified by kind	540	8.125246	3.189331	-11.22333	20
Tariff on other products	540	17.81197	5.887806	-28.32	40

Annex B: Frontier and Export Inefficiency Estimates

Table B1: Frontier and export inefficiency estimates

Variable	(1) Agricultural, forestry and fishery (SIC 0)	(2) Mineral commodities (SIC 1)	(3) Manufactured commodities (SIC 2)	(4) Manufactured commodities not identified by kind (SIC 3)	(5) Other commodities (SIC 9)
Frontier					
Log GDP_i	0.291	0.0560***	1.691***	1.549**	0.344**
	(0.58)	(11.34)	(4.59)	(1.82)	(2.85)
Log GDP_j	0.423**	0.242***	0.382***	0.193	0.0234
	(3.20)	(14.28)	(4.96)	(0.99)	(0.72)
Log $Population_j$	0.764***	0.585***	0.331***	0.655***	-0.0255
	(4.76)	(24.15)	(3.88)	(3.46)	(-0.94)
Log Distance	-0.400*	-1.461***	-1.058***	-2.827***	-0.0452
	(-1.92)	(-7.97)	(-7.63)	(-9.44)	(-0.86)
Constant	-8.878	7.761***	-37.87***	-70.47	18.74***
	(-0.71)	(5.94)	(-4.25)	(-0.25)	(6.09)
Export inefficiency					
ECOWAS	-4.395***	-2.786**	-9.295***	-0.781	-0.0146
	(-4.61)	(-2.23)	(-5.53)	(-1.05)	(-0.09)
WTO	-4.361*	-6.349	-6.964	-54.38	-0.508
	(-1.96)	(-0.25)	(-0.48)	(-0.19)	(-0.21)
EU	-3.518***	-3.014***	-0.210	-1.969***	-0.106
	(-5.17)	(-4.18)	(-0.60)	(-6.12)	(-1.04)
Language	-0.721	-0.506	-1.786***	-1.776***	-0.146
	(-1.29)	(-0.65)	(-4.12)	(-5.52)	(-1.37)
Landlocked	2.867**	1.986*	2.155**	2.900***	0.177
	(2.17)	(1.65)	(2.42)	(5.52)	(0.98)
$Logistics_i$	-6.801**	-13.85	-7.541**	-19.99***	-0.0772
	(-2.13)	(-1.63)	(-2.99)	(-3.44)	(-0.15)
$Logistics_j$	-4.478***	-3.239	-5.130***	-13.66***	-0.295**
	(-4.90)	(-0.96)	(-7.05)	(-8.09)	(-2.12)

$Inflation_i$	0.198**	0.0801	0.00259	0.160***	0.0103
	(2.57)	(0.87)	(0.06)	(3.50)	(0.66)
Economic $Freedom_i$	-3.040	-0.190	-0.531	-2.877**	-0.122
	(-1.34)	(-0.07)	(-0.38)	(-2.44)	(-0.44)
Economic $Freedom_j$	-1.441**	-1.828**	-1.664***	-0.237	-0.387***
	(-2.62)	(-2.89)	(-4.10)	(-0.75)	(-3.82)
Tariff	0.253	0.0788*	0.135***	0.0400	0.107
	(1.00)	(1.96)	(3.87)	(0.90)	(1.04)
Sigma- squared (σ^2),	2.462***	3.350***	1.477***	1.881***	-0.463***
	(17.29)	(86.79)	(13.70)	(30.91)	(-5.02)
Gamma (γ)	0.891***	0.345	0.694**	0.0134	0.981***
Likelihood ratio test	160.144	110.959	254.588	197.717	43.833
Observations	540	540	540	540	540

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; *t* statistics in parentheses; country i and j refers to exporter and importer, respectively.

Annex C: Export Efficiency Scores

TableC1: Export efficiency scores (%) 2000–2018

Country	Agricultural, forestry and fishery	Mineral commodities	Manufactured commodities	Manufactured commodities identified by kind	Other commodities
Angola	0.128	27.478	2.632	0.001	48.591
Australia	0.027	37.029	23.475	2.053	37.460
Belgium	50.317	56.862	33.468	0.140	27.618
Brazil	7.117	35.402	4.907	0.029	27.276
Burkina Faso	37.119	47.347	75.061	0.031	30.743
Canada	5.247	44.410	21.805	2.535	36.927
China	0.785	56.782	23.951	0.203	40.845
Côte d'Ivoire	44.959	32.791	53.760	0.004	24.707
Denmark	29.974	6.711	20.659	0.073	35.838
Finland	1.460	28.346	12.883	0.077	11.987
France	23.179	48.594	21.884	0.069	43.176
Gambia	10.527	24.354	54.554	0.002	23.959
Germany	14.254	35.481	35.424	1.215	29.835
Greece	1.541	42.184	7.937	0.004	30.773
Hong Kong	0.754	42.105	24.852	3.257	22.291
India	0.734	56.680	48.913	0.263	36.386
Indonesia	0.996	48.287	3.519	0.020	36.891
Ireland	34.272	32.081	15.896	0.254	27.953
Israel	3.849	34.048	12.775	0.460	30.226
Italy	18.757	49.880	22.312	0.044	36.419
Japan	7.531	45.797	11.945	0.647	29.698
Kenya	0.017	44.171	1.403	0.065	22.568
Korea,	2.996	41.118	2.412	0.258	18.184
Liberia	7.817	39.232	44.470	0.003	23.235
Malaysia	41.895	47.886	19.248	0.129	24.953
Netherlands	62.667	65.396	51.857	0.154	31.325
Niger	14.601	48.301	67.467	0.020	48.346
Nigeria	1.403	28.911	56.239	0.008	27.771
Norway	0.036	37.954	4.523	0.417	38.343
Poland	3.075	24.135	9.298	0.020	31.379
Portugal	9.689	18.582	5.149	0.020	25.890
Saudi Arabia	0.231	26.804	9.385	0.042	32.282
Senegal	4.040	43.237	63.866	0.001	40.525

Sierra Leone	4.816	47.337	46.410	0.000	37.779
Singapore	20.375	50.370	49.649	4.682	24.209
South Africa	34.310	43.888	52.942	1.286	35.064
Spain	29.631	37.965	28.599	0.041	28.651
Sweden	0.513	53.652	5.231	0.117	40.110
Switzerland	15.181	62.734	24.629	9.759	22.942
Togo	45.782	42.893	62.008	0.001	37.673
Turkey	16.275	50.017	9.925	0.110	25.540
Ukraine	2.259	47.965	0.801	0.009	26.466
United Arab Emirates	2.313	26.239	46.457	0.399	23.088
United Kingdom	29.091	55.591	36.359	0.562	30.966
United States	4.136	63.453	37.272	3.250	20.695
Average	**14.37**	**41.86**	**27.62**	**0.73**	**30.84**

Annex D: Selected Countries

United Kingdom, United States, France, Italy, Germany, Spain, Belgium, Japan, Nigeria, Malaysia, Ukraine, Turkey, China, India, Portugal, Australia, Benin, Burkina Faso, Cote d`Ivoire, Croatia, Mali, Netherlands, Nigeria, Sierra Leone, Singapore, South Africa, Switzerland, Togo, Ukraine. Spain, Estonia, Denmark, Senegal, Ireland, Iran, United Arab Emirates, Brazil, Guinea-Bissau, Vietnam, Greece, Lebanon, Egypt and Niger.

Annex E: Formula for Computing RCA for Imports

We use the same formula for RCA applied to export, but in this case for imports. Therefore, we compare the average imports of a particular product by the AfCFTA to the total imports by the continent and the total import of that particular product to world trade. The ratio gives us the intensity indicator:

$$RCA_{cp} = \left(\frac{M_{cp}}{\sum_c M_{cp}}\right) / \left(\frac{\sum_p M_{cp}}{\sum_{c,p} M_{cp}}\right)$$

where M represents imports and c in this case represents AfCFTA countries and the rest as explained above. Hence, for a particular product, if the calculated RCA is greater than one, we conclude that the continent has RCA in the importation of that product and for that reason the product is intensively imported.

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