

Can Africa raise export competitiveness through economic complexity? Evidence from (non)-parametric panel techniques

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Abstract

Economic complexity is an indicator of a nation's productive capabilities. It therefore determines the nature and quality of the products that a country can put up for exports. This suggests that building economic complexity can serve as a channel through which African countries can boost export competitiveness. To this end, the impact of economic complexity on the export volume of Africa's top 10 exporting countries which jointly account for about 78% of total trade volume on the continent for the period 2000–2018, is examined. Employing a parametric common correlated effects mean group estimation technique and a non-parametric time-varying model with fixed effects technique, this study shows that economic complexity is indeed a determinant of export competitiveness. However, its effect is not as powerful as those of GDP, real exchange rate, trade openness and foreign direct investment. This suggests that, although policies that emphasize economic complexity are useful, they should not be treated as stand-alone policies. Instead, governments should adopt holistic trade policy reforms that take economic complexity into account, along with other factors such as exchange rates, economic growth, trade openness and foreign direct investment.

KEYWORDS

Africa, economic complexity, export competitiveness, non-parametric/parametric panel data

1 | INTRODUCTION

Africa is significantly rich in natural resources (Habiyaemye, 2013). Approximately 30% of the world's mineral reserves are situated in Africa (African Natural Resources Center, 2016). In spite of these tremendous resources, the continent currently accounts for less than 3% of global trade (African Export–Import Bank [Afreximbank], 2019). The inability of Africa to actively compete in the international trading system is partly due to inferior technology and know-how, which has restricted countries within the continent to the exportation of a few primary commodities such as mineral fuels, iron ores, gold and cocoa beans (Olofin, 2002; Oyejide, 2007; Verter, 2017). Table 1 shows that primary commodities dominate the major commodity exports from the top 10 exporting African countries. The inability of African countries to add value to primary commodities before they are exported has proved to be intractable. African products are often banned from international markets owing to their inability to meet international quality standards. For instance, agricultural exports from Nigeria were prevented from entering into the Organisation for Economic

Co-operation and Development market in 2015 owing to their failure to adhere to international safety standards (The Centre for Public Policy Alternatives [CPPA], 2018). An often suggested means of achieving global export competitiveness is the expansion of the production and export of value-added goods, which can be achieved through improvements in economic complexity (Erkan & Yildirimci, 2015; Hidalgo & Hausmann, 2009).

Economic complexity represents the productive knowledge and diversity of a particular country (Boleti et al., 2021; Hausmann et al., 2014). Conceptually, economic complexity highlights the ability of countries to produce locally based knowledge goods and to substantially diversify their export baskets. Although economic complexity is a relatively broad concept, the emphasis is on the ability of countries to apply technical knowledge in improving product sophistication and diversification for both domestic and international markets (Sepehrdoust et al., 2019). Sepehrdoust et al. (2019) argue that, as the export basket of a nation becomes more diverse and sophisticated, the country will become a more powerful player in global economic interactions. This suggests that, to raise export competitiveness and attain sustainable economic growth, economies must transition from traditional to modern by switching their export composition from primary to manufactured products (Kwasi Fosu & Mold, 2008; Zeufack, 2001).

Although Africa continues to experience a substantial decline in the share of the labor force engaged in the extraction of primary products (items that require relatively minimal processing prior to export), the continent is still heavily reliant on primary commodities for export income (Diao et al., 2017). As noted by Verter (2017), while Africa is a net exporter of crude oil, it is also a net importer of several manufactured fuel products. Although a net exporter of cocoa products, it is also a net importer of chocolates and other cocoa-containing processed food items. Despite being a net importer of raw hides and skin, it is also a net importer of leather products that have undergone tanning or crusting.

A plausible reason for the significant differences in levels of productivity between countries is that some of the individual activities required in the production process, such as regulation, infrastructure and specific labor skills, need to be available domestically (Hidalgo & Hausmann, 2009). Therefore, a country's productive capabilities depend on the domestic availability of embedded knowledge capabilities. Thus, cross-country differences in production for exports can be explained by differences in economic complexity, as measured by the diversity of productive capabilities. In other words, countries that are able to export a wide range of products (highly diversified) generally exhibit more capabilities. Also, goods that can only be exported by a few countries (low ubiquity) generally require complex capabilities. Consequently, the composition and diversification of countries' export baskets are reliable measures of the complexity of their products and therefore serve as useful means of ranking countries and products. As shown in Table 2, countries with high economic complexity tend to rank relatively high in terms of exports, while those with low economic complexity tend to rank poorly in exports. Unsurprisingly, as also shown in Table 2, no African country ranks among the top 20 most complex economies in the world. Instead, they make up 75% of the bottom-ranking countries.

TABLE 1 Major commodity exports from the top 10 exporting African countries (2018)

Country	Major exports
South Africa	Gold (17.9b), diamonds (9.38b), platinum (9.14b), cars (6.8b) and coal briquettes (6.71b)
Nigeria	Crude oil (44.8b), petroleum gas (8.61b), refined petroleum (940 m), cocoa (621 m) and gold (577 m)
Angola	Crude oil (35.5b), diamonds (2.49b), petroleum gas (1.65b), refined petroleum (514 m) and coal-tar oil (146 m)
Algeria	Crude oil (15.9b), petroleum gas (12.8b), refined petroleum (7.05b), nitrogenous fertilizers (809 m) and ammonia (456 m)
Libya	Crude oil (24.2b), petroleum gas (1.38b), refined petroleum (1.01b), gold (805 m) and scrap copper (95.9 m)
Egypt	Crude oil (4.93b), refined petroleum (1.99b), gold (1.86b), nitrogenous fertilizers (1.39b) and petroleum gas (1.17b)
Morocco	Cars (4.92b), insulated wire (3.53b), fertilizers (worth 2.86b), phosphoric acid (1.48 b) and knitted women's suits (1.38b)
Ghana	Gold (10b), crude petroleum (4.65b), cocoa (1.78b), cocoa paste (489 m) and cashews, Brazil nuts and coconuts (424 m)
Tunisia	Insulated wire (2.01b), male suits (1b), olive oil (789 m), knitted women's suits (628 m) and crude oil (614 m)
Ivory Coast	Cocoa (3.53b), Brazil nuts, cashews and coconuts (1.17b), refined petroleum (1.1 b), rubber (886 m) and gold (818 m)

Note: b stands for billion.

Source: Authors' compilation using data from <http://atlas.media.mit.edu/en/rankings/sitc/> and <http://comtrade.un.org>

TABLE 2 Countries by complexity (2018)

Top 20 countries			Bottom 20 countries		
Country	Rank of economic complexity index	Rank of export values (2018)	Country	Rank of economic complexity index	Rank of export values (2018)
Japan	1	4	Ghana	123	78
Taiwan	2	15	Mongolia	124	99
Switzerland	3	17	Mozambique	125	111
South Korea	4	6	Mauritania	126	142
Germany	5	3	Afghanistan	127	159
Singapore	6	12	Equatorial Guinea	128	103
Sweden	7	28	Sudan	129	115
Czech Republic	8	31	Libya	130	66
Austria	9	30	Burkina Faso	131	128
Slovenia	10	60	Angola	132	56
United Kingdom	11	10	Nigeria	133	52
Finland	12	45	Guinea	134	135
United States	13	2	Papua New Guinea	135	90
Hungary	14	35	Iraq	136	46
Italy	15	5	South Sudan	137	147
France	16	7	Chad	138	131
Slovakia	17	37	Syria	139	138
Ireland	18	23	Sierra Leone	140	155
Israel	19	43	Niger	141	146
China	20	1	Malawi	142	144

Source: Authors' compilation using data from <http://atlas.media.mit.edu/en/rankings/sitc/> and <http://comtrade.un.org> and <https://databank.worldbank.org/source/world-development-indicators>

This paper contributes to trade literature both theoretically and empirically. On the theoretical front, it is the first study to identify low economic complexity as a major factor that determines poor trade performance in Africa. On the empirical front, it is the first paper in the body of economic complexity literature to employ both the parametric common correlated effects mean group (CCEMG) estimation technique and the non-parametric time-varying framework in examining its effect on trade. This study further contributes to literature by adopting the recently developed economic complexity index which ranks countries on the basis of the level of diversity (the number of different kinds of products that a country can produce) and ubiquity (the number of countries that can make a particular type of product) of their exports.

The rest of this paper is structured thus: Section 2 presents a discussion of related literature, Section 3 provides information about the data used, Section 4 details the methodology adopted, Section 5 renders a discussion of the empirical results and Section 6 concludes the study with some policy implications.

2 | LITERATURE REVIEW

Trade is generally beneficial to all participating countries (Sakyi et al., 2017). Available data shows that if the continent had been able to achieve only a percentage increase in its share of global trade in 2018, this would have amounted to approximately US\$195 billion. This value is almost four times the size of the total foreign aid inflow into Africa in the previous year.¹ Classical economic theories such as the absolute advantage theory (Smith, 1776), the comparative advantage theory (Ricardo, 1817) and the Heckscher–Ohlin factor endowments theory (Heckscher, 1919; Ohlin, 1935) posit that nations engage in international trade mainly because of differences in the costs of production or factor endowments.

As a result, countries gain from trade by focusing on the export of products for which they have a comparative advantage and the import of products for which they are disadvantaged comparatively. According to Verter (2017), this is the reason why African countries export simple primary commodities and import complex manufactured goods. In addition to production cost and factor endowments, technological change, national income, imperfect competition and changing economies of scale have been identified by modern theories of trade as factors capable of stimulating international trade (see Helpman & Krugman, 1985; Leontief, 1953; Linder, 1961; Porter, 1990; Vernon, 1966).

The O-ring production function of Kremer (1993) states that workers are categorized according to their abilities. Since production is carried out in a sequential order, workers with limited abilities will be allocated to the early stages of the production process (simple primary products) and will be paid less, whereas more capable workers will be allocated to later stages of the production process (complex products) and will be paid better. Gebrerufael (2017) suggests that this is the reason why the advanced economies produce and export more valuable complex products, while African countries produce less valuable primary products.

The literature directly linking economic complexity with trade is almost non-existent, except for the study carried out by Erkan and Yildirimci (2015), which shows that the production of complex goods in Turkey is able to increase its earnings from trade. Inferences on the economic complexity–trade link can, however, be made indirectly from extant literature. For example, technology gap theorists like Hirsch (1967), Kravis (1956), Posner (1961) and Vernon (1966) argue that innovation enhances the production of new goods, which increases earnings, and improves production techniques, which enhances productivity. These claims suggest that more innovative countries are likely to be able to raise their export competitiveness through the export of more complex products. Schott (2004) submits that skill- and capital-abundant nations use these endowments to include additional features or improve the quality or the variety of goods that they produce, and are thus able to trade their goods for better prices. Consequently, in global trade, unit values are greater for goods originating from capital- and skill-intensive nations when compared with labor-intensive nations. Hummels and Klenow (2005) also show that the level of export product diversity (a component of economic complexity) displayed by large economies is responsible for 60% of their greater export volumes. The overview of extant literature on the connection between exports and economic complexity provided in this section shows that, while it is possible to make indirect inferences on the link between both variables, so far, no direct empirical study exists on the economic complexity–trade link, especially for Africa. This is the gap that this study seeks to fill.

3 | DATA

The data structure for the empirical analysis is a balanced panel of the top 10 exporting African countries between 2000 and 2018. The study sample consists of the following countries: South Africa, Nigeria, Angola, Algeria, Libya, Egypt, Morocco, Ghana, Tunisia and Côte d'Ivoire, all of which make up about 78% of all African exports and thus give an idea of the export activities within the continent. The panel data is constructed for the variables included in the models estimated. The choice of the time frame is solely dependent on data availability.

The regressor of interest—economic complexity—is captured through the economic complexity index computed using the methodology introduced by Hausmann et al. (2014). The index measures the amount of productive knowledge available to different countries by ranking them on the basis of the level of diversity (the number of different kinds of products that a country can produce) and ubiquity (the number of countries that can make a particular type of product) of their exports. Thus, countries lying on the higher end of the economic complexity index spectrum are those that display sophisticated manufacturing capabilities by exporting more varieties of technologically complex products. The methodology adopted in the calculation of the economic complexity index is the method of reflections. In the method of reflections, the economic complexity of each country is measured as the mean of the complexities of goods contained in its export basket (diversity). As a mirror image, a particular product's complexity is measured as the mean of the complexities of the countries exporting it (ubiquity). To obtain the economic complexity index through the method of reflections, following Hausmann et al. (2014), a binary country–product matrix M with elements M_{cp} is defined, where c is country and p is product, such that if a country has a revealed comparative advantage ($RCA > 1$ for product p), then $M_{cp} = 1$. If not, then $M_{cp} = 0$. The RCA is obtained via the Balassa (1965) index given as:

$$RCA_{cp} = \frac{x_{cp} / \sum_p x_{cp}}{\sum_c x_{cp} / \sum_c \sum_p x_{cp}}. \quad (1)$$

Here, x_{cp} refers to country c 's exports of product p .

The number of products for which a particular country has RCA (*diversity*) is obtained from the summation of the rows of the M matrix and is denoted by k_c .

$$k_c = \sum_p M_{cp}. \quad (2)$$

The number of countries with RCA for a particular product (*ubiquity*) is likewise obtained through the summation of the columns of the M matrix and is denoted by k_p .

$$k_p = \sum_c M_{cp}. \quad (3)$$

Finally, the economic complexity index is defined as the eigenvector associated with the second highest eigenvalue of the matrix $[\tilde{M} = D^{-1}S]$.

Here, D is the diagonal matrix of the diversity vector, while S is a symmetric matrix reflecting the level of similarity between the export baskets of countries. The economic complexity index values are standardized by subtracting their average values and dividing the outcome by the standard deviation. As a result, the standardized index has a mean of zero and ranges between the values -2.5 and $+2.5$. For this study, the index values are rescaled to a range of 0–100 for easy interpretation. On this scale, higher values correspond to higher levels of economic complexity.

Export volume (EXP)—the dependent variable—is the value in US dollars of all movable goods that change ownership from residents of the selected African countries to non-residents. Furthermore, variables generally considered as determinants of exports—inflation (INF), real exchange rate (REXR), openness to trade (OP), gross domestic product (GDP), foreign direct investment (FDI) and institutional quality (IQ)—are also included in the models estimated to serve as control variables. Data on economic complexity index was obtained from Massachusetts Institute of Technology's Observatory of Economic Complexity. Data on INF, REXR, OP, GDP and FDI were retrieved from the World Development Indicators of the World Bank. Data on institutional quality was obtained from the World Governance Indicators of the World Bank. All of the variables are used in their logarithmic forms for the econometric analysis to mitigate the potential effects of non-normality, non-linearity and heteroskedasticity, as well as to ensure ease of interpretation.

The summary statistics for the variables included in the study analysis are reported in Table 3. With regards to the variables of interest (exports and economic complexity), export volume across the sampled countries ranges between US\$2.4 billion and 133 billion with a mean value of US\$42.9 billion over the period considered. Economic complexity, on the other hand, ranges between -2.173 and 0.378 , with an average value of -0.825 during the period considered.

TABLE 3 Summary statistics

	EXP	EC	REXR	OP	GDP	FDI	IQ
Mean	42.9	−0.825	92.092	73.356	138	2.484	−0.618
Median	35.5	−0.864	8.867	71.302	85	1.883	−0.761
Maximum	133	0.378	732.398	152.547	469	24.009	0.423
Minimum	2.4	−2.173	0.512	20.723	18.4	−6.370	−1.904
SD	35.7	0.656	166.113	25.082	125	3.295	0.554
Skewness	0.938	−0.101	2.288	0.375	1.161	2.509	0.064
Kurtosis	2.864	2.147	7.240	2.983	3.200	16.188	2.127
Jarque–Bera	28.018***	6.087**	308.012***	4.457	43.007***	1576.126***	6.158**

Abbreviations: EXP, Export volume; EC, Economic complexity; REXR, real exchange rate; OP, openness to trade; GDP, gross domestic product; FDI, foreign direct investment; IQ, institutional quality.

** $p < .05$; *** $p < .01$.

The Jarque–Bera test statistics indicate that we are able to reject the null of normality for both exports and economic complexity, thus justifying the use of the logarithmic forms of the variables.

4 | PRE-ESTIMATION ANALYSIS AND METHODOLOGY

4.1 | Cross-sectional dependence and unit root testing

As shown by econometric evolution, conventional estimation methods often produce unreliable results when the underlying data series exhibit cross-sectional dependency. In response, new econometric techniques that are robust to the challenges posed by cross-sectional dependence are now widely adopted. Since the presence of cross-sectional dependence determines the choice of the empirical approach to be adopted in panel data analyses to a large extent, cross-sectional dependence tests were first conducted as a form of pre-estimation analysis. The presence of cross-sectional dependency in the underlying data series was checked using Breusch and Pagan's (1980) Lagrange multiplier (LM) test, Pesaran's (2004) scaled LM test and Pesaran et al.'s (2008) bias-adjusted LM test. The results as shown in Table 4 confirm cross-sectional dependence in all of the variables. Owing to the detection of cross-sectional dependence, second-generation unit root testing that is robust to cross-sectional dependence was conducted to determine the stationarity properties of the data series. Non-stationarity affects the behavior and properties of data series and renders the standard assumptions of the asymptotic analysis invalid. Thus, failure to properly deal with the presence of unit roots in the data series results in the generation of parameter estimates that are unreliable, consequently leading to spurious regression. To this end, the cross-sectionally augmented Im, Pesaran and Shin (Im et al., 2003) panel unit root test of Pesaran (2007) was carried out. As reported in Table 5, the results show that all of the variables contain unit roots but become stationary after the first differencing, the only exception being inflation, rate which is stationary at this level.

4.2 | Parametric estimation

When the nulls of cross-sectional independence and stationarity are rejected, long-run impacts can be efficiently determined through the parametric CCEMG estimator of Pesaran (2006) and Lee et al. (2021). The CCEMG is able to accommodate cross-sectional dependence and time-variant unobservables with heterogeneous effects across panel cross-sections (Pesaran, 2006). In the CCEMG procedure, cross-section mean values of the regressand and regressors are included as additional regressors when carrying out ordinary least squares regressions on each cross-section. According to Kapetanios et al. (2011), CCEMG has satisfactory small sample properties, deals adequately with structural breaks, non-stationarity, non-cointegrated common factors and certain autocorrelation; it is also a robust estimator of short-run dynamics. The CCEMG procedure is given thus:

$$\hat{b}_{\text{CCEMG}} = N^{-1} \sum_{i=1}^N \hat{b}_{\text{CCE},i}, \quad (4)$$

$$\text{SE}(\hat{b}_{\text{CCEMG}}) = \sqrt{N^{-1} \left[\sum_{i=1}^N \sigma(\hat{b}_{\text{CCE},i}) \right]}, \quad (5)$$

where $\hat{b}_{\text{CCE},i}$ represents the CCE estimator which is the estimator for the i th cross-section's slope coefficient, $\hat{b}_{\text{CCEMG}}$ is the CCEMG estimator computed as the average of the individual CCE estimators ($\hat{b}_{\text{CCE},i}$) and $\text{SE}(\hat{b}_{\text{CCEMG}})$ is the standard deviation of the CCEMG estimators.

The following econometric model is specified to examine the impact of economic complexity on trade using the parametric CCEMG approach:

$$\text{EXP}_{it} = \beta_0 + \beta_1 \text{EC}_{it} + \beta_2 \text{INF}_{it} + \beta_3 \text{REXR}_{it} + \beta_4 \text{OP}_{it} + \beta_5 \text{GDP}_{it} + \beta_6 \text{FDI}_{it} + \beta_7 \text{IQ}_{it} + e_{it}, \quad i = 1, \dots, N, t = 1, \dots, T, \quad (6)$$

where N is the size of the cross-section, T is the length of the time series and e_{it} is the error term.

4.3 | Non-parametric estimation

While we tried to control for all relevant factors in the construction of equation (6) and so believe that the parameter estimates generated are unbiased, we still proceed with a non-parametric analysis. This is because time-invariant parametric linear regression models are based on restrictive functional form assumptions and are

TABLE 4 Cross-sectional dependence tests

Variable	Test	Test statistic
Panel A: Export volume		
	Breusch–Pagan LM	415.536***
	Pesaran scaled LM	38.004***
	Bias-corrected scaled LM	37.726***
Panel B: Economic complexity		
	Breusch–Pagan LM	203.298***
	Pesaran scaled LM	15.632***
	Bias-corrected scaled LM	15.354***
Panel D: Inflation rate		
	Breusch–Pagan LM	91.857***
	Pesaran scaled LM	3.885***
	Bias-corrected scaled LM	3.607***
Panel E: Real exchange rate		
	Breusch–Pagan LM	415.536***
	Pesaran scaled LM	38.004***
	Bias-corrected scaled LM	37.726***
Panel F: Openness to trade		
	Breusch–Pagan LM	192.335***
	Pesaran scaled LM	14.476***
	Bias-corrected scaled LM	14.199***
Panel G: Gross domestic product		
	Breusch–Pagan LM	630.084***
	Pesaran scaled LM	60.619***
	Bias-corrected scaled LM	60.341***
Panel H: Foreign direct investment		
	Breusch–Pagan LM	108.355***
	Pesaran scaled LM	5.624***
	Bias-corrected scaled LM	5.346***
Panel I: Institutional quality		
	Breusch–Pagan LM	235.905***
	Pesaran scaled LM	19.069***
	Bias-corrected scaled LM	18.791***

Notes: The null hypothesis for all tests is “no cross-sectional dependence”.

Abbreviation: LM, Lagrange multiplier.

** $p < .05$; *** $p < .01$.

TABLE 5
 Cross-sectionally augmented IPS unit-root test

Variables	Intercept only		Intercept and trend	
	Level	First difference	Level	First difference
Export volume	−1.305	−1.626*	−2.236	−2.597***
Economic complexity	−1.764	−3.884***	−1.960	−2.333***
Inflation rate	−3.275***	−3.095***	−3.940***	−3.726***
Real exchange rate	−0.749	−3.354***	−1.770	−2.915*
Openness to trade	−1.736	−2.210*	−2.411	−3.145**
Gross domestic product	−1.545	−2.400*	−1.651	−2.488*
Foreign direct investment	−1.946	−2.469**	−1.568	−2.469**
Institutional quality	−2.064	−4.135***	−2.791	−4.365***

Notes: The null hypothesis for the test is “presence of unit-root in panel data with cross-sectional dependence”. Critical values are obtainable in Pesaran (2007). Cross-sectionally augmented IPS generates panel averages of cross-sectional augmented dickey fuller test statistics.

* $p < .1$; ** $p < .05$; *** $p < .01$.

therefore prone to misspecifications that result in biased and inconsistent parameter estimates when the actual nature of the underlying functional form is unknown (Dogan et al., 2018). Moreover, factors such as trade policy changes, business cycles and macroeconomic fluctuations can introduce non-linearities and parameter instabilities into the economic complexity–trade nexus. Hence, a non-parametric time-varying framework which allows the data to “speak for itself” is again adopted for the robustness check. Non-parametric regression models eliminate the need for prior knowledge about the exact nature of functional forms and also relax linearity assumptions, thereby providing some degree of flexibility in data exploration (Dogan et al., 2018; Lee & Robinson, 2015). By employing a non-parametric time-varying approach, common trend functions are treated as functions of time to capture common global shocks that may occur as a result of factors such as economic depressions/recessions and shocks. Non-linearities and country-specific heterogeneities are also captured through time-varying coefficient functions (Liddle et al., 2020).

Following the methodological approach of Li et al. (2011), this study adopts a non-parametric time-varying coefficient panel data model with fixed effects. Although this approach is superior to time-invariant parametric CCEMG in the sense that it is generally robust to factors such as parameter instabilities, non-stationarity, regime shifts and time variations, it is inferior on the grounds that it is not robust to cross-sectional dependence. Both approaches are therefore used alongside each other in this study. The econometric model relating economic complexity to trade is specified thus:

$$EXP_{it} = f_t + X_{it}^T \beta_t + \alpha_i + e_{it}, i = 1, \dots, N, t = 1, \dots, T, \tag{7}$$

where EXP_{it} is export volume; $f_t = f_i(t/T)$ represents unknown trend functions; $X_{i,t} = (EC_{it}, INF_{it}, REXR_{it}, OP_{it}, GDP_{it}, FDI_{it}, IQ_{it})^T$ is a vector of the regressors—economic complexity, inflation rate, real exchange rate, openness to trade, gross domestic product, foreign direct investment and institutional quality; $\beta_t = (\beta_{t,1}, \dots, \beta_{t,6})^T$ represents an unknown vector of time-varying coefficients; α_i stands for unobserved individual effects; N is the size of the cross-section; T is the length of the time series; and e_{it} is the error term.

The trend functions and time-varying coefficients showing the impact of economic complexity on trade are obtained using the local linear dummy variable estimate owing to its superiority over available alternatives in terms of rate of convergence of coefficient functions (Li et al., 2011; Sadik-Zada & Loewenstein, 2020). Also, confidence intervals for the trend and time-varying functions are constructed via wild bootstrapping.

TABLE 6 Common correlated effects mean group

Variables	Estimates	SE	p-Values
EC	0.014***	0.003	.000
INF	0.024	0.023	.300
REXR	0.043*	0.023	.064
OP	0.031*	0.016	.081
GDP	0.107***	0.029	.000
FDI	0.016**	0.006	.012
IQ	0.013*	0.007	.051
Constant	−3.873	7.243	.593
Observations	190		
Groups	10		
F Statistic	4.02***		
R^2_{MG}	0.87		

Notes: R^2_{MG} is the mean-group R^2 .

* $p < .1$; ** $p < .05$; *** $p < .01$.

5 | EMPIRICAL RESULTS

5.1 | Parametric results

The parametric CCEMG estimation outcomes are shown in Table 6. Economic complexity is found to have a positive and significant impact on export volume in the selected African countries. Specifically, a percentage point increase in economic complexity is capable of inducing an increase of 0.014% in export volume. The result is significant at $p < .01$. This establishes the importance of economic complexity on the continent. With regards to control variables, the results show that currency depreciation positively impacts export volume in Africa as it makes domestically produced goods relatively cheaper in comparison with foreign goods. A percentage increase in the real exchange rate (currency weakening) will cause export volume to increase by 0.043%. The result is significant at $p < .1$. Openness to trade likewise positively affects export volume, reflecting the importance of policies that are positively disposed towards trade. A percentage increase in openness will raise export volume by 0.031%. The result is significant at $p < .1$.

GDP has the largest impact on export volume. A percentage increase in GDP will result in 0.107% increase in export volume. The result is significant at $p < .01$. This indicates that the overall size of an economy chiefly determines its trade performance. FDI also has a positive and significant impact on export volume. When FDI rises by 1%, exports are expected to rise by 0.016%, with the result being significant at $p < .05$. Results also show that the quality of institutions is an important determinant of export performance. This indicates that factors such as political instability, corruption, rule of law, regulatory quality, government effectiveness and voice and accountability elicit macroeconomic responses. A one-percentage point rise in institutional quality is able to cause a 0.013% rise in export volume. The coefficient for inflation rate is insignificant, making it impossible for us to reach any conclusion concerning the nature of its relationship with exports on the basis of our analysis.

It is, however, worthy of mention that while economic complexity significantly improves exports, its positive effect on exports is not as powerful as those of GDP, real exchange rate, trade openness and FDI. This suggests that, although policies that emphasize economic complexity are useful, they should not be treated as stand-alone policies. Instead, governments should adopt holistic trade policy reforms that take economic complexity into account, along with other factors such as exchange rates, economic growth, trade openness and FDI.

TABLE 7 Non-parametric time-varying coefficient panel data model with fixed effects

Year	EC	INF	REXR	OP	GDP	FDI	IQ
2000	0.012	−0.000	−0.014	0.064*	0.041**	−0.432	0.001
2001	0.012	−0.001	−0.011	0.066*	0.065**	−0.395	0.001
2002	0.012*	−0.002	−0.007	0.067*	0.097**	−0.357	0.001
2003	0.012*	−0.003	−0.004	0.069*	0.121**	−0.320	0.000
2004	0.013*	−0.004	−0.001	0.070*	0.153**	−0.283	0.000
2005	0.013*	−0.005	0.002	0.072*	0.182*	−0.245	0.001
2006	0.013**	−0.005	0.005	0.073*	0.200*	−0.208	0.001
2007	0.013**	−0.006*	0.008	0.074*	0.234*	−0.171	0.002
2008	0.013**	−0.007*	0.012	0.076*	0.263*	−0.133	0.002
2009	0.013**	−0.008**	0.015**	0.077*	0.294**	−0.096	0.003
2010	0.013**	−0.009**	0.018***	0.079*	0.327**	−0.059	0.003
2011	0.013**	−0.010**	0.022***	0.080*	0.340	−0.021	0.004
2012	0.014**	−0.011**	0.025***	0.082*	0.373	0.002	0.004
2013	0.014**	−0.011**	0.028***	0.083	0.406	0.005*	0.004
2014	0.014**	−0.012**	0.032***	0.084	0.439	0.009*	0.005*
2015	0.014**	−0.013**	0.035***	0.086	0.462	0.013*	0.005*
2016	0.014**	−0.014**	0.038***	0.087	0.484	0.016*	0.006*
2017	0.014**	−0.015**	0.042	0.089	0.515	0.020*	0.006*
2018	0.014**	−0.016*	0.045***	0.090	0.547	0.023*	0.007*
Mean	0.013	−0.011	0.030	0.073	0.180	0.014	0.006

Notes: Mean refers to the average of the significant coefficients. A total of 10,000 bootstrap replicates were performed.

p* < .1; *p* < .05; ****p* < .01.

5.2 | Non-parametric results

Table 7 reports the results of the non-parametric time-varying model with fixed effects. To rid the independent variables of the presence of unit roots, data stationarization via detrending was carried out. The year-on-year parameter estimates showing the impact of economic complexity on trade volume indicate that the effect is positive and predominantly significant. The only recorded insignificant years are 2000 and 2001. Overall, the size of the coefficient increased slightly with time with an average value of 0.013. This is an indication that a percentage point increase in economic complexity is capable of raising export volume by 1.3% on average. The size of the coefficients from the non-parametric (0.013) and the parametric (0.014) models are not significantly different from each other. The results also show that inflation rate negatively impacts export volumes, while currency depreciation, openness to trade, GDP, FDI and IQ have positive impacts. Figure 1 is a representation of the coefficients reported in Table 7, showing the evolution of the time-varying parameter estimates over time. The graph confirms the gradual increase in the size of the coefficient over time. This shows the growing importance of economic complexity for exports in Africa.

6 | CONCLUSION AND POLICY IMPLICATIONS

Africa's production process is currently predominantly labor-driven. The continent currently has minimal capacity for production and export of value-added goods owing to its low economic complexity. Consequently, countries within the continent are still insignificant players in the international trading system. An examination of the economic complexity

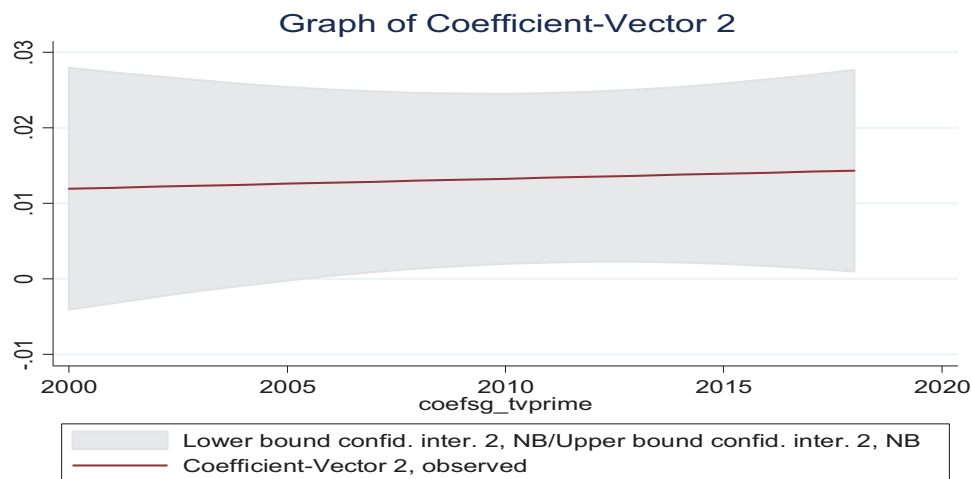


FIGURE 1 Coefficients of economic complexity [Color figure can be viewed at wileyonlinelibrary.com]

index shows that high complexity index is associated with the production of complex goods that are technology intensive, whereas lower levels of complexity index are correlated with the production of basic goods such as primary commodities. Africa's concentration on the exports of these basic commodities has not led to any significant growth in its international trade position over the years, thus suggesting the need for strategic change in the structure of the continent's export basket. The impact of economic complexity on the export volume of African countries was thus examined in this study. The aim was to determine whether Africa can considerably improve its exports by developing its economic complexity.

To this end, both parametric and non-parametric panel data techniques were employed to disentangle the connection between economic complexity and export volumes in a panel of the top 10 exporting countries in Africa that jointly account for approximately 78% of the total exports from the continent. Specifically, the parametric CCEMG estimator was first employed to test the relationship. The choice of this alternative approach is due to the following: robustness to cross-sectional dependence, structural breaks, short-run dynamics, non-stationarity, non-cointegrated common factors and serial correlation. It also displays satisfactory small sample properties. A data-driven non-parametric time-varying coefficient panel data model with fixed effects was then employed for a robustness check and also as a means of examining the evolution of the relationship over time.

Findings from both approaches conclusively showed economic complexity to be a key determinant of export performance in Africa. A percentage point increase in economic complexity was found to be capable of raising export volume by 0.013–0.014% in Africa. This paper thus provides empirical evidence to support the need for more complex economies as a means to achieve improved global trade performance on the continent. This study reinforces the importance of production capacity development for its ability to considerably drive trade. Moreover, the findings confirmed real exchange rate, openness to trade, GDP and FDI as determinants of exports in Africa.

The empirical findings from this study unambiguously indicate that the quality of the composition of a country's export basket matters more than the volume of exports from the country. A country's ability to export better quality products gives it more clout in the international trading system. This limits the vulnerability of such a country to international trade shocks that may be caused by factors such as price competition from low-wage countries (Amiti & Khandelwal, 2013; Henn et al., 2020). Recommendations based on these findings follow below.

First, there is a need to expand the domestic innovation capabilities of African countries and bolster their ability to quickly adapt to new technology in a way that makes it possible for them to not only significantly diversify their product baskets, but also attain low ubiquity. As such, African countries will not only be able to transition from producing primary commodities to producing technology-intensive manufactured goods, but will also be able to increase the variety of products that they export. This requires huge investments in human capital development and research and development across the continent. Strong cooperation between the tertiary institutions and the private sector should also be prioritized so as to ensure the supply of workers with relevant skills to the private sector.

Second, African countries can also improve trade performance by adopting holistic trade policy reforms that take economic complexity into account, along with other factors like exchange rate control (lower values of real exchange rate lead to cheaper exports, which improves export competitiveness), economic growth (richer countries can afford to

invest more in the export sector), trade openness (unhindered international trade results in more efficiently allocated resources and expanded global production frontiers, since countries concentrate on goods that they have a comparative advantage at producing) and FDI (which boosts exports directly by making desperately needed capital available and indirectly by facilitating the diffusion of technological know-how). As observed from our analysis, the positive effect of economic complexity on exports is not as powerful as those of GDP, real exchange rate, trade openness and FDI. This suggests that, although policies that emphasize economic complexity are useful, they should not be treated as stand-alone policies.

ENDNOTE

¹World Bank, World Development Indicators (2020).

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