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Taxation, Economic Growth and Trade Openness in African Countries: Heterogeneous and Semi-parametric Panel Causality Analysis

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Abstract: The coming into force of the African continental free trade area to enhance intra African trade relations has implications for trade openness due to the harmonization of trade liberalization processes in member countries. These countries experience declining levels of trade taxes thereby reducing their overall tax revenue which adversely affects economic growth. However, other empirical evidences reveal that trade openness positively drives tax revenue through increased productivity from importation of inputs leading to economic growth. In view of the uncertainty in the relationship, this study attempts to empirically examine the causal effects of economic growth and trade openness on taxation for selected African countries**.** In view of the uncertainty in the relationship, this study attempts to empirically examine the causal effects of economic growth and trade openness on taxation for selected African countries by using semiparametric heterogeneous panel causality analysis to estimate the annual dataset from 2000 to 2019. The semi-parametric estimates show a *U*-shaped effect between growth and taxation, while it reveals elastic opposite direction effect of trade openness on taxation. This result suggests that higher growth tends to have positive influence on taxation, and trade openness show a positive effect on economic growth. The Dumitrescu-Hurlin heterogeneous Granger causality test indicates bidirectional causality between growth and taxation, and a unidirectional causality from trade openness to taxation, and from growth to trade openness which supports the nexus between growth and taxation. Therefore, economic growth and trade openness can predict sustainable tax levels, as such African countries should implement trade openness policies through low tariff rate adjustments to enhance tax revenue performance for economic growth.

Keywords: Taxation; Economic growth; Trade openness; Semiparametric panel; Africa

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1. Introduction

Theoretically, the connection between taxation and trade openness is identified through economic growth or price changes as pointed out by various studies (Frankel & Romer, 1999; Ebrill, Gropp & Stotsky, 1999 and Tanzi, 1987). In particular, Ebrill, Gropp and Stotsky, (1999) reveal that trade openness is associated with high levels of economic growth and that countries which have with greater trade openness have increased their growth levels and tax levels. Frankel and Romer, (1999) also point out that trade openness significantly raises income in the sense that higher volumes of trade derived from increased share of exports and imports in GDP induce higher incomes. In further support of the hypothesis that trade openness leads to increase trade volumes and economic growth, Addison and Levin (2006) explain that the growth in the economy is likely to be affected directly by income taxes. Thus, higher per capita income may lead to widening of the tax base for higher income taxes. Tanzi (1987) provides a theory of tax base and tax handle in favour of the causal link between per capita income and tax levels where it is stated that an increase in per capita income increases the size of public sector thereby raising the country's tax base and taxable capacity.

The latter part of the twentieth century has been associated with substantial expansion in trade flows, capital movements as well as mobility of labour across borders. During the period world trade in goods and services has grown dramatically from about US $6.199 trillion in 1994 to approximately US $26.02 trillion in 2012. This reflects a growth rate of 76.1 percent (World Bank, 2012). In African, trade within the continent is rising fast but is still at low levels compared to developed countries. For instance, in 2016 Africa's goods export was valued at about US$361 billion, while services exports reached almost US$96 billion. In addition, intra-African trade valued at US$129 billion accounts for about 15.4% of the Africa's total goods trade in 2016 (UNCTADStat, 2016). The rise in African trade has been attributed to technological improvement on transportation and communication which have greatly reduced the costs of transporting goods, services as well as factors of production. Additionally, the increasing convergence of tastes and preference of individuals and societies has increased demand for goods and services across countries. Lastly, the global economic cooperation has led to trade openness or reduction and removal of barriers to free trade. These three reasons have influenced the growth in world trade and African trade as well (World Trade Organization, 2013).

According to the WTO, the importance of trade openness is influenced by four major factors which may be derived from unilateral trade openness policies as well as from regional and multilateral negotiations (World Trade Organization, 2013). The first gain from trade openness is that it allows countries to export those goods and

services that they make efficiently and to import those goods and services that they make inefficiently. Secondly, trade openness leads to lower prices, enabling an increase in real income which increases consumer and producer welfare. Additionally, trade openness leads to gains in total factor productivity where unrestricted trade exposes countries to new production technologies that foster higher productivity at both firm and industry levels. Also, trade openness enables low income countries to raise their income levels towards high income countries (Gupta, 2007; Frankel & Romer, 1999).

Policy makers have argued that the reduction or removal of barrier to free trade, such as import tariffs lower import prices but also reduces an array of taxes charge on importation. The gains from removal of barriers to free trade are expected to increase domestic output through the use of better imported skills and technology to foster high productivity at both firm and industrial level; thereby lowering import for certain categories of goods but also increasing revenue performance of domestic productions. Often, tariffs are introduced to boost government revenue and not as a protective device, particularly in less developed countries. This is so when duties are levied on imported goods for which there is no substitute in domestic production. There may, however, be indirect protective consequences in the use of tariffs. Developing countries tend to be confronted with erosion of their trade tax revenue which eventually affects their total tax revenue as a result of inevitable process of increased trade liberalization (Sena, 2019). As a result these countries have engaged in tax transition reforms to change their tax revenue structures towards domestic tax revenue. In view of this, there is the need to understand the relationship between trade openness and taxation in order to know the appropriate tax policy design for countries that can accommodate the effects of trade liberalization and not to hurt the domestic economies. Therefore, given the lack of empirical consensus on the exact relationship between taxation, trade openness and economic growth in African countries, this study will help provide some empirical evidence in that respect.

This study has become, particularly important considering the coming into force of the African Continental Free Trade Area (AfCFTA) agreement which commits countries to remove tariffs on 90% of goods, progressively liberalize trade in services and address a host of other non-tariff barriers. It is therefore imperative to ascertain the causal effects of the removal of tariffs and the liberalized trade on tax revenue of African countries and the implications on economic growth. This would equip policy makers to design domestic fiscal policies that could take objectives of the continental trade agreement into consideration.

The remainder of this paper is organised as follows: Section 2 briefly looks at the theoretical development and existing empirical works on the subject. This is followed

by the empirical model and the estimation techniques in Section 3. The empirical results are discussed in Section 4 and finally the section 5 concludes the study.

2. Literature review

This section briefly reviews related literature on the subject organized in three main themes which touches on the relationship between trade openness and taxation, taxation and economic growth as well as, trade and economic growth.

2.1. Trade openness and taxation

Literature reveals that the relationship between trade openness and tax, particularly indirect taxes is more complicated to assess as compared to the relationship between trade openness and income taxes. This is because the effects of trade openness on indirect taxes depends on many factors such as the price elasticity of demand for imports and the price elasticity of supply of import substitutes (Addison & Levin, 2006). For example, when import tariffs are reduced, the relative price of imports to substitutes of imports may also decrease, which tend to shift domestic consumption toward these imports. Subsequently this may lead to a fall in domestic taxes on production of import substitutes and an increase in taxes from imports.

The effect of trade openness on tax can also be viewed through its impact on economic growth. For example, the assumption that tax bases grow as economic growth proceeds is also true for the consumption tax. The growth in the economy is also related to the growth in the consumption tax base (Addison & Levin, 2006). Therefore consumers should have more income in their hand as the economy grows, which means that there is higher purchasing power and higher demand for domestic consumption.

Nonetheless, Tanzi (1989) points out that there is no correlation between consumption taxes and income per capita. In the same way the amount of consumption taxes collected depends directly on the domestic consumption, that is, larger countries tend to have a high population and a large domestic market whereas smaller countries seem to have a smaller population and their size of domestic market is smaller. As a result, switching sources of tax from trade tax to a broad-based consumption tax, although applicable for developed countries, may cause fiscal problems for developing and less developed countries which have smaller market sizes. Therefor the impact of trade openness ought to be evaluated.

Gupta, (2007) studies the principal determinants of tax performance across developing countries by using a broad dataset of 105 countries over 25 years. The study noted that per capita GDP, agriculture share in GDP, trade openness, foreign

aid, corruption, political stability, the share of direct and indirect taxes are significant in determining tax performance. In conclusion, the study finds that tax collections are low in countries which heavily depend on taxing goods and services, while countries that depend on income taxes have high outturn of tax. However for countries that have opened up their trade regimes, trade taxes appear to have declined.

Similarly, Ebrill, Gropp and Stotsky, (1999) proposes that if trade openness is accompanied with a reduction in tariff dispersion, then tax revenue may increase. This is because if a reduction in the dispersion of tariff is often done by lowering the higher tariff and increasing lower tariff in order to obtain average values. The study further proposes that if the initial tariff rates are high, then tariff reduction may lead to an increase in tax revenue since price elasticities of demand and supply are not constant over the entire range of prices. This effect is explained by Laffer (2004) that when the initial tariff rate is prohibitively high, the trade volumes are likely to be adversely affected and tax would be low. Therefore, reducing tariffs lead to a substantial increase in trade volumes and a decrease in the incentive to evade taxes. However, if there is a further tariff reduction after trade has been fairly liberalized at the tax maximizing rate, the increase in trade volume would not be large enough to offset the lower tariffs and so the direct effect of tariff reduction would result in the loss of taxes. As a result, overall tariff revenue tends to decrease (Ebrill, Gropp & Stotsky, 1999; Laffer, 2004; Agbeyegbe *et al*, 2006).

Examining the relationship from the perspective of trade openness and economic growth volatility, Mireku *et al*., (2017) used data from Ghana for the period 1970-2013 and applied cointegration and error correction techniques for the analysis. The result shows that economic growth volatility affects trade openness in the long as well as the short run. In particular, shocks after the economic liberalization and financial openness among other variables influence economic growth volatility in the short run. In a related study, Silajdzic and Mehic (2018) examine the empirical evidence on the benefits of trade liberalization and the possible theoretical issues on adverse effects of trade openness. They find that openness measured by trade intensity indicators may lead to misleading conclusions about the trade- growth nexus. They conclude that the positive influence of trade barriers on economic growth goes well beyond the context of transition.

2.2. Taxation and economic growth

Some countries with high tax burdens have high growth rates and some countries with low tax burdens have low growth rates. Despite much theoretical and empirical inquiry as well as policy controversy, no simple answer exists concerning the relationship of tax on economic growth especially in developing countries.

Theoretical literature suggests that taxes have negative effect on economic growth in the sense that higher rates may be more distortionary and diminish economic growth while lower rates may generate revenues that are spent in productive ways. However, the empirical literature suggests both direct and indirect relationship between tax burdens and rates of growth, so higher tax burden can decrease or elevate the rate of economic growth. Thus, future economic output may be higher with the optimal rate of taxation and hence future tax revenues would be higher with a lower rate of taxation.

Skinner (1988) used pooled cross-section time-series data set for 31 sub-Sahara African countries during 1965-72 and 1974-82 to conclude that income, corporate, and import taxation led to greater reductions in output growth than average export and sales taxation. Easterly and Robelo (1993) sampled 32 developing countries and applied a growth model on average marginal income tax rates that combines information on statutory rates with the amount of tax revenue collected and data on income distribution. As expected, they find positive correlation between income and weighted average marginal tax rates; and the level of real per capita income. This explains why developed economies tend to rely more on income taxes than less developed countries. In their case, Padda and Akram (2009) tests whether tax policies conducted by Pakistan, India and Sri Lanka have transitory or permanent effect on their economic growth over the period 1973–2008 and they find that the impact of tax rate changes is transitory and negative in the short-term for Pakistan and India but for Sri Lanka it is positive for first year and thereafter it turned negative on economic growth. By examining the impact of tax revenue on the economic growth in Nigeria judging from its impact on infrastructural development from 1980 to 2007, Worlu and Emeka (2012) find that tax revenue stimulates economic growth through infrastructural development.

To analyse the effects of various tax handles on economic growth, the study by N'Yilimon (2014) examines the four types of taxes, namely taxes on revenue, taxes on goods and services, taxes on income, profits, and capital gains as well as taxes on international trade on economic growth of 47 developing countries. By using the system GMM estimator over the period 2000–2012, the study finds a non-linear relationship between taxes on revenue and economic growth. In addition, there exists a nonlinear (U-shaped) relationship between taxes on income, profits and capital gains, international trade and economic growth. In their study, Nanthakumar *et al.*, (2017) also examine the causal relationship between economic growth and stock traded on taxation for selected emerging Asian countries including China, India, Indonesia, Republic of Korea, Malaysia and Thailand for a period covering 1990-2014. They find a *U*-shaped effect between growth and taxation suggesting higher growth leading to positive effect on taxation. The result also revealed a bi-directional causality between

growth and taxation suggesting the presence of a growth-taxation nexus in emerging Asian countries.

2.3. Trade openness and economic growth

In view of no simple and clear theoretical explanations on the effect of trade restrictions and economic growth, it is not surprising that empirical evidence on the benefits of trade openness measured using various trade policy indices reveals mixed results and inconclusive evidence. In the study of Yanikkaya (2003), evidence show that trade restrictions in the form of tariffs, as well as trade related taxes, are positively associated with economic growth relying on a large sample of both developing and developed countries and concludes that the relationship between trade openness and growth is complex and depends on the level of development and the size of the economy of an individual country as consistent with theoretical propositions. Similarly, contrary to the conventional view that trade barriers are distortive and detrimental to growth, Rodriguez and Rodrik (1999) have found that the average tariff growth rates positively affect the total factor productivity growth (TFP) for the sample of 46 countries over the 1980–1990 period, while Edwards (1993) suggests a rather weak relationship between trade restrictions and economic growth. Contrary to these findings, a study by Harisson (1999), for example, found a significant and negative effect of tariff rates on economic growth.

Notwithstanding the inconsistency in the results obtained from the empirical investigation of the effect of trade restrictions on economic growth, other studies, which rely on trade intensity measures as export and import to GDP ratio as well as export to GDP ratio among others, by and large reveal evidence on the positive impact of trade on economic growth (Alcala & Ciccone, 2004; Busse & Koeniger, 2012). Nonetheless, it has been argued that studies which attempt to use conventional measures of trade openness, that is, trade intensity ratios as proxy for trade openness, suffer from serious inconsistencies between theoretical propositions and empirical findings.

Contemporary trade theories integrated in endogenous growth models imply that trade may be beneficial to economic growth with the underlying mechanism of influence relating to increases in economies of scale, technology transfer and knowledge-related externalities, as well as an increased competition. These mechanisms positively affect productivity patterns of local firms and industries, raising value addition and income. However, these mechanisms are conditional on endogenous nature of technological change and subsequent growth and diversification of industrial production and export base. Essentially, the theoretical presupposes that the differences in the levels of industrial development and technological capabilities across countries may well be

associated with possible different outcomes of trade openness on economic growth, depending on the size of the economy, technological proficiency and the degree of industrial diversification (Rodrigez & Rodrick, 1999).

According to Rodrick and Rodrigez (2001) moreover, using trade volume and trade intensity indicators as a proxy for trade openness may be entirely misleading. They explain that apart from differences in the size of the economies and the overall level of development, higher export and import shares to GDP may well reflect on a countries' technological prowess and its industries' ability to boost growth via exports and/or imports of technology, production-related factor inputs and intermediary products. This in effect means that increased trade integration may not necessarily be related to government's exercise of trade-related 'neutrality principle'.

Kitessa and Jewaria, (2018) examine the key determinants of tax revenue in East African countries from 1992-2015 by using panel cointegration techniques with focus on the Feasible Generalized Least Squares (FGLS) and dynamic General Method of Moments (GMM). The FGLS result indicates among other variables that per capita GDP and trade openness have positive effect on tax revenue of East African countries over the study period. A similar study by Micah *et al.*, (2017) employed a panel data cointegration technique to investigate the effects of trade openness on different categories of taxes for East African countries covering the period 1994-2012. They find that the average tariff rate used as a measure for trade openness positively influences total tax, indirect tax and trade tax while the average tariff rate squared impacts the taxes negatively confirming the Laffer curve theory.

From a panel of developing country perspective, a study by Sena (2019) empirically analyse 92 developing countries from 1980-2014 to ascertain whether countries that engage in transition tax reforms experience greater openness. The findings show that least developed countries (LDCs) appear to enjoy a higher effect of tax reform on trade openness than non-LDCs. This suggests that in general LDCs enjoy a high positive effect of tax reform on trade openness than relatively advanced developing countries. In a related study to assess the impact of trade liberalization on tax structure, Mohammad *et al.*, (2016) use a panel of 97 developing countries for the period 1993-2012 and applied the fixed effect estimator for the analysis. The results reveal that trade liberalization in the form of trade openness did not have a strong impact on major tax sources of developing countries. Instead, trade liberalization in the form of tariff reduction seems to have a contribution to tax structure in these countries.

From the above literature review, it is apparent that the causal relationship between the variables is not direct as they influence each other in different ways depending on the nature of the country, trade policies, tariff regimes and their economic

characteristics. It is therefore imperative to understand the causal effects of the study variables in the African countries to help design appropriate fiscal policy responses to the implementation of the AfCTA agreement, especially the transition tax reforms in various countries towards domestic tax revenue mobilisation.

3. Empirical model and data

3.1. The empirical model

The basic function of the variables used in this study can be written as follows:

$$Tax_{it} = A\, TradeOpen_{it}^{\varphi}\, Growth_{it}^{\gamma}\, Growth_{it}^{2\delta} \tag{1}$$

where A is the constant value, *Tax* is the natural log of total tax revenue (percentage of GDP); *TradeOpen* is the natural log of trade openness (percentage of GDP), *Growth* and *Growth squared* is the natural log of per capita income converted from the domestic currencies using the current currency exchange rates in the international currency market.

While, φ, γ and δ represent the coefficients for trade openness, growth and growth squared respectively.

When dealing with time series panel estimates, attention must paid to robustness and whitenoise.

To overcome this problem, the variables are transformed into logarithm so the basic function is specified with *apriori* expectations as:

$$Tax_{it} = f\left(\begin{array}{ccc} + & + & + \\ TradeOpen_{it} & Growth_{it} & Growth_{it}^{2} \end{array}\right) \tag{2}$$

Tax revenue (Tax) is the independent variable which is defined in terms of trade openness *(TradeOpen)* and Economic Growth (*Growth*) measured as GDP per capita.

Trade openness (TradeOpen) is expressed as a ratio of the sum of exports and imports of goods and services to GDP and it measures the degree to which a country is open to international trade. Greater trade openness may be beneficial in two ways; first, cost of exports fall, while the cost of imported goods and services increase. This increase in the traded goods widens the tax base and likely to encourage a transition from cross-border taxation to domestic taxation. Given that trade creates jobs, expands markets, facilitates competition; disseminates knowledge and raises income, particularly in less developed countries a main engine of growth, trade openness is expected to have a positive effect on tax revenue (Kitessa & Teera, 2018).

Economic growth (Growth) is a sustained increase in GDP which lead to increase in GDP per capita used to measure the relative economic performance of one country

in relation to another. It is a tool for comparing the economic welfare of countries over a period of time; as such higher incomes lead to higher GDP per capita which culminate into higher tax GDP ratio. Therefore, a positive relationship is expected between GDP per capita and tax revenue.

3.2. The Analytical techniques

This study examines the causal relationship between tax revenue, economic growth and trade openness using the fundamental growth theory. The analysis is in three phases, the first phase estimates the parametric-based fixed effects and the semi-parametric aspect. The second phase involves identification of the order of integration while the third stage determines the long-run cointegration relationship between the variables.

As a pre-estimation procedure before the cointegration test, the time series properties of the panel data needs to be examined using the panel unit root tests. Each of the panel unit root tests has its own strength and is becoming popular because of its ability to capture the country-specific effects, and at the same time allow for heterogeneity on the direction as well as the magnitude of the parameters.

As mentioned by Yatchew (1998) and Zhu, You, and Zeng (2012), most of the economic theories have not been able to capture the specific form of relationship between the dependent and independent variables, especially when we are dealing with time series estimation.

According to Baltagi and Li (2002), the semi-parametric panel estimation is a suitable and flexible model which is able to avoid misspecification in estimation and is more accurate for panel data. The semi-parametric model was established based on equation (1), and we eliminated the unobserved heterogeneity effects of β_1 by introducing a first difference of the variables as proposed by Desbordes and Verardi (2012) as follows:

$$P^d(Growth_{it}),(Growth_{it-1}) = [P^d(Growth_{it}) - P^d(Growth_{it-1})] \tag{3}$$

where, P^d represents the sequence function of the panel series of equation (4) and to illustrate the sequence using graphs, we used the *B*-spline regression model with $d = 2$. Once the semi-parametric relationship was obtained, the next useful step was illustrated by the fitted partial semi-parametric curve. Desbordes and Verardi (2012) and Zhu *et al.*, (2012) suggest that the partial fitted semi-parametric curve is based on the following equation:

$$\varepsilon_{it} = \hat{\beta} - \hat{\beta}_1 \ TradeOpen \tag{4}$$

where, ε_{it} is defined as,

$$\varepsilon_{it} = f(Growth_{it}) + \mu_{it}$$

The next stage is to determine the long-run cointegration between taxation and the control variables. Basically, the Pedroni (1999) cointegration has seven different statistics, such as the panel Augmented Dickey-Fuller (ADF)-statistic, panel Phillips-Perron (PP)-statistic, panel ρ-statistic, panel *v*-statistic, group ADF statistic, group PP-statistic and group ρ-statistic.

The first four statistics are panel statistics and based on the 'within dimensions' approach, while the last three statistics are group panel cointegration statistics and are based on the 'between dimensions' approach. In order to obtain stable cointegration estimation results, the Kao's (1999) cointegration test is employed which is based on the Engle-Granger two-step procedure. In addition, the study adopts the Dynamic Ordinary Least Square (DOLS) technique proposed by Kao and Chiang (2000) to identify the long-run cointegration relationship. In the specific case of this study, T = 20 and N = 10 which gives a relatively small T and small N panel. From the literature the use of the DOLS estimators tend to perform well in small samples. The DOLS model is considered superior to other estimation techniques because it inherently correct for endogeneity, serial correlation and asymptotic bias.

Equation (5) indicates the DOLS model:

$$Tax_{it} = \Sigma_{i=1}^{N}(\Sigma_{i-1}^{T} Tax_{it} \ln Tax'_{it})^{-1}(\Sigma_{i-1}^{T} Tax_{it} TradeOpen'_{it})(\Sigma_{i-1}^{T} Tax_{it} Growth'_{it}) \quad (5)$$

Afterwards, the heterogeneous panel cointegration test is conducted based on Westerlund (2007). This test is considered to be more accurate with capturing the error correction term by inferring the null hypothesis of no cointegration with four types of different test statistics. These four different statistical values can be divided into two major groups, which are the panel statistics, represented by P_{τ} and P_{α} and the mean for group statistics represented by G_{τ} and P_{α}.

In addition, the estimation continues with the Pooled Mean Group (PMG) technique proposed by Pesaran, Shin, and Smith (1999). As usual, the sign of the lagged error correction term should be negative and significant, implying that the variables return to long-run equilibrium stage from the short-term unstable condition. From equation (6), ect_{t-1} represents the error correction term, while γ_i is the coefficient measuring the speed of adjustment.

$$\begin{aligned} Tax_{it} = {} & \propto_1 + \Sigma_{i=1}^{m-1} \beta_{ik} \Delta Tax_{i,t-k} + \Sigma_{k=0}^{n-1} \varphi_{ik} \Delta TradeOpen_{i,t-k} + \Sigma_{k=0}^{p-1} \gamma_{ik} \Delta Growth_{i,t-k} + \\ & \Sigma_{k=0}^{q-1} \sigma_{ik} \Delta_{ik} Growth_{i,t-k} + \mu_i + \varepsilon_{ik} \end{aligned} \quad (6)$$

In the final analysis, the Dumitrescu and Hurlin (2012) heterogeneous panel Granger causality test is conducted to identify the causal relationship between the

variables. This approach is more accurate compared to the traditional panel Granger causality test, where the DH causality test is specially designed for mixed *I*(0) and *I*(1) variables with nonlinear estimates. In this study, a balanced heterogeneous panel estimation methods are used and this DH model is flexible for asymptotic (T>N) or semi-asymptotic (N>T) distributions as well as in stressing the simulated critical values from thousands of replications (Akbas, Senturk, & Sancar, 2013). The DH statistic, which has the asymptotic and semi-asymptotic distributions, can be written as follows:

$$W_{it}^{DH} = (T - 2K - 1)\left(\frac{\delta_{it}\ \gamma_{it}\ \varepsilon_{it}}{\delta_{it}\ Y_{it}\ \varepsilon_{it}}\right) \tag{7}$$

$$Z_{N}^{DH} = \frac{\sqrt{N}[W_{it}^{DH} - N^{-1}\Sigma_{i=1}^{N}E(W_{it})]}{\sqrt{N^{-1}\Sigma_{i=1}^{N}Var(W_{it})}} \tag{8}$$

3.3. Data source and description

This study examines the top ten (10) richest African countries ranked by GDP and primary exports published by the IMF and World Bank in May 2021 over the period 2000–2019 with a balanced panel of series (40 observations for each country). These countries include Nigeria, South Africa, Egypt, Algeria, Morocco, Kenya, Angola, Ethiopia, Ghana and Tanzania. The countries were selected purposively based on IMF and World Bank's ranking of richest African countries as at 2020 and the data series for the study, thus total tax revenue (% GDP), trade openness and GDP *per capita* were obtained from the World Development Indicators database published by the World Bank (2021).

4. Results and discussion

The panel data set consist of 10 richest African countries as at 2020 with cross-country observations. The basic summary statistics of the variables is reported in Table 1 while the parametric fixed effect and semi-parametric estimate are reported in Table 2. The parametric fixed effect results indicate that all the series are statistically significant at a 1% level of significance with a positive sign. This indicates that, a 1% change in economic performance would lead to a 36.4% change in taxation. This shows that there is a significant positive effect between growth and taxation which provides evidence of the growth-led taxation nexus as generally expressed by Atems (2015), Bishnu, Ghate, and Gopalakrishnan (2016), Aghion *et al*, (2016); and Choi and Kim (2016). However, the positive growth squared coefficient indicates a *U*-shape effect of

economic performance on taxation and this reveals that growth conditions cause an upward movement of taxation in the longer period.

Table 1: Summary of statistics

Variables	*Mean*	*Standard Deviation*	*Min*	*Max*
Tax_{it}	3.215	0.621	–1.214	4.213
$TradeOpen_{it}$	4.131	1.102	0.512	5.113
$Growth_{it}$	2.115	0.314	–1.621	3.062

Table 2: Results of parametric (FE) and semi-parametric panel estimates

	Parametric (FE)		*Semi-parametric*	
Variables	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
Constant	1.132			
$TradeOpen_{it}$	–0.082*	2.538	–0.074*	5.356
	(0.010)		(0.004)	
$Growth_{it}$	0.244*	4.203		
	(0.007)			
$Growth^2_{it}$	0.104**	3.112		
	(0.016)			
Year dummies	√		√	
Country dummies	√		√	
R-square	0.742	0.624		

Note: *, ** denotes the rejection of the null hypothesis at 1% and 5% levels of significance; and values in parentheses indicate standard errors.

This gives an indication that the economic growth of African countries tend to follow the trend of tax movement, particularly in an upward trend. Aghion *et al.*, (2016) also find a similar *U*-shape growth-taxation nexus relationship. In contrast, the trade openness coefficient gives an opposite direction effect on taxation. It suggests that a 1% change in trade openness would lead to 8.2% change in taxation in the opposite direction. This shows that international trade activities should be considered as important factor in designing fiscal policy for African countries.

In addition to the semi-parametric estimates, the nonlinear effect of taxation growth is captured using a partial fits graph. Figure 1(a) illustrates the fitted parametric figure which compresses the taxation and growth (control variable). On Figures 1(b) and (c), each point denotes the partial residuals for the Tax series in the parametric and the semi-parametric models, respectively. The shaded area of Figure 1(c) corresponds

to 95% confidence intervals. It is therefore obvious that there exist a *U*-shaped effect when the growth series reaches 0 to 2 in both Figure 1(b) and (c). Therefore, both partial fit lines confirm the *U*-shape effects of growth and taxation for African countries.

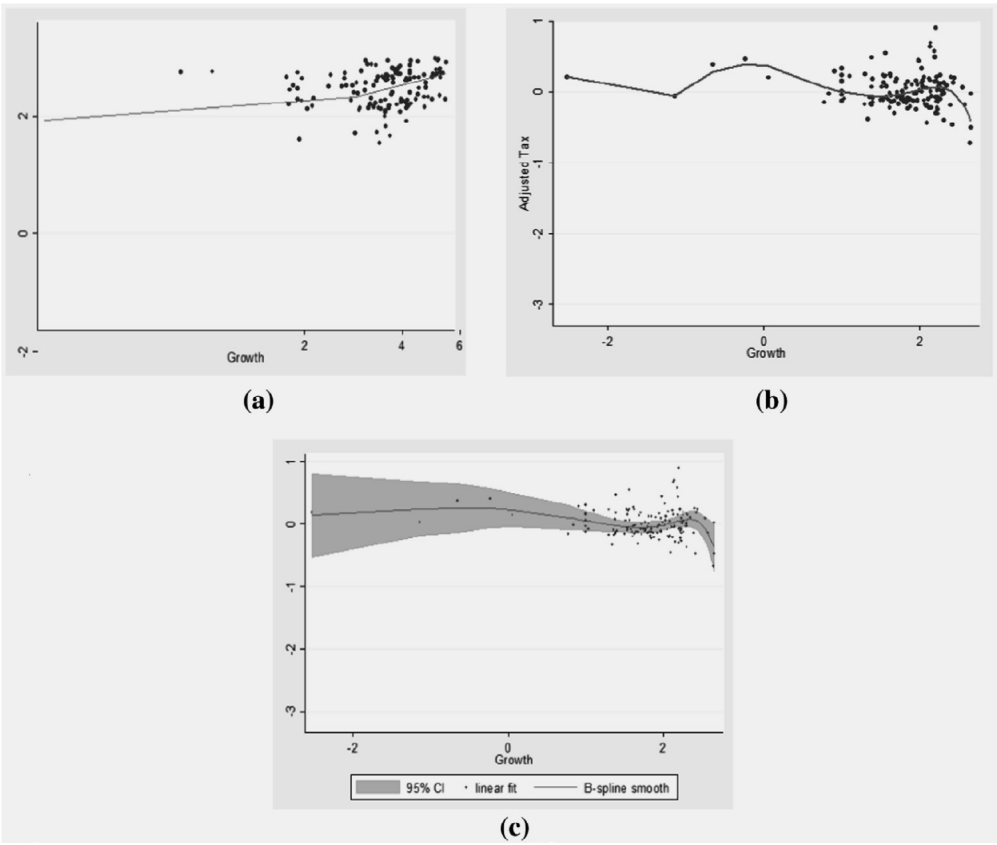

Figure 1: Linear and partial fitted graphs of the relationship between economic growth and taxation

Additionally, Table 3 reports on the panel unit root test in levels and first differences. In the levels form, we fail to reject the null hypotheses for all the unit root methods except for the trade openness variable which rejects the null hypothesis at the levels based on the Levin-Lin-Chu (LLC) test at 5% significance level and the IPS test at 1% level of significance, while the growth variable is significant at 1% using the ADF-Fisher test. With the first differences of the variable, the Levin–Lin–Chu (LLC), Im-Pesaran-Shin (IPS) and ADF-Fisher panel test results indicate a rejection of the null hypotheses at the 1% level of significance and concludes that all the variables are integrated at *I*(1).

Table 3: Panel unit root tests results

	At level		*At first difference*	
Variable	*Statistics*	*p-value*	*Statistics*	*p-value*
LLC test				
Tax_{it}	–1.213	0.065	–5.104*	0.000
$TradeOpen_{it}$	–1.922**	0.011	–4.213*	0.000
$Growth_{it}$	–0.814	0.053	–2.511*	0.000
IPS test				
Tax_{it}	–0.427	0.120	–4.355*	0.000
$TradeOpen_{it}$	–1.054*	0.010	–3.749*	0.000
$Growth_{it}$	–0.611	0.409	–4.107*	0.000
ADF-Fisher				
Tax_{it}	11.326	0.214	54.531*	0.000
$TradeOpen_{it}$	10.042	0.335	49.226*	0.000
$Growth_{it}$	25.526*	0.002	50.613*	0.000

Note: *denotes the rejection of the null hypothesis at the 1% level. The optimal lag selection is based on AIC.

Given that the unit root test declares the variables to be integrated at $I(1)$, the subsequent stage is the conduct of a long-run cointegration relationship between the variables. At this stage, the Pedroni (1999) and Kao (1999) cointegration tests are applied. Table 4 reports both the within and the between dimension panel Pedroni cointegration test results with a constant. This is based on the average and individual autoregressive coefficients related to the first order of the unit root test in the panel data sets. In addition, the study finds that two out of four Pedroni panel cointegration tests reject the null hypothesis of no cointegration at 5% and 1% significance levels for ADF-statistic and PP-statistic respectively. Also, the group panel shows that ADF-statistic rejects the null hypothesis of no cointegration at a 5% significance level.

The Kao (1999) residual test estimate for the long-run cointegration between the variables indicates a rejection of the null hypotheses of no cointegration at the 5% significance level suggesting the existence of long-run cointegration between taxation and the other variables. The cointegration results indicate that there is a long-run equilibrium relationship that exists between taxation, economic growth and trade openness. This finding is akin to the study by Bujang *et al*, (2013) which find a long-run relationship between taxation and economic growth.

Table 4: Pedroni and Kao's panel cointegration test results.

Test type	*Panel*	*Group*	*Kao*
ADF-statistic	−1.253*	−1.421**	−2.631*
	(0.002)	(0.311)	(0.000)
PP-statistic	−3.092**	−1.117	
	(0.000)	(0.031)	
ρ-statistic	−0.516	−0.723	
	(0.142)	(0.366)	
v-statistic	0.652		
	(0.203)		

Note: *, ** denote the rejection of the null hypothesis at 1% and 5% respectively. Values in parentheses indicate p-value.

Table 5 presents the dynamic ordinary least squares (DOLS) long-run cointegration results. This test reduces the number of degrees of freedom and improves the robustness of the estimates by including leads and lags in the data series. The overall panel DOLS coefficient estimates are positive and statistically significant at 5% level for economic growth and 1% level for trade openness. This implies that a 1% change in trade openness increases tax revenue by 11.7%; and 1% change in economic growth lead to 23.1% increase in tax revenue. The DOLS estimates also show that Nigeria, South Africa, Egypt, Morocco, Ethiopia, Ghana and Tanzania have positive cointegration effects caused by economic growth which satisfies the growth-taxation nexus. Furthermore, it is evident from the result that both Nigeria and South Africa have high elasticity coefficients of economic growth in relation to taxation. However, Algeria, Kenya and Angola have a negative cointegration relationship with economic growth because these countries experienced economic downturn as a result of civil wars due to political instability, low crude prices and poor weather conditions.

The results also indicate that Egypt, Morocco and Angola have negative cointegration effect with trade openness because these countries are in the process of recovery from the effects of macroeconomic instability due to pro-democracy protest and uprising since the mid-2000s which has affected annual economic growth over the period. Although these countries show similarities with respect to the impact of the macroeconomic instabilities during the time, Egypt and Morocco have demonstrated concerted efforts to economic recovery based on well-structured fiscal and trade policies in recent years. Meanwhile, countries with a huge population, such as Nigeria and Ethiopia, have a positive relationship with trade openness as these countries focus more on trade openness to attract inputs and capital to enhance domestic manufacturing activities. Governments of both countries also provide grants and subsidies to directly

develop the export sector to stabilize the balance of payments, and indirectly enhance the growth rate in various sub-sectors of the economy.

These findings are consistent with the findings of Zafar and Bukhari (2015) for Pakistan; and Enisan and Olufisayo (2009) for the sub-Saharan countries, which clearly indicate the positive effects of trade openness on economic growth. The use of the DOLS estimation also allows for diminishing returns to scale of the economic growth on taxation. In this case, the study finds that Nigeria, Egypt, Morocco, Ethiopia and Ghana exhibit an inverted *U*-shaped effect in the long-run relationship, while Kenya, Angola show a *U*-shaped effect.

Table 5: DOLS estimate results

Country	*Variables*	*Lag lenght (±)*	$TradeOpen_{it}$	$Growth_{it}$	$Growth^2_{it}$
Nigeria	Coefficient	1	0.021*	2.215*	- 3.103*
	p-value		(0.002)	(0.001)	(0.004)
S. Africa	Coefficient	2	0.011**	1.402**	1.303
	p-value		(0.026)	(0.017)	(0.139)
Egypt	Coefficient	1	- 0.213**	0.361*	- 0.746*
	p-value		(0.031)	(0.003)	(0.001)
Algeria	Coefficient	2	0.025	- 0.012**	- 0.018
	p-value		(0.114)	(0.031)	(0.204)
Morocco	Coefficient	1	- 0.014**	0.152*	- 0.312*
	p-value		(0.041)	(0.001)	(0.000)
Kenya	Coefficient	1	0.312*	- 0.301**	0.235**
	p-value		(0.003)	(0.027)	(0.032)
Angola	Coefficient	1	-0.113*	- 1.003**	0.312*
	p-value		(0.000)	(0.028)	(0.003)
Ethiopia	Coefficient	2	0.114**	0.207**	- 0.233**
	p-value		(0.038)	(0.029)	(0.041)
Ghana	Coefficient	1	0.103*	0.127**	- 0.083**
	p-value		(0.002)	(0.031)	(0.018)
Tanzania	Coefficient	1	0.073*	0.055**	0.152
	p-value		(0.000)	(0.013)	(0.071)
$Panel_{DOL}$	Coefficient	1	0.117**	0.231*	0.052
	p-value		(0.029)	(0.001)	(0.347)

Note: *, ** denote the rejection of the null hypothesis at 1% and 5% respectively. The lead and lag values are based on the AIC lag selection criteria.

Table 6 summarizes the Westerlund cointegration test results where the null hypothesis of no cointegration is rejected at both panel and group stages with a 1% level of significance. This result suggests that long-run cointegration exists at panel and group stages, where economic growth and trade openness have a long-run integrated relationship with tax revenue for African countries. This result is consistent with several

empirical findings such as Romero-Avila & Strauch (2008), Soli *et al.*, (2008) and Marques *et al.*, (2013).

Table 6: Westerlund heterogeneous panel error correction estimate results.

Statistics	*Value*	*z-value*	*p-value*
$Group_{\tau}$	−2.331*	−2.522	0.002
$Group_{\alpha}$	−2.115**	−2.836	0.029
$Panel_{\tau}$	−5.057*	−3.164	0.000
$Panel_{\alpha}$	7.218*	2.023	0.000

Note: *denotes the rejection of the null hypothesis at 1% and lag length is equal to 1 based on the AIC lag selection criteria.

For the longrun and shortrun dynamics estimates of the model, the heterogeneous panel cointegration is considered to be the appropriate. The model below expresses a simplified result of panel Autoregressive Distributed Lag (ARDL) (1,1,2,1) which show that the long-run coefficient of trade openness variable is negative at the 1% level of significance in both the shortrun and the longrun with the rejection of the null hypothesis at 1% and 5% levels of significance, respectively. The result further show that the coefficient estimates of the economic growth variable is positive and highly significant at the 1% level in the both the longrun and the shortrun indicating a rejection of the null hypothesis for economic growth in both short and long runs. However, the results failed to reject the null hypothesis for the squared economic growth in the short-run. The estimate for the speed of adjustment to long-run equilibrium is 66.8%. This result is similar to empirical studies by Aghion *et al.*, (2016), Bishnu *et al.*, (2016) and Atems (2015).

$$\Delta Tax_{it} = \underset{(0.021)*}{0.536} - \underset{(0.035)*}{0.072}\, TradeOpen_{it} + \underset{(0.027)*}{0.125}\, Growth_{it} + \underset{(0.042)**}{0.033}\, Growth^2_{it} - \underset{(0.538)*}{0.027}\Delta TradeOpen_{it} + \underset{0.206)}{0.061}\Delta Growth_{it} + \underset{(0.181)*}{0.012}\Delta Growth^2_{it} - 0.668\, ECT_{t-1}$$

Note: ** and ** denote the rejection of the null hypothesis at 1% and 5% respectively.*

After establishing the existence of the longrun and shortrun heterogeneous cointegration among the series, the study undertakes the Dumitrescu and Hurlin (DH) heterogeneous Granger causality test proposed by Dumitrescu & Hurlin (2012). This test helps to establish the causal relationship between variables under the conditions of cross-sectional dependence, as shown in Table 7.

Table 7: DH heterogeneous panel causality estimate results.

Direction of causality	W^{DH}	Z^{DH}	*p-value*	*Decision*
$Tax_{it} \rightarrow Growth_{it}$	4.134*	2.115	0.000	Bi-directional
$Tax_{it} \rightarrow Growth_{it}$	9.692*	5.036	0.002	
$Tax_{it} \rightarrow TradeOpen_{it}$	2.153**	0.838	0.037	Uni-directional
$Tax_{it} \rightarrow TradeOpen_{it}$	1.739	0.627	0.122	
$TradeOpenk_{it} \rightarrow Growth_{it}$	1.511*	0.223	0.003	Bi-directional
$TradeOpen_{it} \rightarrow Growth_{it}$	2.118**	1.201	0.024	

Note: *, and ** denote the rejection of the null hypothesis at 1% and 5% respectively. The lag length of DH Granger causality equals to 1, based on AIC lag selection.

From the DH causality test, the result shows a bi-directional causality running between taxation and economic growth. This implies that there exists taxation-led growth theory in African countries, which is consistent with the findings of Bird and Zolt (2011), Taha *et al*., (2013) and; Choi and Kim (2016). Meanwhile, a uni-directional causal relationship is established, running from taxation to trade openness. Also, there is a bi-directional causal effect between trade openness and economic growth. In general, it can be identified that taxation is critical for economic growth in most African countries.

Conclusion and policy suggestions

The study examines the causal effects of trade openness and economic growth on taxation in selected African countries over the period, 2000-2020. To a certain degree, the study draws a consistent conclusion with other studies that there is a relationship between economic growth and trade openness through the analysis of heterogeneous and semi-parametric approaches. The empirical result indicates that the semi-parametric estimates reveal a *U*-shaped effect between growth and tax revenue. It also shows elastic opposite directional causality from trade openness to taxation. The result implies that higher economic growth positively influence taxation while trade openness leads to a positive effect on economic growth which is consistent with the fundamental growth theory which emphasizes the role of labour, capital and technological progress as a catalyst for economic transformation. The Dumitrescu - Hurlin (DH) heterogeneous Granger causality test provides a bi-directional causality between growth and taxation, and a uni-directional causality from trade openness to taxation, and from growth to trade openness which confirms the growth-taxation nexus. The result simply means that economic performance and trade openness can be used to predict tax sustainability in African countries. As a policy directive, governments of African countries should implement trade openness policies through low tariff rate adjustments to enhance

tax revenue performance and economic growth. Nevertheless, as there are some homogeneity issues that arise in the panel data, it is clear that the outcomes cannot be generalised on the nexus between tax revenue, economic growth and trade openness in African countries.

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Appendix A
Top 10 Richest African Countries in 2020 Ranked by GDP & Primary Exports

Country	*GDP (Billion)*	*GDP per capita*	*Primary Exports*
NIGERIA	$446.543	$2,222	Petroleum (crude, refined and gas), Cocoa beans, Rough woods, Chemicals, Vehicles and aircraft parts.
SOUTH AFRICA	$358.839	$6,100	Gold, diamonds, platinum, coal, iron ore, other metals and minerals machinery and equipment, motor cars, agricultural foodstuff, wine.
EGYPT	$302.256	$3,046	Crude oil and petroleum products, cotton, textiles and agricultural goods, metal products, chemicals
ALGERIA	$172.781	$3,980	Petroleum, natural gas and petroleum products, ammonia
MOROCCO	$119,04	$3,345	Clothing and textiles, automobiles, aircraft parts, electric components, inorganic chemicals, crude minerals, fertilizers, petroleum products, citrus fruits, vegetables, fish.
KENYA	$99,246	$2,010	Tea, coffee, horticultural products, petroleum products, fish, cement, apparel.
ANGOLA	$91,527	$3,038	Crude oil, refined petroleum products, diamonds, coffee, sisal, fish and fish products, timber, cotton.
ETHIOPIA	$91,166	$953	Coffee, gat, gold, leather products, live animals.
GHANA	$67,077	$2,223	Gold, bauxite, aluminum, manganese ore, diamonds, oil, cocoa, timber, tuna, horticultural products.
TANZANIA	$62,224	$1,105	Primary Export: Gold, cashew nuts, coffee and cotton

Source: IMF, World Bank, 2021