The growth effect of trade openness on African countries: evidence from using an Instrumental Variable Panel Smooth Transition Model

Bonga-Bonga, Lumengo and Kinfack, Emilie

University of Johannesburg, University of Johannesburg

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ABSTRACT

This paper assesses the relationship between trade openness and economic growth in Africa by accounting for the heterogeneity of African countries. In addition, the paper contributes to the literature of trade openness and economic growth nexus by applying the instrumental variable panel smooth transition regression (IVPSTR), a methodology that accounts for nonlinearity and endogeneity in the relationship between the two variables. The results of the empirical analysis reveal that the level of investment is a channel through which trade openness affects economic growth in the African continent. In addition, the relationship between trade openness and economic growth varies according to the degree of a country's development in Africa. For low-income countries, the study finds no significant relationship between openness and growth. Conversely, for middle and upper-income countries, the coefficients of trade indicators are positive and statistically significant. The results indicate that African countries are not homogenous, especially with regard to trade openness and economic growth nexus.

INTRODUCTION

One of the very important contribution of international trade theory is that free trade, or trade openness, is crucial in stimulating economic growth in both developed and developing countries (Romer, 1993; Grossman and Helpman, 1991; Barro and Sala-i-Martin, 1995; Rassekh, 2007; Sakyi *et al.;* 2015). Trade openness allows countries to penetrate different markets, become competitive and consequently increase their market size (Andersen and Babula, 2008; Ahmed *et al.,* 2008). Another important advantage of trade openness is the transfer of technology from the source (usually developed) to destination countries (in most cases developing countries). However, academic opinion is still divided on the effects of trade openness on economic growth. While some studies support the positive effect of trade openness on economic growth (see Dollar, 1992; Edwards, 1992 and 1998; Sachs and Warner, 1997a; Harrison, 1996; Frankel and Romer, 1999; Greenaway et al., 2002; Lee et al., 2004; Kim, 2011), others maintain the view that trade openness harms the development of such growth (see Edwards, 1993; Rodrik and Rodriguez, 2000; Sachs and Warner, 1997). Yet another strand of empirical studies maintains that trade openness solely benefits developed countries while benefits to developing countries are insignificant. For example, Grossman and Helpman (1990, 1991) and Rodrik (1999) show that the benefit of free trade or trade openness between developing and developed countries profits the latter, since developing countries have a lower marginal propensity to export compared to developed economies. However, Lindert and Williamson (2003) believe that small countries benefit more from trade openness, especially when they trade with more advanced and developed economies.

Different explanations have been provided in the literature to explain these controversies.

The reasons range from measurement problems with respect to trade openness (see Greenaway et *al.,* 2002) and poor quality of data, especially for developing countries (Tahir and Hajah, 2014), to problems related to inappropriate econometric techniques employed (see Tahir *et al.,* 2014). With regard to econometric technique, most studies that investigate the relationship between trade openness and economic growth make use of linear models. Those studies have been heavily criticised, as their methodologies are considered inappropriate, because the relationship between trade openness and economic growth may vary through time or could take any form of nonlinearity (see Karadam and Ocal, 2014; Baldwin, 2003; Chang et al., 2009). To address this, some studies such as Chang et al. (2009) use non-linear growth model specifications that interact trade openness with inflation stabilisation, financial depth and labour market flexibility. With such an interactive model, the authors intend to show that growth effect of trade openness depends on a variety of structural characteristics. Moreover, Kim and Lin (2009) examine the relationship between trade openness and economic growth by using the Panel Transition Regression (PTR) model on both developed and developing countries. The authors conclude that there is an income threshold level above which trade openness impacts positively on economic growth. Below that threshold, the effect of trade openness on economic growth is statistically insignificant.

Previous studies that support the non-linear relationship between trade openness and economic growth have ignored the issue of endogeneity that arises in modelling this relationship (see Kim and Lin, 2009; Chang et al., 2009). In order to overcome the limitations of previous studies, this paper proposes to assess the effect of trade openness on economic growth by accounting for both endogeneity and non-linear relationship between trade openness and economic growth. Thus, the paper contributes to the literature on trade openness and economic growth in two ways. Firstly, the paper applies the Instrumental Variable Panel Smooth

Transition Regression (IVPSTR) to account for endogeneity in the non-linear relationship between trade openness and economic growth. With the use of IVPSTR, this paper shows the importance of transition variables or structural characteristic, such as countries' level of investment, in driving the relationship between trade openness and economic growth. Secondly, the paper accounts for the heterogeneity of the African continent by grouping African countries into three main categories: upper-, middle- and low-income countries, along the World Bank's classification of African countries. The heterogeneous nature of the African continent is well documented in the literature (see Bonga-Bonga, forthcoming; Meniago and Asongu, 2018). For example, in their assessment of the role of financial development on income inequality among 48 African countries, Meniago and Asongu (2018) acknowledge the heterogeneity of these countries.

The relationship between trade openness and economic growth is of great interest to policymakers in African countries, especially at this time when many of these countries are affiliated to different regional and global groupings, and hence have substantial international trade and financial integrations. However, very few studies have assessed the relationship between trade openness and economic growth in Africa. For example, Chang and Mendy (2012) investigate the effects of trade policies on growth in Africa and report a positive and significant relationship between investment openness and economic growth. Using the Instrumental Variable approach in the context of linear equations, Brueckner and Lederman (2015) examine trade openness and economic growth relationship on Sub-Sahara Africa countries. The results reveal a significant and negative effect of economic growth on trade openness, while trade openness affects positively on economic growth in Africa. Musila and Yiheyis (2015) study the effects of trade openness on the level of investment and economic

growth in Kenya and find that trade openness positively and significantly affects both these variables (level of investment and economic growth) in Kenya.

The remainder of the paper is organised as follows: Section 2 provides a brief overview of the history of trade agreements in Africa. Section 3 presents the PSTR model, the data used as well as the advantages of using this model while Section 4 provides the analysis of the empirical results. The last section, section 5 concludes the paper with a few policy recommendations.

TRADE AGREEMENT IN AFRICA: A BRIEF HISTORICAL REVIEW

Since the 1970s, African countries have used regional integration as a strategy to increase intra-African trade and achieve their developmental goals. Both the Lagos Plan of Action agreed upon in 1980 and the Abuja Treaty of 1991 call for the formation of an African Economic Community (AEC). The AEC goals were to be achieved in five main stages: firstly, it focused on strengthening existing regional economic communities (RECs) and establishing new ones in regions where they did not exist. Secondly, it determined that each REC should embark on stabilising tariff and non-tariff barriers, customs duties, internal taxes and so on. Thirdly, it determined that each REC should establish a Free Trade Area (FTA) and a customs union. In the fourth stage, it proposes the establishment of an African Common Market (ACM). The fifth and the last stage concerns the consolidation and strengthening of the ACM with the free movement of people and goods as well as the creation of a single domestic market and the establishment of a central Bank for the AEC.

The intention of the Lagos Plan of Action was to eradicate poverty and underdevelopment through the establishment of regional economic corporations (RECs). Thus, African countries have affiliated themselves to a number of regional integration institutions, with some having overlapping memberships. As a result of this process, the continent's current portfolio of

regional integration schemes contains a large number of different types of RECs, so much so that the literature review points to this multiplicity of RECs and overlapping of membership as one of the hindrance to intra-African trade (Sako, 2006). Although the African union recognises eight RECs, the Arab Maghreb Union (UMA), the Community of Sahel-Saharan States (CEN-SAD), COMESA, EAC, ECOWAS, the Economic Community of Central Africa States (ECCAS), the Inter-Governmental Authority on Development (IGAD) and the SADC, as the building blocks of the African Economic Community (AEC), the continent actually contains a total of 14 RECs with several membership overlaps.

Regional Economic Communities are essential for African countries insofar as they reduce their vulnerabilities to external influence, increase investment, assist in responding to the new and emerging challenges, increase intra and inter regional trade within the continent and increase their market size. The RECs are also an essential element for economic integration and key actors in ensuring political stability in Africa (Draper, 2010). The RECs are governed by a number of agreements and protocols ranging from Article 14 to Article 88 of the African Union's Constitutional Act. These include, amongst others, protocols in the areas of trade and customs, trade liberalisation, special treatment and exemption countries, establishment of a Pan African Parliament as well as a Court of Justice and so on.

Despite the efforts made by the RECs, the literature acknowledges some significant weaknesses in the protocols. According to the Economic Commission for Africa (2004), there is a lack of complementarities across RECs; the negotiation process among members within RECs is too lengthy, while some countries within RECs that are not eager to implement certain elements of the protocols simply refuse to pass them into domestic legislations. Besides, the large number

of RECs, in addition to the problem of overlapping memberships, makes it difficult for these countries to implement protocols and even more difficult to coordinate the evolution of RECs.

METHODOLOGY

To assess the relationship between trade openness and economic growth in Africa, the study extend the non-dynamic Panel Smooth Transition Regression (PSTR) model developed by Gonzalez *et al.,* (2005) to account for possible endogeneity of the dependent variables in Equation 1. The key to the PSTR model proposed by Gonzalez *et al.* (2005) is that the shift from one regime to another is gradual. Consequently, with the PSTR model, the move from one regime to another is smooth and there might be more than two regimes. Furthermore, the PSTR is a generalised form of the PTR and allows for more regimes than the latter.

The general form of the PSTR model is specified as follows:

$$Y_{it} = \alpha_i + \beta_0' X_{it} + \sum_{k=1}^{n} \beta_k X_{it}\ g(S_{it}, \gamma, c_j) + \varepsilon_{it} \qquad (1)$$

With $i = 1,2,3\ldots\ldots\ldots N$ and $t = 1, \ldots\ldots, T$ which denote respectively the individuals (which comprise African countries in this case) and the time length of the panel. y_{it} is the dependent variable, α_i is the fixed individual effect, and X_{it} is a matrix of independent variables, ε_{it} is an independent and identically distributed error term while s_{it} is the threshold variable, which in our study is investment per GDP. The speed of transition is gamma (γ) and c_j is the threshold parameter. The threshold variable is unknown and had to be estimated. The main characteristic of the PSTR model is the inclusion of the transition function, $g(s_{it}, \gamma, c)$, which is normalised and bounded between 0 and 1 (Gonzalez *et al.,* 2005). This function allows Equation 1 to

change smoothly, depending upon a certain level of the transition variable (s_{it}). Gonzalez *et al.,* (2005) recommend that it is sufficient to consider only two cases of nonlinearity in order to capture the regime switching. These cases are the number of thresholds (*m)* , which are 1 and 2.

The general specification of the transition function is given as follows:

$$g(S_{it},\gamma,c) = \frac{1}{1+\exp(-\gamma\prod_{j=1}^{m}(S_{it}-c))} \qquad (2)$$

it is important to note that $g(s_{it},\gamma,c)$ becomes a logistic function if m=1. If m=2, $g(s_{it},\gamma,c)$ becomes a quadratic function. Model building procedures of PSTR models, which include specification, estimation and diagnostic stages, are provided in details in Gonzales et al. (2005).

To account for endogeneity in PSTR models, Equation 1 needs to be transformed before applying the estimation technique suggested by Gonzales. We follow the transformation suggested by Kremer et al. (2013) when extending the estimation of the non-dynamic PTR model suggested Hansen (1999) to a dynamic specification. Thus, in the first step, we eliminated the individual fixed effect α_i by applying the forward orthogonal deviation transformation. With the forward orthogonal deviation transformation, each observation is subtracted by the mean of the remaining future observation available in the sample. The transformed variables and errors become as;

$$Y^{*}_{i,t-s} = w_t\left[Y_{i,t-s} - (Y_{i,t-s+1} + \ldots + Y_{i,T-s})/(T-t)\right] \; s = (0,1,\ldots,p) \qquad (3)$$

$$\mu_{it}^{*} = w_t \left[\mu_{i,t} - (\mu_{i,t+1} + \ldots, \mu_{iT}) / (T-t) \right] \text{ with } w_t^2 = (T-t)/(T-t+1) \qquad (4)$$

Where T is the size of the time series for a given country, which should be the same for all the countries in a balanced panel. w_t is the weighting matrix assumed to be non-singular. $Y_{i,t-s}^{*}$ is a vector of dependent and independent variables. In the second step, we estimate the endogenous variable as a function of instrumental variables. The endogenous variables are then replaced by the predicted values. Instrumental variables used in this paper include population growth, land area and distance from the equator. Beside the lag of economic growth, literature supports possible feedback from trade openness and economic growth, and vice versa, thus, raising the issue of endogeneity (see Brueckner and Lederman , 2015).

DATA, ESTIMATION AND DISCUSSION OF RESULTS

a. Data

The study uses a balanced panel data of 38 African countries with annual data for the period 1970-2016 (see Appendices A and B for list of countries and sources of data respectively). The starting period is informed by data availability. A detailed list of African countries used is presented in Appendix A. The following regressors are used to control the effect of trade openness (*openk*) on economic growth (*dgdp*): the initial value of GDP growth ($dgdp_{-1}$) (added to account for the effects of initial conditions), the (logarithm of) average years of schooling (*humank)* (added to account for the degree of human capital), the real exchange rate *(rer*) is also included in our model. It is important to note that various measures are used for trade openness; these included the trade share, which is equal to the sum of export plus import divided by GDP, the ratio of export over GDP and the ratio of import over GDP. The study

considered all these measurements of trade openness to guarantee the robustness of the results. As stated earlier, the ratio of investment per GDP (*Invest*) is used as a transition variable. All the data used as well their sources are presented in Appendix B.

b. Estimation and discussion of results

The aim of the paper is to estimate the following equation for each of the groupings of African countries based on their level of development, namely, low-income, middle-income and upper-income countries:

$$Y_{it} = \alpha_i + \beta_0' X_{it} + \beta_1' X_{it}\, g(S_{it}, \gamma, c) + \varepsilon_{it} \qquad (5)^1$$

with $X_{it} = \{dgdp_{-1it}, openk_{it}, humank_{it}, rer_{it}\}$ and $S_{it} = \{Invest_{it}\}$

Before estimating Equation 5, it is important to establish whether all variables are stationary and that there is a nonlinear relationship between economic growth and openness, with investment per GDP as the possible transition variable. The results of the panel unit root, especially the LLC (Levin, Lin and Chu, 2002) and the IPS (Im, Pesaran and Shin, 2003) reported in Table 1 show that the null hypothesis of unit root is rejected for all the variables.

[1] Note that the fixed effect is eliminated by using the forward orthogonal deviation transformation.

Table 1. Panel unit root test

Variables	Deterministic	IPS	LLC
		Level	
dgdp	Intercept	-19.31***	-15.08***
	Intercept and trend	-18.40***	-14.27***
Openk	Intercept	-3.95***	-2.97***
	Intercept and trend	-3.16***	-2.23**
Invest	Intercept	-2.88***	-1.88**
	Intercept and trend	-2.09**	-3.14***
humank	Intercept	8.94**	3.07*
	Intercept and trend	7.61**	4.88
rer	Intercept	9.90**	7.66**
	Intercept and trend	2.38*	1.34

Note: ***, ** and * denote respectively significance at 1%, 5% and 10%. IPS stands for Im, Pesaran and Shin Wald-statistic

The results of the linearity test are reported in Tables 2, 3 and 4. These results provide evidence of non-linearity amongst variables in the three sub-groupings with the null hypothesis of linearity being rejected at more than 1% in most of the cases for the alternative of PSTR of logistic form, $m = 1$. The transition variable is identified as the first lag of investment per GDP.

Table 2. Test of linearity and number of threshold for low-income countries

Low income countries				
Hypothesis		LM	LMF	LRF
H_0: linearity	H_1: PSTR	23.665***	5.903***	24.142***
r = 0	r = 1	(0.000)	(0.000)	(0.000)

LM, LMF and LRT stand for Lagrange Multiplier Wald test, Lagrange multiplier Fisher test and likelihood-ratio tests respectively. Values in brackets are p-value. ***, ** and * indicate the significance at 1%, 5% and 10 % respectively. r is the number of regime.

Table 3. Test of linearity and number of threshold for middle-income countries

Middle income countries				
Hypothesis		LM	LMF	LRF
H_0: linearity	H_1: PSTR	12.195**	3.051**	12.505***
r = 0	r = 1	(0.016)	(0.018)	(0.000)

LM, LMF and LRT stand for Lagrange Multiplier Wald test, Lagrange multiplier Fisher test and likelihood-ratio tests respectively. Values in brackets are p-value. ***, ** and * indicate the significance at 1%, 5% and 10 % respectively. r is the number of regime

Table 4: Test of linearity and number of threshold for upper-income countries

Upper- income countries				
Hypothesis		LM	LMF	LRF
H_0: linearity	H_1: PSTR	24.292***	6.377***	25.555***
r = 0	r = 1	(0.000)	(0.000)	(0.000)

LM, LMF and LRT stand for Lagrange Multiplier Wald test, Lagrange multiplier Fisher test and likelihood-ratio tests respectively. Values in brackets are p-value. ***, ** and * indicate the significance at 1%, 5% and 10 % respectively. r is the number of regime

As suggested by Gonzales (2005), we apply the fixed effect estimator and the non-linear least square to the transformed data to estimate parameters in Equation 5. The results of the estimated parameters are reported in Table 5.

It is shown in Table 5 that the estimated slope parameters γ for all the three groupings of African countries are less than unity, confirming that transition between regimes are smooth. Moreover, the threshold coefficients c (the ratio of investment per GDP), which delimit the two regimes, are set to 14.89 for low-income, 30.85 for middle-income and 40.27 for upper-income countries. The coefficients of the first regime, when the threshold variable is less than c, correspond to the value of β_0 whereas the coefficients of the second regime, when the threshold variable is more than c, correspond to $\beta_0 + \beta_1$.

Table 5. Threshold effects of trade share on African countries

Models	1		2		3	
	Low income countries		**Middle income countries**		**Upper income countries**	
γ	0.0781		0.6898		0.1411	
c	14.8983		30.8519		40.2768	
Threshold variable	*Invest per GDP*					
	β_0	β_1	β_0	β_1	β_0	β_1
Dgdp-1	0.6462*** (0.2374)	-1.0484*** (0.4142)	0.0648 (0.0838)	0.5406 (0.3469)	0.2912 (0.1672)	-0.3060 (0.3037)
Humank	-0.1317 (0.0908)	0.1669 (0.1511)	-0.0721*** (0.0239)	0.0593 (0.0817)	0.0088 (0.0261)	-0.1447* (0.0783)
rer	-0.0848 (0.1887)	0.4170 (0.3653)	0.9967*** (0.2296)	1.5810 (1.1545)	0.0039 (0.0106)	0.0351 (0.0269)
openk	0.0861 (0.0825)	0.0352 (0.0605)	0.0577*** (0.022)	-0.0869 (0.0916)	-0.0643 (0.0645)	0.1296*** (0.0593)
observations	946	946	361	361	406	406

Notes: ***, ** and * denote respectively significance at 1%, 5% and 10%. Values in brackets are standard errors. To test the threshold, the study follows the Gonzalez *et al.,* (2005).

With regard to low-income countries, coefficients of trade openness (*openk*) are not statistically significant in the two regimes, suggesting that trade openness has not effect on economic growth in low-income African countries. This finding is also supported by other studies. For example, Sakyi *et al.,* (2015) find the absence of a long-run relationship between trade openness and economic growth in low-income countries. The reason behind this finding is that a number of industries in low-income countries are in infancy stage and that infant industries need protection from free trade or trade openness. Government or policymakers in low-income countries might use domestic production subventions, tariffs, or quotas in order to protect the domestic infant industries. Another possible reason for the lack of significant link between

openness and growth in low-income countries is the low value-added of primary commodities, which are the main exports of low-income countries. Studies show that trade openness often worsens the price of these commodities and accelerates poverty in the low-income countries (UNCTAD, 2014; Afari-Gyan, 2010).

Regarding middle-income countries, the results reported in Table 5 indicate that the coefficient of trade openness is positive and statistically significant when the level of investment ratio is inferior or equal to 30.85 percent. Given that the coefficient β_1 is not statistically different to zero, we can infer that the positive relationship still exists when investment ratio is above 30.85%. The structure of import and export of middle-income countries, which may be more diversified than the ones of the low-income countries, could explain this positive link between the variables of interests. Studies found that countries that have managed to improve the types of commodity they export or diversify them have been able to benefit more from trade openness (Sakyi *et al.,* 2015). This is the case of middle-income countries whose exports are mainly manufacturing products.

Concerning upper-income countries, Table 5 indicates that trade openness affects positively and significantly economic growth but only when the level of investment is superior or equal to 40.27 percent. Thus, trade openness has beneficial effects on economic growth for more advanced countries only if they reach a high level of investment per GDP. Upper-income African countries are the true competitors of more advanced economies in terms of the quality of product they produce and export. For example, like many developed economies, South Africa exports high-tech military equipment making the country an important competitor to a number of developed countries. However, it is important to note that the more resources or investment the country allocates to their export sectors the more the reward in term of market

share, which translates into economic growth. Furthermore, we may argue that South Africa was about to be suspended under the African Growth and Opportunity Act by the United State because of its capacity to compete with developed economy. The country seems to be prevented from privileges granted to developing economies as it is seen not to be ranked as one of them.

Another important observation from the results reported in Table 5 is the decreasing return of human capital in Upper-income African countries. The results reported in Table 5 show that the contribution of human capital to economic growth decreases when the ratio of investment to GDP reaches the threshold of 40.27%. This outcome may be attributed to the scarcity of skill workers who become costly in advanced African economies due to their high demand when the level of investment increases (see Bonga-Bonga and Phume, 2018).

c. Robustness test

In order to conduct the robustness test, alternative measures for trade openness were used. Thus, both the ratio of import over GDP and the ratio of export over GDP were utilised and the results are reported in Tables 6 and 7, respectively. The robustness test shows that the results presented in Tables 6 and 7 are similar to those reported in Table 5. For example, the increasing level of investment per GDP, the threshold variable, from low-income to upper-income African countries is observed in the results reported in Tables 6 and 7. Moreover, the results reported in Table 6 and 7 show the neutral effect of trade openness on economic growth in the low-income African countries.

Table 6. Threshold effects of trade share on African countries (The ratio of import/GDP)

	Low income countries		**Lower-middle income countries**		**Upper income countries**	
δ	0.0804		40.8375		0.1018	
c	13.6148		28.8041		36.2618	
Threshold variable	***Investment per GDP***					
	β_0	β_1	β_0	β_1	β_0	β_1
Dgdp-1	0.6622***	-	0.1295	0.4942***	0.3137	0.0565
	(0.2463)	1.0320***	(0.0830)	(0.2054)	(0.2054)	(-0.7510)
		(0.4128)				
Humank	-0.1138	0.1320	-0.0010	-0.0462	0.0337	-0.1884
	(0.0955)	(0.1523)	(0.0173)	(0.0449)	(1.2250)	(0.0808)
rer	-0.0445	0.3209	0.0022	-0.0018	-0.0088	0.0499*
	(0.2049)	(0.3802)	(0.0028)	(0.0060)	(0.0125)	(0.0307)
openk	0.1086	0.0924	0.0944**	0.0340	-0.2501**	0.0339**
	(0.1315)	(0.1082)	*	(0.0643)	(0.1503)	*
			(0.0370)			(0.1131)

Notes: ***, ** and * denote respectively significance at 1%, 5% and 10%. Values in brackets are standard errors. To test the threshold, the study follows the Gonzalez *et al.,* (2005).

Table 7. Threshold effects of trade share on African countries (The ratio of export/GDP)

Indicator	**Low income countries**		**Middle income countries**		**Upper income countries**	
δ	0.076		517.6069		0.1307	
c	18.7255		28.8710		43.2562	
Threshold variable	***Invest***					
	β_0	β_1	β_0	β_1	β_0	β_1
Dgdp-1	0.5794***	-1.0589***	0.1363	0.4622***	0.2435	-0.0721
	(0.0259)	(0.4044)	(0.0825)	(0.2087)	(0.1542)	(0.3238)
Humank	-0.1451**	0.2140	-0.0075	-0.0566	0.0101	-0.1997
	(0.0757)	(0.1413)	(0.0184)	(0.0531)	(0.0375)	(0.1173)
rer	-0.0986	0.5171	0.0006	-0.0040	0.0072	0.0451
	(0.1572)	(0.3466)	(0.0029)	(0.0085)	(0.0106)	(0.0267)
openk	0.3203	0.0192	0.1100***	0.0874	-0.1783	0.1740***
	(0.2553)	(0.1253)	(0.0366)	(0.8016)	(0.8299)	(0.1131)

Notes: ***, ** and * denote respectively significance at 1%, 5% and 10%. Values in brackets are standard errors. To test the threshold, the study follows the Gonzalez *et al.,* (2005).

V. CONCLUSION AND RECOMMENDATIONS

This paper analyses the relationship between trade openness and economic growth in Africa. Unlike previous studies that have investigated the same issue on African countries at an aggregate level, this paper contributes to the literature by, firstly, treating African countries as heterogeneous, depending on the level of income of each country grouping and secondly, applying the instrumental variable PSTR to account for endogeneity and nonlinear effect between economic growth and trade openness in these countries. The results reveal that the level of investment is a channel through which trade openness affects economic growth. In

addition, the relationship between trade openness and economic growth varies according to the degree of a country's development. For low-income countries, the study finds no significant relationship between trade openness and economic growth. Conversely, for middle and upper-income countries, the coefficients of trade indicators are positive and statistically significant; suggesting that for both middle and upper income countries, trade openness positively affects economic growth, depending on a threshold level of investment per GDP. Thus, a greater level of investment in upper-income countries stimulates production and subsequently economic growth, through trade openness. For low-income countries, no significant effect was found. Sakyi *et al.,* (2015) made use of a different approach to ours and reported a positive and significant correlation between trade openness and economic growth for upper and middle-income countries and no relationship for lower income countries. Relying on these results, we recommend that low-income African countries should first improve their production capacity, by either diversifying their export products or increasing their level of industrial or manufacturing capacity, before engaging in any form of free trade agreement.

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Appendices

Appendix 1. Countries used in the study

Upper-income countries	**Middle-income countries**	**Low-income countries**
Algeria	Cameroon	Benin, Burkina Faso
Botswana	Ivory Coast	Burundi, Central Africa, Republic
Equatorial Guinea	Egypt	Chad,
Gabon	Ghana	Democratic Republic Congo
Mauritius	Morocco	Ethiopia, Gambia
Namibia	Nigeria	Guinea- Bissau, Kenya
South Africa	Zambia	Madagascar, Malawi, Mali
Tunisia	Republic of Congo	Mozambique, Niger, Rwanda
		Sierra Leone, Swaziland, Togo
		Uganda , Zimbabwe

Appendix 2. Definition of variables and data sources

List of data	Acronym		sources
Growth rate per GDP	*Ldgp*	GDP per capita growth (annual %)	World Bank
Initial income	*Initial*	GDP (annual %)	World bank
Trade share	*opens*	(X+M)/ GDP *100	World bank
Ratio of export over GDP	*Lexp/GDP*	(X)/GDP*100	World Bank
Ratio of import over GDP	*Limp/GDP*	M/ GDP *100	World Bank
Human capital	*humank*	Average years of schooling	World bank
Real exchange rate	*rer*		World Bank
Investment	*invest*	(Gross fixed capital formation/GDP)	World Bank and OECD