

Determinants of export diversification in Sub-Saharan African region: a fractionalized logit estimation model

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Abstract The paper uses panel data of 32 countries from 1995 to 2013 to investigate the determinants of export diversification in Sub Saharan Africa (SSA). As opposed to previous studies on determinants of export diversification, the empirical model was estimated using the fractionalized logit technique based on the fact that the dependent variable (Herfindahl-Hirschman Concentration Index) is fractional. The average statistics clearly showed that among the countries used in this study, the most diversified economies are South Africa (0.14), Kenya (0.22) and Tanzania (0.22), while the most concentrated are Angola (0.92), Nigeria (0.85) and Chad (0.80). The results of our empirical analysis revealed that overall export diversification is significantly promoted and determined by trade openness, value added in agriculture, value added in manufacturing and foreign direct investment; while GDP per capita was a significant deterrent to export diversification in this region. Other results showed that foreign aid, official exchange rate and gross domestic investment were insignificant determinants of export diversification in the selected economies. Our results therefore suggest that to foster export diversification in the Sub Saharan Africa region, it is imperative to promote regulatory reform efforts that facilitates international trade, improve foreign direct investment and promote infrastructural development and performance in the agricultural and industrial sectors.

Keywords Export diversification · Fractionalized logit · SSA

JEL classification F14 · F23 · L6 · O1

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1 Introduction

Trade theories both old (such as Ricardian, Mercantilist) and new (Heckscher – Ohlin) have shown that few countries have developed quickly on the basis of exports of solely primary products. This is so because a more diversified export structure reduces vulnerability to demand shocks and price swings in overseas markets and hence creates greater opportunities in regional as well as global markets (Brenton et al. 2012). Indeed, too much dependence on a small number of primary commodity products exposes a country to the negative effects of unfavorable characteristics of world demand and negative supply side features of these primary products (Samen 2010). Moreover, Kim (2012) argued that if one or two products occupy the commanding share of export or export is concentrated on a few markets, the large amount of export for these few products are easily vulnerable to external shock.

Thus, it is important that such shocks be averted or at least reduced in order to stabilize export earnings. Many countries especially developing countries today have done this by having a variety of product in their export basket (Samen 2010). This practice of export diversification (either by product or geographically) helps to generate more stable income inflow and thus mitigate economic and political risks (Tsvivadze 2011). In same light, Samen (2010) suggested that the improvement in export diversification performance of East Asian countries since the 1970s accounted for approximately 800 % growth of exports as against only 70 % for Africa.

However, exports in African economies until recently have relied heavily and concentrated on unprocessed primary commodities in contrast to other regions of the world like East Asia whose exports is dominated by manufactured products (Kamuganga 2012). Unfortunately, a high concentration of exports in a limited number of products is a well known problem in virtually all developing countries with this phenomenon being more accentuated in the Sub Saharan African (SSA) countries (Cabral and Veiga 2010). Indeed, the economies of SSA are much more dependent on primary commodities than the rest of the world with heavy reliance on fuels, minerals and metals. As at 2009, the exports of primary commodities in SSA excluding South Africa and Nigeria, accounted for 73 % of total merchandise exports (Michalowski 2012).

In many African countries and especially those in the SSA region, export diversification is conceived as a progression from traditional exports such as petroleum, bananas, coffee, and sugar to non-traditional exports like electrical machinery equipment parts (Kamuganga 2012) which however account for a lesser proportion of Africa's export basket. According to Kamuganga (2012), the major exports from Africa include mineral fuels (55.7 %), precious metals (6.2 %); ores (2.8 %), slag and ash (2.4 %); cocoa (2.2 %) and electrical machinery equipment parts, with the top five commodities accounting for approximately 69.3 % of African total exports in the year 2009. This implies that the composition of exports from the region is not very diversified.

A myriad of explanations have been advanced for the dismal performance of export diversification and growth in the SSA Region. For instance, Wood and Mayer (2001) attribute natural resources endowment and infrastructure inadequacy as the important

factors in explaining the low share of manufactured exports in SSA with the results of the former being reaffirmed by Habiyaremye and Ziesemer (2006); while Collier and Gunning (1999) and Elbadawi (1999) accuse high transactions costs as an impediment on the production of manufactured exports in Africa. Gomanee et al. (2005) considered the role played by foreign financial assistance committed by developed world. They argued that though this assistance is aimed at stimulating growth, they are often attached with strings oriented towards intensifying trading ties between or amongst the giving developed country and the highly disfavoured African recipient, thus discouraging diversification.

In recent years however, African countries are beginning to vertically diversify as their production and export structure is shifting from primary commodities to manufactured goods, since many of these countries have started processing commodities that were previously exported in raw form into semi-finished and in some cases finished products. This has also accounted for a slight increase in the value added for the region. Despite this, the question of what accounts for the mark increase in the volume and composition of exports in the SSA region as a whole or in selected economies is an issue earlier studies (Mbaku 1989; Fosu 1996; Biesebroeck 2005; Fonchamnyo 2014) have left unanswered. Rather these studies have been more interested in the growth and performance of the export sector. On the determinants of export diversification, Elhiraika and Mbate (2014) and Kamuganga (2012) focused more on the policy and institutional factors rather than pure economic factors influencing export diversification. Some studies have considered the pattern of diversification (Ferdous 2011), while those that have considered its determinants are based on a combination of developing and developed countries and not purely on countries concentrated in the SSA region. Moreover, previous papers have failed to consider the fractional nature of the export diversification variable. It is therefore imperative to investigate into what the main economic drivers of export diversification in SSA are taking into consideration the fractional nature of export diversification.

The current study thus fills such knowledge vacuum in the context of SSA by investigating the economic drivers of export diversification in thirty two (32) selected countries in SSA using a fractionalized logit model. The rest of the paper is divided into four sections. The next section reviews existing literature on the issue of export diversification, while the section three on model specification and data, presents the estimation techniques and stylized facts about the data. Section four presents and discusses the empirical results on the determinants of export diversification while the last section concludes with some policy implications based on the findings.

2 Literature review

Considering that diversification originates from a structural change which is a multifaceted issue concerning a deep transformation of economies along their development paths (Parteka and Tambari 2011) and in line with the universal adage that it is unwise “to put all eggs in one basket”, the portfolio theory has gained favour as a theoretical backing as to why countries diversify their exports. Brainard and Cooper (1968)

propose that risk-averse countries should diversify their exports taking into consideration the co-variability of different world prices of export goods. Within this analysis, diversification is regarded as a means of reducing a country's dependence on a particular product or a very restricted range of primary products. Many developing countries with low economic growth and relying heavily on a handful of commodities for trade, income and employment would benefit from diversifying their economies by selecting export portfolios that optimized market risks against anticipated returns. On the basis of the portfolio theory therefore, Strobl (2002) finds considerable welfare gains from moving towards a more "optimal" export structure on the mean-variance efficient frontier. But for the fact that the prices of commodities may not follow a deterministic trend, export diversification may reduce the terms of trade deterioration associated with export commodities dependence as asserted by the works of Prebisch (1950).

Munemo (2007) empirically analyzes the effect of foreign aid on export diversification using panel data from 69 developing countries employing the instrumental variables (IV) estimation technique. The findings of the study indicated that foreign aid negatively affects export diversification. On his part, Changbiao (2009) using a panel data set examines the determinants of exports in Chinese electronics industry for the period 1999 to 2002. The study found out that FDI to be a significant and positive determinant of export growth in China. Similarly, by considering FDI as one of the determinants of export diversification, Jayaweera (2009) built an econometric model of instrumental variables to estimate the relationship between FDI and export diversification for a panel of 29 low income nations for the period 1990–2006. His findings show a positive impact of FDI on export diversification.

Using a panel data-set for 60 countries for the period 1985–2004, Parteka and Tamberi (2011) assessed the role played by country specific factors in determining the exports diversification process by applying different synthetic indices of specialisation. Their findings revealed that countries located far from the economic core of the world and those for which barriers to trade are large tend to have less diversified manufacturing exports. In a similar study, Agosin et al. (2011) analysed the determinants of export diversification around the world from 1962 to 2000, employing the Herfindahl, Theil and Gini indices as measures of export diversification. Their data was analysed using the Generalized Method of Moments (GMM) and their findings showed that human capital accumulation contributes positively to diversify exports while real exchange rate volatility promotes export concentration.

In another study, Ferdous (2011) investigated the pattern and determinants of export diversification in East Asian Economies within the context of a fixed panel data model for eight countries for the period 2000 and 2008. The empirical results of the study revealed that greater economic integration in East Asian economies and GDP growth promotes export diversification while exchange rates and tariff rates have tend to dampen export diversification. Meanwhile, Elhiraika and Mbate (2014) were more interested in the long-run determinants of export diversification by estimating a cross country regression model using a panel of 53 African countries for the period 1995 to 2011. By means of a System GMM analysis, the authors found out that per capita income, infrastructure, public investment, human capital and the institutional framework were significant drivers of export diversification within the African economies.

3 Model specification and data

Within a panel data setting in which a cross sectional unit has relatively smaller time periods, the empirical model to be estimated in this study is generally regarded as:

$$EXDIV_{it} = X_{it}\alpha + \varepsilon_{it} \quad (1)$$

EXDIV = Export Diversification index, measured using the World Bank's measure of the Herfindahl-Hirschman Concentration Index. The index has been normalized to obtain values ranging from 0 to 1. An index value that is closed to 1 indicates a very concentrated market (maximum concentration). On the contrary, values closer to 0 reflect a more equal distribution of market shares among exporters or importers. In other words, when the value of the Herfindahl-Hirschman Index approaches one, the country has a greater reliance on a limited group of exports, while a value closer to zero represents a higher degree of export diversification.

α is a vector of regression coefficients to be estimated, X_{it} is a matrix of regressors which are; Foreign Direct Investment Net Inflow (FDI), trade openness (LOPEN), gross capital formation (LGKF); official exchange rate (LOER), agricultural value added (LAVA), manufacturing value added (LMVA), foreign aid (LFA) and real Gross Domestic Product per capita (LGDPPC). All these variables are expressed in natural logarithms and a detailed definition of the variables is described in Table 2 in the Appendix.

A linear form of Eq. (1) is specified as;

$$\begin{aligned} EXDIV_{it} = & \alpha_0 + \alpha_1 LOPEN_{it} + \alpha_2 LAVA_{it} + \alpha_3 LFDI_{it} + \alpha_4 LFA_{it} + \alpha_5 LOER_{it} \\ & + \alpha_6 LGKF_{it} + \alpha_7 LMVA_{it} + \alpha_8 LGDPPC_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

The coefficients of the different variables are expected as follows; $\alpha_1 < 0$, $\alpha_2 < 0$, $\alpha_3 < 0$, $\alpha_4 < 0$, $\alpha_5 < 0$, $\alpha_6 < 0$, $\alpha_7 < 0$, $\alpha_8 < 0$.

In estimation of the above model, though the Ordinary Least Squares (OLS) estimator, the Instrumental Variable estimator or even the GMM of a linear model may yield consistent estimates even by ignoring the bounded nature of the regressand, they however, do not guarantee that their fitted values lie within the unit interval nor that their partial effect estimates for regressors' extreme values are good (Nam 2014). Thus, an additional novelty about this study hinges on the fact that the estimation technique used is the fractionalized logit model which counters the weakness of the former techniques of estimation by considering the fractional nature of the concentration index. We adopt the fractional logit model after Papke and Wooldridge (1996) which is a quasi-likelihood method that does not assume any distribution but only requires the conditional mean to be correctly specified for consistent parameter estimates with an identical likelihood function with a structure similar to that of a Bernoulli distribution. The quasi-log likelihood for observation i is exactly the same as for the logit binary response model and presented as:

$$l_{it}(\alpha) = y_{it}\log[h(X_{it}\alpha)] + (1-y_{it})\log[1-h(X_{it}\alpha)]; \text{ with } 0 \leq y_{it} \leq 1 \quad (3)$$

Where $h(X_{it}\alpha)$ is the logistic Cumulative Distribution Function and $y_{it} \in [0, 1]$ (that differs from binary logit which limits y to values of 0 or 1). The mechanics of obtaining the parameter estimates are identical to the binary response case, but a fully robust variance estimator should be obtained.

The expectation form of the Fractional Logit Model is then specified as:

$$E(y_{it}|X_{it}) = \frac{\exp(X_{it}\alpha)}{[1 + \exp(X_{it}\alpha)]} = h(X_{it}\alpha) \tag{4}$$

The boundary probabilities for the dependent variable and regressands are thus specified as;

$$\Pr(y_{it} = 0|X_{it}) > 0 \text{ and } \Pr(y_{it} = 1|X_{it}) > 0$$

For a robust check of the results produced by the fractional logit model, we used the double limit Tobit model with a latent variable setup with the possibility of two corner solutions as 0 for complete diversification and 1 for complete export concentration. In fact, the model has been commonly used in modeling outcomes with boundaries and is applicable to fractional outcomes in the $[0, 1]$ interval. Theoretically, the Tobit model assumes that there is a latent variable Y^* such that within a panel context we have;

$$y_{it}^* = X_{it}\alpha + f(y_{it-1})\rho + k_i + \varepsilon_{it} \tag{5}$$

$$\varepsilon_{it} \mid (X_i, y_{it-1}, \dots, y_{i0}, k_i) \sim N(0, \sigma_\varepsilon^2) \tag{6}$$

$$y_{it} = \begin{cases} 0 & \text{if } y_{it}^* \leq 0 \\ y_{it}^* & \text{if } 0 < y_{it}^* < 1 \\ 1 & \text{if } y_{it}^* \geq 1 \end{cases} \tag{7}$$

Where X_{it} comprises of all exogenous independent variables, k_i denotes the unobserved effects and ε_{it} is the normally distributed error term across space and time. In order to validate the results estimated, tests for outlier and multicollinearity were performed. The multicollinearity test was conducted using the Variance Inflation Factor (VIF), while the outlier test was done using the Cook’s D statistics which is a combination of the Studentized residuals and the leverage point.

The study used macro data level composed of 32 countries in the Sub Saharan Africa region covering the period from 1995 to 2013. These countries were selected based on availability of data for the variables used in the estimation of Eq. (2). Most of the data were obtained from the World Development Indicators databank (see Table 2 on definition of the variables). Summary statistics showing the mean of the variables used in the model is presented in Table 3 The average statistics on trade diversification clearly shows that the most diversified economies in SSA are South Africa (0.14),

Kenya (0.22), Tanzania (0.22), Madagascar (0.23) and Senegal (0.23); while the most concentrated economies are Angola (0.92), Nigeria (0.85), Chad (0.80), Congo Brazzaville (0.75) and Gabon (0.74). In terms of per capita income, Seychelles, Gabon, South Africa, Botswana and Namibia top the list with the highest per capita incomes.

4 Empirical results on the determinants of export diversification

The empirical results for the Fractionalized logit are presented in the first two columns of Table 1; column 1 shows the logit results, while the marginal effect coefficients are presented in column 2. The tobit results presented in column 3 are directly comparable to the marginal effect presented in column 2, since the data used in this study were not censored. The fractionalized results estimated after the exclusion of 40 potential influential points are presented in Table 4. The results showed that the exclusion of the influential points greatly change the magnitude of the coefficients of the different variables estimated. The results showed that except for openness and foreign aid that witnessed an increase in their absolute magnitudes, the rest of the variables witnessed a decrease in magnitude. The test for multicollinearity conducted using the VIF and presented in Table 5 revealed that the independent variables included in this study are not highly correlated.

The results estimated using the fractionalized logit and tobit techniques showed that a majority of the variables used in the analysis, albeit for exchange rate, foreign aid and capital formation are statistically significant. The results indicated that openness, value added in agriculture, Foreign Direct Investment, Gross capital formation and value added in manufacturing have a negative effect on concentration, while the official

Table 1 Results of the determinants of export diversification in Sub Saharan countries

	Fractionalized logit		Tobit results
	Robust standard errors Coefficient (t-statistics)	Marginal Effect (dy/dx) Coefficient (t-statistics)	Coefficient (t-statistics)
LOPEN	-0.2409** (-2.31)	-0.0599** (-2.31)	-0.0577** (-2.21)
LAVA	-0.1670** (-2.34)	-0.0415** (-2.34)	-0.0404** (-2.60)
LFDI	-0.0738*** (-3.46)	-0.0194*** (-3.81)	-0.0174*** (-3.30)
LFA	-0.0361 (-0.97)	-0.0090 (-0.97)	-0.0086 (-1.00)
LOER	0.0105 (0.70)	0.0026 (0.70)	0.0023 (0.61)
LGKF	-0.0545 (-0.60)	-0.0135 (-0.60)	-0.0133 (-0.78)
LMVA	-0.8837*** (-15.42)	-0.2196*** (-15.32)	-0.210*** (-15.15)
LGDPPC	0.0792* (1.66)	0.0197* (1.66)	0.0135* (1.65)
Cons	3.6274*** (6.92)	–	1.2575*** (7.84)
R ² - type measure	0.4096	–	
Number of observations	478	478	Left-censored =0 Uncensored =478 Right-censored =0

***, ** and * significant at 1 %, 5 % and 10 % level of significance, respectively

exchange rate and GDP per capita were found to have a positive effect on concentration.

The observed negative relationship between the dependent variable and independent variables implied that an increase in the value of these variables resulted to despecialization or diversification, while the positive relationship indicated a movement towards more specialization or concentration.

The results specifically showed that on the one hand, an increase in openness, value added in agriculture, foreign direct investment and value added in manufacturing will increase the likelihood of a country to diversify. The effects of these variables are statistically significant at various levels as shown in Table 1. Specifically the results showed that an increase in the level of openness, FDI, value added in agriculture by one standard unit will result to an increase in the likelihood of diversification by 0.2409, 0.0738 and 0.1670 respectively. On the other hand, an increase in the log of GDP per capita increased the likelihood to concentrate (i.e. diversification is reduced). This effect of per capita income on diversification was statistically significant at the 10 % level of significance.

The coefficient of the other variables showed that gross capital formation had a negative and statistical insignificant effect on concentration while official exchange rate had a positive but statistical insignificant influence on concentration. By implication, an increase in gross capital formation will result to diversification while appreciation of the exchange rate will encourage concentration of exports.

The results of the study showed that improvement in the contribution of agriculture, manufacturing and Foreign Direct Investment to GDP will encourage export diversification in the selected countries of the SSA region. In same light, trade openness also promotes export diversification in the Sub Saharan African region. The results indicated that wealthier countries are more concentrated in terms of their export composition.

The finding of the effect of per capita income on export diversification is consistent with those of Kamuganga (2012) and Cabral and Veiga (2010) who found a positive and statistical significant effect of GDP per capita on export diversification, but contrary to the study of Elhiraika and Mbate (2014) and Parteka and Tamberi (2011) who found a negative and statistically significant effect of per capita on export diversification. The effect of FDI is consistent with those of Bebczuk and Berrettoni (2006) though they found FDI to have a negative and statistical insignificant effect on export diversification. The effect of the manufacturing sector is consistent with those of Bebczuk and Berrettoni (2006), though our result was statistically significant. The coefficient for trade openness is negative which contradicts the results obtained by previous studies (Ongba 2013; Kamuganga 2012 and Agosin et al. 2011) which found that trade openness had a positive and significant effect on export diversification.

5 Conclusion and policy implications

In this study we attempted at examining the determinants of export diversification in 32 countries in the Sub Saharan African region using the Herfindahl-Hirschman Index for measuring export diversification. The 32 countries were included in this sample based on the availability of required data. The specified model was estimated using the fractionalized logit technique. The results of our empirical analysis revealed that overall diversification is significantly determined by openness, GDP per capita, value added in

agriculture, value added in manufacturing and foreign direct investment; while official development assistance, official exchange rate and domestic investment were insignificant determinants of export diversification. The results showed that more open economies tend to be less specialized exporting goods that belong to a more heterogeneous export structure while rich countries (proxy by income per capita) tend to have more specialized (homogenous) export structure, thereby exporting goods that belong to a limited productive economic sectors or products. *Ceteris paribus* an increase in per capita level by 10 % may be associated with 0.792 % decrease in the likelihood to diversify in export (that is, increasing the likelihood to concentrate). Other results showed that an increase in foreign direct investment and an improvement in the contribution of both the agricultural and manufacturing sectors in the overall economy are key to fostering export diversification,

In terms of policy, our results suggest that one effective way for developing countries especially those in the Sub Saharan Africa region to promote export diversification is to focus regulatory reform efforts on facilitating international trade (trade openness) and improving foreign direct investment. The countries therefore need to improve their business regulation, property rights legislation and most prominently the governance environment for doing business. In addition, emphasis should be placed on promoting infrastructural development and industrialization both in the agricultural and industrial sectors so as to enhance productivity and competitiveness. Finally, there is need to expand the end markets for products in the Sub Saharan African region.

Appendix

Table 2 Definition of variables used in the estimation

Variable	Description	Source
Concentration Index (EXDIV)	Herfindahl - Hirschmann index, is a measure of the degree of market concentration. An index value that is close to 1 indicates a very concentrated market (maximum concentration) while values closer to 0 reflect a more equal distribution of market shares among exporters or importers.	UNCTAD
Trade openness (LOPEN)	It is the Sum of imports and exports as a ratio of GDP	UNCTAD
Gross capital formation as a percentage of GDP (LGKF)	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories.	WDI
Official Development Assistance (Net ODA received as a percentage% of GNI)	Consists of disbursements of loans made on concessional and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients.	WDI
Official exchange rate (LOER)	It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar).	WDI

Table 2 (continued)

Variable	Description	Source
Manufacturing, value added (LMVA)	Manufacturing refers to industries belonging to ISIC divisions 15–37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.	WDI
GDP per capita (LGDPPC)	Real GDP per capita is gross domestic product divided by midyear population measured in US dollars.	WDI
Agriculture Value Added (LAVA)	Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.	WDI

WDI World Development Indicators (www.wdi.org/), UNCTAD United Nations Conference on Trade and Development statistics (<http://unctadstat.unctad.org/>)

Table 3 Summary statistics of variables used in the model

Variable Country	Concentration Index	Openness	AVA	FDI	FA	OER	GKF	MVA	Per capita GDP
Angola	0.92	128.91	8.52	7.05	3.66	53.35	17.25	4.83	2298.76
Benin	0.47	55.44	35.19	1.43	9.57	551.20	20.20	8.29	529.09
Botswana	0.70	55.44	35.19	1.43	9.57	551.20	31.21	6.26	4730.80
Burkina Faso	0.59	40.58	36.10	0.86	13.34	551.20	22.42	12.11	403.55
Burundi	0.55	35.54	44.72	0.14	23.80	930.47	15.57	10.79	165.84
Cameroon	0.39	53.06	22.88	1.56	4.80	551.20	17.59	18.28	897.15
CAR	0.45	39.49	53.91	1.53	10.58	551.20	10.90	6.67	351.82
Chad	0.80	82.56	45.32	7.38	10.52	551.20	27.43	5.65	544.06
Comoros	0.60	57.68	41.12	0.92	11.09	413.40	15.05	4.58	601.70
Congo Brazzaville	0.75	137.27	5.98	12.81	8.51	551.20	24.96	4.85	1753.70
DR Congo	0.49	79.29	30.95	3.53	12.72	414.77	12.98	16.16	254.23
Gabon	0.74	85.10	5.72	0.96	0.89	551.20	26.98	4.46	6683.81
Ghana	0.40	63.73	35.24	4.14	8.74	0.88	24.10	8.92	787.25
Guinea Conakry	0.56	56.63	22.54	3.82	7.64	2964.40	17.61	5.57	408.93
Ivory Coast	0.35	84.81	23.64	1.98	5.02	551.20	12.85	14.68	998.31
Kenya	0.22	68.93	28.78	0.54	4.25	72.99	18.35	12.25	659.68
Lesotho	0.39	165.51	11.67	12.22	6.49	7.03	39.15	17.70	690.88
Madagascar	0.23	63.95	28.38	4.47	11.35	1598.64	19.74	12.57	328.06
Malawi	0.58	50.40	33.09	2.23	21.63	112.29	18.73	12.05	234.51
Mali	0.61	61.36	41.06	3.58	14.13	551.20	22.11	4.14	452.60
Mozambique	0.40	73.16	28.99	10.08	25.28	21.58	20.76	12.80	337.47

Table 3 (continued)

Variable Country	Concentration Index	Openness	AVA	FDI	FA	OER	GKF	MVA	Per capita GDP
Namibia	0.29	87.78	9.75	4.36	3.25	7.03	21.98	12.75	3403.69
Nigeria	0.85	71.81	32.29	3.10	1.44	107.82	9.68	4.56	1041.58
Rwanda	0.49	36.55	37.79	0.86	21.61	481.89	17.76	7.25	346.74
Senegal	0.23	67.91	17.44	1.93	9.22	551.20	21.63	15.31	754.94
Seychelles	0.51	163.20	2.87	11.17	3.02	7.60	31.42	11.79	9789.23
Sierra Leone	0.40	42.71	54.47	4.49	20.83	2603.13	12.31	3.58	339.70
South Africa	0.14	56.66	3.23	1.66	0.34	7.03	18.18	17.40	4753.668
Swaziland	0.25	150.74	10.17	2.76	1.95	7.03	14.90	40.44	2200.505
Tanzania	0.22	51.48	33.58	4.20	12.66	1066.04	24.17	8.90	388.38
Togo	0.27	90.07	36.61	2.79	8.18	551.20	16.30	8.47	405.27
Uganda	0.36	43.27	30.25	4.01	12.75	1770.69	20.76	8.10	348.40

Table 4 Results of the determinants of export diversification in Sub Saharan countries estimated without outliers

	Fractionalized logit	
	Robust standard errors Coefficient (t-statistics)	Marginal Effect (dy/dx) Coefficient (t-statistics)
LOPEN	-0.1826 ** (-1.74)	-0.0455** (-1.74)
LAVA	-0.2664*** (-3.62)	-0.0665** (-3.62)
LFDI	-0.0811*** (-3.62)	-0.0202*** (-3.62)
LFA	-0.0209 (-0.58)	-0.0052 (-0.58)
LOER	0.0247* (1.70)	0.0062 (1.70)
LGKF	-0.2738** (-3.23)	-0.0135 (-0.60)
LMVA	-0.9391 *** (-16.92)	-0.2342*** (-16.92)
LGDPPC	0.0892** (2.27)	0.0223* (2.27)
Cons	3.6627*** (5.16)	–
R2-type measure	0.4703	–
Number of observations	438	438

***, ** and * significant at 1 %, 5 % and 10 % level of significance, respectively

Table 5 Multicollinearity test using Variance Inflation Factor (VIF)

Variable	VIF	1/VIF
LAVD	2.37	0.4211
LODA	1.93	0.5172

Table 5 (continued)

Variable	VIF	1/VIF
LOPEN	1.77	0.5636
LGDP PPC	1.49	0.6692
LOER	1.49	0.6718
LGKF	1.29	0.7725
LMVA	1.26	0.7944
LFDI	1.23	0.8133
Mean VIF	1.61	

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