The impact of China's FDI and FDI from other sources on growth in sub-Sahara Africa through export upgrading.

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Abstract

This paper seeks to analyze how FDI from China, US, EU, and the rest of Asia transmit to growth in sub-Sahara Africa through export upgrading for the period (2003-2012). Terms of trade is utilized as a proxy for export upgrading because its improvement reflects the increase in the export value of the merchandise in the economy. The results reveal that FDI from China and the rest of Asia does not influence growth in all countries in the region through export upgrading. Whereas the growth effects of FDI from the US and EU differ from one group of countries in the region to the other subject to terms of trade. Precisely, all countries with worse than 1.08% trade of terms are negatively affected by FDI from the US. FDI from the EU negatively affects African countries with terms of trade ranging between 1.02% and 1.08%. As the terms of trade improve beyond 1.08%, the growth effects of FDI from both EU and US turns positive albeit insignificant. A threshold level of 1.08% provides direction to cartel FDI productivity spillover effects on export upgrading so as to overcome the negative growth effects of FDI from the US and EU in sub-Sahara Africa.

Keywords: Foreign Direct Investment; Growth; Export upgrading; Sophistication.

Introduction

Although it can be argued that decrease in terms of trade reflects export price competitiveness of the country's goods, this paper equally argues that the increase of terms of trade implies a rise in the purchasing power of the economy's exports. All other things held constant, a rise in the purchasing power of the country's exports often improves the balance of trade hence growth. Terms of trade exhibit an economy's export prices relative to its import prices (Wacker et al. 2014). Accordingly, it can be argued that terms of trade improve with the export value of the merchandise. From the production perspective, the terms of trade can, therefore, be

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maximized in various ways including minimizing production costs while improving quality and increasing export basket in terms of quantity. These factors reflect export upgrading and are driven by production know-how because of its ability to stimulate productivity (Zhu & Fu 2013). Mattoo & Subramanian (2009) suggest that export upgrading and the ability to export to the industrialized economies enhance economic growth in the country. Harding & Javorcik, (2012) argue that in developing countries export upgrading is not a trivial task due to several challenges including lack of capital to finance production technologies and poor reputation in the global market. How these impediments can be addressed is subject to a vivid academic debate.

However, the latter concede with Romer (1993) and other potential studies in that FDI is a vital source of innovation to technical laggard economies. In terms of poor market reputation, (UNCTAD 2005) suggests that FDI provides opportunities for technological laggard countries to access the global market even where substantial costs are involved due to the emanation of positive spillover effects from locational proximity to an innovation leader. This connection is also exhibited by Mencinger (2003), who gives confirmation of an unmistakable relationship between the increase of FDI and the rapid integration into the worldwide trade. These views provide ample evidence in that FDI as a source of innovation can catalyze export upgrading and associated terms of trade in the host country.

Zhu et al. (2013) suggest that export-oriented FDI in developing economies is often accompanied by the imports of high technology immediate inputs. These inputs enhance the production of sophisticated final products in the host country let alone making the domestic capital more productive. In line with the latter, Poncet & Starosta de Waldemar (2012) assert that FDI can directly transmit to product upgrading since the quality of commodities produced by multinational corporations (MNCs) in the host country is typically higher than that of the domestic firms. The indirect transmission channel occurs when production technologies from MNCs spillover to domestic firms. However, this channel depends on the capacity of domestic firms to absorb foreign production technologies. Demena & Murshed (2018) argue that significant FDI productivity spillover effects can be realized if domestic firms have the capacity to imitate high tech production processes exposed to them by the MNCs. Otherwise, export upgrading will only be reflected in sophisticated products produced by MNCs. In such cases, growth benefits can hardly be released and the former asserts that this is highly likely in developing countries.

In the context of sub-Sahara Africa, FDI productivity diffusion might be constrained by the nature of industry which foreign investors seem to be targeting. Literature (Collier & Goderis 2009; Busse et al. 2014; Chen et al. 2015; Donou-Adonsou & Lim 2018) provide considerable evidence to substantiate that FDI penetration in Africa from both traditional and new emerging investors is mainly driven by the investors' appetite for natural resources. Resource mining projects are capital intensive investments unaffordable by most domestic firms in sub-Sahara Africa. This explains why the extraction industry in the region is dominated by foreign investors (Asiedu 2013). Based on Demena et al. (2018) and Poncet et al. (2012) assertions, it can be argued that sophistication induced growth in sub-Sahara Africa could be a statistical mirage because export upgrading and associated terms of trade are reflected only in the resources extracted by the MNCs. This follows that only resource export platforms of MNCs are likely to benefit from export upgrading and associated terms of trade (Busse et al. 2014). However, the benefits are volatile subject to the fluctuations in global prices of natural resources.

Empirical studies on the growth effects of FDI through export upgrading are still scarce particularly in the context of Africa. The available potential studies focus mainly on the impact of FDI on export upgrading in developing countries generally. For instance, Harding et al. (2012) provide evidence that FDI can enhance export upgrading in developing countries. In contrast, Wacker et al. (2016) found negative effects of FDI on export upgrading and associated terms-of-trade in South Asia. The latter, however, argue that FDI productivity spillover effects on export upgrading depend on the quality of human capital. Likewise, Zhu et al. (2013) provide evidence that the effect of education is significant in FDI-induced-export upgrading in low-income countries. This paper contributes to the existing literature in various ways. First, it uses disaggregated FDI data to investigate how FDI from various sources can transmit to growth through export upgrading. Second, this paper uses the PTR model to account for the heterogeneity of African countries' industrial policy in terms of export upgrading.

The rest of the paper is structured as follows. Section two specifies the model. Section three describes data, variables and empirical strategies. Section four presents the empirical results and discusses the findings of the main parameters. Section five concludes the study.

Model specification

In the exogenous growth models pioneered by Solow and Swan (1956), FDI simultaneously serves as a capital and technological input and hence forestalls physical capital falling into diminishing returns due to the presence of consistent contribution of the technology growth. Likewise, in endogenous growth theories pioneered by Romer (1986), technology diffusion through MNCs impel productivity coming about to increase economic growth both in the short and long-run. In either case, production technology embodied in FDI promotes capital deepening which led to the quality improvements of existing varieties of capital goods (Aghion & Howitt 1992; Aghion et al. 2015) and the invention of totally new varieties of capital goods (Romer 1990).

The model of this paper follows the FDI-augmented version of the Solow growth model. The model was proposed by Neuhaus (2006) following the lead of Mankiw et al. (1992) and Bassanini & Scarpetta (2001). The model replaces Human Capital in the augmented-Solow model of Mankiw et al. (1992) with the stock of FDI. Thus we account for two different stocks of physical capital; domestic capital investment (K_d) and foreign direct investment (K_f).

$$Y(t) = K_d(t)^{\alpha} K_f(t)^{\beta} A(t) L(t)^{1-\alpha-\beta} \quad (1)$$

where Y, K and A proxy for aggregate output, the stock of physical capital, and the productivity parameter respectively. The subscript L denotes labor input while t represents time. α and β represent production elasticities of domestic and foreign capital stocks, respectively.

Since our model follows the neoclassical growth theories, we utilize changes in the log of per capita GDP in real terms as our dependent variable ($lny_{it} - lny_{it-1}$). The specification of our regressors incorporates fundamental determinants of the steady-state and technical progress variables. The steady-state determinants according to Solow (1956) include the convergence term (y_{it-1}), population growth rate (*n),* changes in technology (*g*), the rate of depreciation for capital stock (d) and domestic investment savings rate (s_d). Bassanini et al. (2001) suggest that technical progress (A) consists of two elements. One that accounts for various policy oriented variables ($X_{i,t}$) such as institutional framework, inflation, resource rents and terms of trade among other variables. The other element reflects exogenous technical progress, that is, all other unexplained trend growth variables which the model does not explicitly account for.

$$lny_{it} - ln_{yit-1} = \alpha + \beta lny_{it-1} + \gamma lns_{d,it} + \varphi\, ln(n_{it} + g + d) + \varphi' lnX_{it} + \lambda_t + \eta_i + \varepsilon_{it} \quad (2)$$

FDI is in this paper incorporated both as physical capital (s_f) and technology input. In terms of the latter input, this paper is interested in the FDI productivity spillover effects on export upgrading in sub-Sahara Africa. This is quantified using the interaction term between FDI and terms of trade (*FDI*TOT*). Moreover, in the study of Mankiw et al. (1992) the depreciation rate of the physical capital stock (*d*) and changes in technology (*g*) is assumed to be constant over time and equal to 0.05. Thus the equation (2) translates to equation (3) as follows;

$$lny_{it} = \alpha + (\beta + 1)lny_{it-1} + \gamma lns_{d,it} + \emptyset lns_{f,it} + \varphi\, ln(n_{it} + 0.05) + \varphi' lnX_{it} + \vartheta \ln(FDI * TOT)_{it} + \lambda_t + \eta_i + \varepsilon_{it} \quad (3)$$

where $\lambda_t, \eta_i, \varepsilon_{it}$ proxy for period-specific effects that are assumed to affect all countries for example technology shocks, unobserved country-specific effects, and white noise error term respectively. The subscript i denotes cross-sectional dimension.

Data and variables description

This paper measures per capita GDP in real terms for income levels. The domestic investment savings rate is measured using Gross Capital Formation as a percentage of GDP while foreign investment savings rate is measured using the share of inward stock of FDI in GDP. We use stock rather than flow data of FDI to capture for perpetual and some of the immeasurable effects of FDI on growth. Neuhaus (2006) argue that that the ratio of inward stock of FDI to GDP is more accurate than flows in capturing for perpetual and some immeasurable effects of FDI on economic growth. FDI is differentiated between FDI from a particular source and FDI from the rest of the world (ROW) to sub-Saharan African countries. FDI from ROW is controlled by subtracting source's FDI from the total inward stock of FDI to Africa. For population growth, we add 0.05 before generating logs. The components of X_{it} include total natural resource rents as a percentage of GDP to capture the revenue obtained from extraction of resources, rule of law to proxy for institutional quality and GDP deflator, the annual change in percentage to control for inflation. All these control variables are in logarithms. The summary of all the variable descriptions and data sources is provided in Table 1 below.

Table1: Variable Descriptions and Data Sources

VARIABLE	DESCRPTION	SOURCE
GDP per capita	Gross Domestic Product (GDP) per capita, constant 2010 US$.	WDI (2019)
Domestic Investment	Goss Capital Formation, % of GDP.	WDI (2019)
Population Growth	Population growth rate in %.	WDI (2019)
Terms of Trade	Terms of trade in %, based on an index 2000=100.	WDI (2019)
Inflation	GDP deflator, annual change in %.	WDI (2019)
Rule of Law	Rule of Law: The estimates range from approximately -2,5 to 2.5 indicating weak and strong governance performance respectively.	WDI (2019)
FDI ROW	Total inward stock of FDI from the rest of the world (Total inward stock of FDI less inward stock of FDI from China/USA/EU/Asia), % GDP.	UNCTAD stat (2019)
FDI (CHINA/USA/EU/ROA)	Inward stock of FDI from China, USA, European Union and the Rest of Asia respectively, % of GDP.	UNCTAD stat (2019)
Total Natural Resource Rent (% of GDP)	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.	WDI (2019)

Our sample embraces a panel of 42 sub-Sahara African countries over the period of 2003-2012. Guided by the analytical framework of Sy (2014)[2], our analysis of FDI sources accounts for China, USA, EU, and Asia excluding China (rest of Asia). Our study period (2003-20012) is restricted by the availability of inward stock of FDI data from the named FDI sources to African countries, likewise our sample. The list of the sample is provided in Table 2 below.

[2] An analytical framework of Sy (2014) shows that there has been a surge of inward stock of FDI in Africa from $27.2 billion to approximately $132.8 billion between the periods (2001-2012). This surge was mainly fuelled by China, whose FDI grew at an annual rate of 53 percent, compared with, 16 percent for the EU and 14 percent for the U.S. In addition to China, other new emerging investors were increasingly investing in the continent.

Table 2: Sample[3]

Angola	Benini	Botswana	Burkina Faso	Burundi	Cameroon	Cape Verde	Central Africa Republic
Chad	Comoros	Congo	Cote D'Ivoire	DRC	Equatorial Guinea	Eritrea	Ethiopia
Gabon	The Gambia	Ghana	Guinea	Guinea-Bissau	Kenya	Lesotho	Liberia
Madagascar	Malawi	Mali	Mozambique	Niger	Nigeria	Rwanda	Sao Tome & Principe
Senegal	Seychelles	Sierra Leone	South Africa	Swaziland	Togo	Uganda	Tanzania
Zambia	Zimbabwe						

Estimation Techniques

Endogeneity is a central econometric problem prone to economic growth models. Hauk (2016) asserts that bias arising from omitted variables and reverse causality are the most common sources of endogeneity which often renders the OLS parameter estimates of the growth models inconsistent. In a single regression framework, the workhorse of dealing with endogeneity is using instrumental variables estimator and the popular form of that estimator, often utilized is known as two-stage least squares (2SLS). Accordingly, the estimates of the equation (3) are derived from the fixed-effects 2SLS regression model. Regressions are conducted separately for each source of FDI. Following the approach utilized in the study of Donou-Adonsou et al. (2018), we instrument each source of FDI with its first three lags. The consistency of fixed-effects 2SLS estimator relies upon the test for endogeneity and the validity of the instruments utilized. The standard formal test for endogeneity is a Hausman test or C test. For the validity of instruments, we use the Hansen test of overidentifying restrictions.

However, one of the weaknesses associated with classical fixed effects models in as much as the interaction term is concerned (*FDI*TOT*) is the inability to capture for varying slopes.

[3] The estimation results of the PTR model are based on 34 sub-Sahara African countries for the regression relating to China and 35 countries for other sources of FDI. Countries removed from the main sample are Benini, Ghana, Guinea-Bissau, Mali, Rwanda, Sao Taome & Principe, Senegal, and Togo. We removed Ghana on the regression relating to China only. These countries reported very few observations (mostly less than three) of inward stock of FDI from all the FDI sources considered in this study for the period (2001-2012). The estimation of PTR using STATA is very sensitive to missing values hence, these countries were removed to obtain a strongly balanced panel data. We hardly could ipolate and epolate for the missing FDI values of the removed countries.

Rather they reflect the heterogeneity of different countries in intercepts. To circumvent this drawback we also run equation (3) using fixed effects panel threshold regression (PTR) of Hansen (1999). PTR can account for different links in terms of statistical significance, magnitude and signs among or between the variable of interest in distinct regimes.

Allowing for fixed individual effects (μ_i) and given terms of trade ($TOT_{i,t}$) as a threshold variable, the PTR divides the observations into two or more regimes, depending on whether each observation is above or below a threshold level. The econometric equation of PTR model with two extreme regimes can be defined as follows;

$$y_{it} = \mu_i + \beta'_{it} s_{f,it} g(TOT_{it}; c) + \varphi' X_{it} + \varepsilon_{it} \tag{4}$$

Where X_{it} denotes for fundamental Solow growth variables and other control variables discussed above excluding terms of trade. Excluding terms of trade from other regressors in the main equation controls for reverse causality and collinearity. The subscript $s_{f,it}$ represents the inward stock of FDI while ε_{it} is the error term. The binary transition function $g(TOT_{it}; c)$ divides the single threshold equation (4) into two regimes with coefficients β_1 and β_2, where *c* is the threshold parameter. This translate equation (4) into the following equation:

$$y_{it} = \begin{cases} \mu_i + \beta'_1 s_{f,it} + \varphi' X_{it} + \varepsilon_{it} & if\ TOT_{it} \le c \\ \mu_i + \beta'_2 s_{f,it} + \varphi' X_{it} + \varepsilon_{it} & if\ TOT_{it} > c \end{cases}, \tag{5}$$

Equation (5) can be thought of as linear heterogeneous panel model with coefficients that vary across cross-section units and over time. Where the slope parameters satisfy;

$$\frac{\partial y_{it}}{\partial s_{f,it}} = \beta_{it} = \begin{cases} \beta_1\ if\ TOT_{it} \le c \\ \beta_2\ if\ TOT_{it} > c \end{cases}, \tag{6}$$

For multiple thresholds that is, models with $r + 1 > 2$ regimes or threshold parameters $c_1, .. c_r$, the general specification is as follows:

$$y_{it} = \mu_i + \sum_{j=1}^{r} \beta'_j\, s_{f,it} \mathrm{I}_{(c_{j-1} < TOT_{it} \le c_j)} + \varphi' X_{it} + \varepsilon_{it} \tag{7}$$

where $\mathrm{I}_{(c_{j-1} < TOT_{it} \le c_j)}$ represents the indicator function and $c_0 = -\infty$ while $c_{r+1} = +\infty$.

Equation (7) ought to be fitted sequentially for instance in the case of a double threshold that is, three regimes model the specification is presented below;

$$y_{it} = \mu_i + \beta'_1 s_{f,it}(TOT_{it} < c_1) + \beta'_2 s_{f,it}(c_1 \le TOT_{it} < c_2) + \beta'_3 s_{f,it}(TOT_{it} \ge c_2) + \varphi' X_{it} + \varepsilon_{it} \tag{8}$$

where $c_1 < c_2$.

Notwithstanding uncertainty about the endogeneity bias and potential reverse causality, this study uses lagged values of FDI and terms of trade. This translates equation (4) and (7) into the following equations, respectively:

$$y_{it} = \mu_i + \beta_{it}' s_{f,it-1} g(TOT_{it-1}; c) + \varphi' X_{it} + \varepsilon_{it} \quad (9)$$

$$y_{it} = \mu_i + \sum_{j=1}^{r} \beta_j' \, s_{f,it-1} \mathrm{I}_{(c_{j-1} < TOT_{it-1} \leq c_j)} + \varphi' X_{it} + \varepsilon_{it} \quad (10)$$

Estimation procedures

First, we estimate equation (3) using the fixed effects 2SLS estimator to determine how FDI from China, US, EU and rest of Asia contribute to growth in sub-Sahara Africa through export upgrading. The latter estimation procedure ignores the heterogeneity of the African countries in terms of export upgrading policies. Rather, it regards all countries in the region as one. However, this paper argues that the industrial policy of sub-Sahara Africa countries in terms of export upgrading may be different and most likely the structural relationships may vary from one country to the other. We, therefore, run equations (9) and (10) to determine the impact of FDI from the mentioned sources on growth in sub-Sahara Africa subject to different levels of terms of trade. Where terms to trade quantify export upgrading.

The first test of the PTR model is conducted to determine the significance of the threshold effect in equation (9). The threshold effect hypothesis can be presented as follows;

$H_0 \colon \beta_1 = \beta_2$

The rejection of H_0 is an indication that the single threshold regression is appropriate otherwise, equation (9) collapses to equation (3). The main econometric problem associated with the test for no threshold effects is the presence of the nuisance parameter in the null hypothesis. Thus, the threshold parameter c is not identified under H_0 Davies (1987). This problem renders the asymptotic distribution of F_1 statistic non-standard. Hansen (1996) proposed the use of bootstrap simulation as a solution to the nuisance parameter issue. The bootstrap analog produces first-order asymptotic distributions and therefore test statistic F_1 and the corresponding p-value attained from the bootstrap are asymptotically valid. The null hypothesis is rejected if the test statistic $F_1 >$ its critical value.

The second test of the PTR model is conducted to determine the number of thresholds. A sequential procedure based on $F_2, \ldots F_j$ (until the corresponding H_0 is accepted) allows the determination of the number of thresholds hence the appropriate regression. Starting with statistic F_2, H_0: Single threshold regression. The hypothesis of the single threshold is rejected in favor of a double threshold if $F_2 >$ its critical value. The corresponding asymptotic *p*-value for $F_2, \ldots F_j$ can again be estimated using bootstrap simulation (Hansen 1999).

Estimated Results

The estimated results of the fixed-effects 2SLS estimator are exhibited in Table 3 below. Column (1)-(4) shows the regressions relating to the FDI from China, US, EU and the rest of Asia, respectively.

The results show that lagged dependent variable (convergence term) and domestic investment coefficients are highly significant and enter the model as expected across all regressions. Contrary to the literature, population growth coefficient is positive however statistically insignificant and small. The results also show that the direct impact of FDI from China is negative and statistically significant at 5% while FDI from other sources is statistically insignificant. Thus, a 1% increase in FDI from China can lead to a decrease in sub-Sahara Africa's real GDP per capita by approximately 0.18%. In terms of FDI from the rest of the world, 1% rise in FDI from the rest of the world while separately controlling for EU and the rest of Asia decreases Africa's real per capita GDP with approximately 0.07% on both cases.

Rule of law coefficient enters the model with the expected sign across all regressions albeit statistically significant only in the regression relating to Chinese FDI. The estimated coefficients of all other variables including the interaction term between FDI and terms of trade are statistically insignificant. We then can turn to the PTR estimations.

Table 3: Fixed-effects 2SLS estimated results

Dependent Variable: In real GDP per Capita				
	(1)	(2)	(3)	(4)
Lagged Dep Var	0.715***	0.710***	0.719***	0.727***
	(0.084)	(0.066)	(0.068)	(0.058)
ln Domestic Investment	0.013***	0.012***	0.013***	0.013***
	(0.005)	(0.004)	(0.005)	(0.005)
ln Population Growth	(-0.009	0.004	0.008	0.001
	(0.015)	(0.021)	(0.018)	(0.017)
In inflation	0.005	0.005	0.006	0.005
	(0.007)	(0.007)	(0.008)	(0.007)
ln Natural Resource Rents	0.006	0.005	-0.001	0.005
	(0.015)	(0.17)	(0.016)	(0.016)
ln FDI ROW	-0.061	-0.101	-0.066*	-0.070**
	(0.038)	(0.070)	(0.039)	(0.033)
ln Rule of Law	0.041*	0.040	0.031	0.035
	(0.023)	(0.039)	(0.024)	(0.027)
ln FDI China	-0.182**			
	(0.084)			
ln FDI US		-0.027		
		(0.100)		
ln FDI EU			-0.019	
			(0.051)	
In FDI ROA				0.061
				(0.138)
In FDI^j*TOT	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	252	227	237	244
Countries	42	42	42	42
R-Squared (within)	0.803	0.794	0.789	0.800
Hausman/C test (p-value)	0.000	0.001	0.000	0.000
Hansen test (p-value)	0.874	0.238	0.271	0.340

Notes: The subscript *j* represents a specific source of FDI. FDI^j*TOT is the interaction term between FDI from a specific source and terms of trade. Robust standard errors are in parentheses. *significant at the 10% level; **significant at the 5% level; ***significant at the 1% level. In all regressions from column 1-4, specific FDIs are instrumented using their first three lags and the p-values of the Hausman test are <10% implying that 2SLS estimates are preferred to standard OLS fixed-effects estimates. All p-values of the Hansen test are >10% implying that the instruments used are valid.

This study uses terms of trade as the threshold variable. The variable is summarised in Table 4. Row (1) exhibit terms of trade in logarithms while row (2) presents the corresponding values in their raw form as extracted from the WID (2019). Terms of trade above 1% indicate an improvement in the value export portfolio otherwise a worsening. In the context of this study improvement in terms of trade imply export upgrading. The results reveal that on average, terms to trade in sub-Sahara Africa does not exceed 4.33% while the minimum is 0.55%.

Table 4: Summary of the threshold variable

Variable		Min	25% Quantile	50% Quantile	75% Quantile	Max
In terms of trade	(1)	-0.590	-0.097	0.028	0.270	1.465
Terms of trade	(2)	0.554	0.908	1.028	1.309	4.329

Notes: Authors own calculation based on terms of trade data from WID (2019).

Table 5 presents the results of the hypothesis of no threshold effects and the tests to determine the number of thresholds. These estimation procedures were conducted separately for each source of FDI. The test statistic F_1 of the regressions relating to FDI from US and EU are both significant at 5% with an equal corresponding bootstrap *p*-value of 0.02 while the test statistics F_1 of both China and the rest of Asia are statistically insignificant. These results imply that the hypothesis of no threshold effects is rejected for the regression relating to FDI from US and EU while accepted for China and the rest of Asia. Hence, the estimated results in Table 3 holds for FDI from China and the rest of Asia.

For the FDIs which passed the PTR test, the test statistics F_2 of the regression relating to EU is statistically significant at 5% while that of the US is statistically insignificant. The test statistic for a third threshold F_3 of FDI from EU is however statistically insignificant. Thus, the results imply one threshold (two regimes) for PTR analysis of FDI from the US and two thresholds (three regimes) for FDI from the EU.

Table 5: Test for threshold effects and number of thresholds

	Chinese FDI	US FDI	EU FDI	ROA FDI
Test for Single threshold(two regimes)				
F_1	8.99	24.94	16.35	3.61
P-Value	0.160	0.020**	0.020*	0.680
1% critical values	14.28	38.66	17.02	15.09
5% critical values	12.41	18.78	13.72	13.09
10% critical values	10.88	13.09	12.36	10.95
Test for Double threshold(three regimes)				
F_2		8.86	14.67	
P-Value		0.160	0.040**	
1% critical values		22.33	24.94	
5% critical values		16.37	11.37	
10% critical values		11.65	10.15	
Test for Tripple threshold(four regimes)				
F_3			6.82	
P-Value			0.760	
1% critical values			35.60	
5% critical values			27.36	
10% critical values			19.92	

Notes: *P*-values and critical values are computed from 50 bootstrap simulations. F_1 represents the Fisher type statistic associated with the test of H_0 of no threshold against a single threshold. F_2 corresponds to the test of a single threshold against a double threshold and F_3 corresponds to the test of double threshold against a triple threshold. *significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

Results of the terms of trade threshold parameter estimates of regressions relating to the FDI from the US and EU are exhibited in Table 6 below. As shown in Table 5 above, FDI from the US is analyzed in two regimes demarcated with a threshold point estimate of 0.077. Whilst FDI from the EU is analyzed in three regimes separated by threshold point estimates of 0.020 and 0.077. The point estimates of 0.020 and 0.077 correspond to the terms of trade threshold levels of 1.02% and 1.08%, respectively. Thus for EU FDI, the first, second and third regime is such that; $TOT_{it} < 1.02$, $1.02 \leq TOT_{it} < 1.08$ and $TOT_{it} \geq 1.08$, respectively. For US FDI, the first and second regimes are respectively separated as; $TOT_{it} \leq 1.08$ and β_2: $TOT_{it} > 1.08$. The results also show that the asymptotic confidence intervals for the thresholds are equal at 95% and 99% across all the estimations, indicating certainty about the nature of this division.

Table 6: Terms of trade threshold level estimates

		Point Estimate	95% Confidence Level	99% Confidence Level
US FDI	Single threshold	0.077	[0.057;0.084]	[0.057;0.084]
EU FDI	Single threshold	0.077	[0.057;0.084]	[0.057;0.084]
	Double threshold	0.020	[0.004;0.026]	[0.001;0.026]

The main results of the PTR analysis are presented in Table 7. Column (1) reports the results relating to FDI from the US while results in column (2) relate to the FDI from the EU.

Dependent Variable: ln real GDP per Capita			
		(1)	(2)
Lagged Dep Var		0.754***	0.791***
		(0.039)	(0.040)
ln Domestic Investment		0.012***	0.013***
		(0.004)	(0.005)
ln Population Growth		0.009	0.010
		(0.005)	(0.006)
ln Natural Resource Rents		0.007	0.013
		(0.009)	(0.008)
In inflation		-0.0001	-0.0001
		(0.0002)	(0.0002)
ln FDI ROW		-0.137***	-0.094**
		(0.043)	(0.037)
ln FDI US		0.062	
		(0.059)	
In FDI EU			-0.012
			(0.050)
ln $FDI^j I_{(.)}$	β_1	-0.073**	0.002
		(0.032)	(0.029)
	β_2	0.031	-0.116***
		(0.025)	(0.033)
	β_3		0.020
			(0.023)
Observations		350	350
Countries		35	35
R-Squared (within)		0.866	0.870

Notes: The subscript j denotes FDI from a specific source while $I_{(.)}$ represents the indicator/transition function. For EU FDI, β_1: ($TOT_{it} < 0.020$), β_2: ($0.020 \leq TOT_{it} < 0.077$) and β_3: ($TOT_{it} \geq 0.077$) while for US FDI, β_1: $TOT_{it} \leq 0.077$ and β_2: $TOT_{it} > 0.077$. Robust standard errors are in parentheses.*significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

β_1, β_2, and β_3 respectively correspond to the first, second regime for both sources of FDI and third regime for EU FDI only. Results in column (1) reveal that β_1 is negative and significant at 5% while β_2 is positive albeit statistically insignificant. In column (2), β_1 and β_3 are positive however statistically insignificant while β_2 is negative and highly insignificant.

Discussion of the main parameters

Accepting the hypothesis of no threshold effects in regressions relating to FDI from China and the rest of Asia is a confirmation that productivity spillover effects of FDI from the sources on export upgrading are insignificant in all sub-Sahara Africa countries, whether improving or worsening terms of trade. The growth effects of FDI from the US are significantly negative in African countries with worse than 1.08% terms of trade. In contrast, the growth effects of FDI from EU are insignificant within almost the same range as the latter, however, turns to be significantly negative in countries with improving terms to trade from 1.02% to 1.08%. Improvement of terms of trade beyond 1.08%, renders the growth effects of both FDI sources in sub-Sahara Africa insignificant.

Our results reveal that FDI productivity spillover effects on export upgrading and associated terms of trade in sub-Sahara Africa are marginal. At best, the export upgrading is reflected in the sophisticated products produced by the MNCs only. Unfortunately that best is not significant enough. This is consistent to the study of Poncet et al. (2012) which disputed the realization of significant economic growth benefits in such cases, especially in developing countries. Moreover, Demena et al. (2018) suggest three channels through which FDI-induced-export upgrading can lead to growth in the host country. The first and vital one is that domestic firms should be able to imitate high tech production processes exposed to them by the MNCs. The second relates to the mobility of physical human capital from the MNCs to domestic firms or entrepreneurial ventures. The third channel postulate to emerging competition between domestic firms and MNCs in the local market. This competition can be interpreted as an incentive for domestic firms to imitate production processed utilized by the MNCs, hence productivity. However, crowding out effect may occur if domestic firms fail to compete.

Given the capital requirements of the industry which foreign investors seem to be targeting in sub-Sahara Africa, all the channels discussed above are constrained. First and foremost, there is a limited number of domestic firms investing in resource extraction projects in the region due to capital constraints. Accordingly, existing domestic firms in the resource extraction industry operate at a small scale relative to MNCs. This explains why imitation of high tech production processes is at zero and why sub-Sahara Africa is prone to FDI crowding out effect. Second, the mobility of labor is discouraged by wage differentials between domestic firms and MNCs, hence constraining production technology diffusion. MNEs offer high wages relative to domestic companies and the wage differentials are high in developing countries (Aitken et al. 1996).

Regardless of the industry, our results also convey information that there might be a scarcity of skilled labor to absorb FDI production know-how in sub-Sahara Africa. (Fu & Li 2010) assert that the absorption of knowledge embodied in FDI requires highly educated human capital. This is in line with the empirical work of Wacker et al. (2016) which exhibited that negative effects of FDI on export upgrading and associates terms of trade realized in South Asia were attributed mainly by the shortage of skilled human capital. Likewise, Zhu et al. (2013) provide evidence that the effects of education are significant in FDI-induced-export upgrading in low-income countries. This economic intuition implies human capital development as a vital factor which can enhance FDI productivity spillovers on export upgrading in the host country.

Conclusion and recommendations

The recent surge of FDI from both traditional and new emerging investors in Africa has spawned substantial debate in particular on the growth effects of FDI from China as a new emerging investor in Africa. Most of the studies have mainly focused on the approach of measuring the impact of FDI from China as a capital input in the growth model of the continent. However, literature provides ample evidence in that FDI can serve simultaneously as a capital and technology input. This paper intends to contribute to the literature by analyzing how production technology embodied in FDI from China, US, EU and the rest of Asia can spillover to growth in sub-Sahara Africa through export upgrading. We use terms of trade to proxy for export upgrading because it quantifies the improvement of export value of the merchandise in the economy. The findings of this study show that FDI from China and the rest of Asia does not influence growth in all African countries through export upgrading. Whereas the growth effects of FDI from the US and EU differ from one group of countries to the other subject to terms of trade. Precisely, all countries with worse than 1.08% trade of terms are negatively affected by FDI from the US. The impact of FDI from the EU negatively affects African countries with terms of trade improving from 1.02% to 1.08%. As the terms of trade improve beyond 1.08%, the growth effects of FDI from both EU and US turns positive albeit insignificant.

The threshold level obtained is crucial for FDI-induced-export upgrading development policies in sub-Sahara Africa because it provides direction for mitigation procedures corresponding to the specific source of FDI. Thus, a threshold level of 1.08% provides direction to cartel FDI productivity spillover effects on export upgrading so as to overcome the negative growth effects of FDI from the US and EU in sub-Sahara Africa. The mitigation procedures can include but not limited to human capital development and attraction of diversified FDI. Absorption of production know-how embodied in FDI is effective through the streams of the skilled and educated labor force. On the dimension, FDI attracted towards economic sectors in which domestic firms can be able to imitate production processes from MNCs and compete with them enhances sophistication. Given the availability of data, further studies should be directed towards analyzing FDI-induced-export upgrading in a specific industry of the host economy.

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