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Human capital and the FDI-Income inequality nexus in African countries: Panel smooth transition regression approach

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Abstract. *The link between foreign direct investment (FDI) and income inequality has received little attention in the literature. This paper investigates empirically the relationship between FDI and income inequality using an unbalanced panel data made up of 26 African countries over the period 1990-2013. First, we estimate the linear relation using the now popular System-GMM estimation techniques to control for potential endogeneity bias. We find that FDI deepens income inequality. Secondly, we go further in the analysis to examine whether the impact of FDI on income inequality depends on absorptive capacity, by employing a panel smooth transition regression model which is more suitable to deal with cross-country heterogeneity issues. We use human capital stock as a proxy for absorptive capacity, and the results show that the impact of FDI on income inequality is conditioned by the level of human capital stock in the host country. Specifically, we find that FDI increases income inequality in countries with low levels of human capital stock, and reduces income inequality in countries with high levels of human capital stock. These findings suggest that policies oriented towards FDI liberalization in African countries should go hand in hand with policies that aim at improving human capital stock in order to mitigate the potential inequality-increasing effect of FDI.*

Keywords: Foreign direct investment, human capital, income inequality, absorptive capacity, System-GMM, Panel Smooth Transition Regression.

JEL Classification: F21; O15; O11.

1. Introduction

While the predominant conclusion from the recent literature is that FDI can enhance significantly economic growth in the recipient countries with better domestic conditions also known as absorptive capacity, the question of whether the whole population benefit equally from FDI or not, is less documented (Figini and Görg, 2011; Mah 2012; Lin et al., 2013). Understanding the effect of FDI on income distribution has important policy implications. For example, if FDI improves economic growth and income distribution, inclusive growth can be achieved through FDI liberalization policy since this policy breaks the tradeoff (dilemma) between efficiency and equity which is often confronted by policymakers. In contrast, if FDI enhances growth and exacerbates income inequality, unless appropriate policy is implemented, the growth gain from FDI may not be sustainable since the growing inequality can lead to socio-political instability which in turn reduces investment with a negative effect on economic growth (Alesina and Rodrick, 1994; Persson and Tabellini, 1994; Alesina and Perroti, 1996; Ostry et al., 2014).

Despite the high level of income inequality and the increasing FDI flows to Africa in recent years(1), only a handful of papers has attempted to investigate the distributional impact of FDI in the specific context of Africa. Sharma and Abekah (2017), and Kaulihowa and Adjasi (2017) look into this issue; however, they did not systematically investigate the role of domestic conditions in the relationship between FDI and income inequality. Recently, the inconclusive results concerning the impact of FDI on income inequality has triggered a new generation of studies examining the role of domestic conditions such as human capital, local financial development, and infrastructure development among others in modulating the link between FDI and income inequality (see for example, Wu and Hsu, 2012; Lin et al., 2013; Lin et al., 2014; Mihaylova, 2015).

This new approach concerning the relationship between FDI and income inequality remains largely unexploited in the specific context of Africa. It is against this backdrop that this study seeks to investigate the effect of FDI on income inequality in African countries and ask whether the relationship varies with domestic conditions (absorptive capacity) or not. In particular, we choose human capital as a proxy for absorptive capacity and examine whether it exerts a nonlinear effect on the relationship between FDI and income inequality in African countries.

The remainder of the paper is organized as follows: section 2 provides a review of some theoretical arguments and previous empirical findings on the link between FDI and income inequality. The third section highlights the data and methodology used. Section 4 presents the empirical results and discussions while the latter draws a conclusion.

2. Literature review

The existing theoretical and empirical literature concerning the effect of FDI on income inequality is inconclusive. According to Mundell (1957), FDI liberalization leads to capital inflows from capital abundant countries (developed countries) to capital-scarce countries (developing countries) in order to take advantage of the returns on capital differentials.

Thus foreign firms compete with local firms in the labor market. As a result, the labor income will increase and domestic firms profit will decrease. Ultimately, the relative returns on capital to labor fall thereby reducing income inequality in developing countries. In other words, FDI has an equalizing effect in developing countries according to Mundell "hypothesis".

Modernization theory is one of the important theories about the consequences of foreign direct investment in the host country. The position of the proponents of modernization theory on income inequality is consistent with what is referred to as "Kuznets hypothesis" according to which income inequality tends to rise in the initial phase of economic development and then falls in the latter stages of development. According to the modernization theory, the development of countries follows a process with different stages, and each stage has different impact on income inequality. According to this theory, foreign capital increases income inequality at the initial phase of development, but this income inequality will decline once the country has reached a certain optimal level of development (Tsai, 1995; Kaulihowa and Adjasi, 2017).

In contrast to the modernization theory, the dependency theory is more critical of the distributional impact of FDI. According to this theory, multinational corporations often use more advanced technology which requires high skilled labor. As a result, the demand for high skilled workers increases, and consequently increases their wage. In other words, as unskilled workers are abundant in developing countries, FDI activities in these countries is highly likely to exacerbate income inequality by generating a highly paid elite and a large number of marginalized unskilled workers (Girling, 1973; Bornschier and Chase-Dunn, 1985).

This argument is well developed by Feenstra and Hanson (1997). Using a framework of North-South model, they argue that a relatively cheap labor in the South (developing countries) encourages firms in the North (advanced countries) to shift the labor-intensive parts of their production to the South. However, activities that are known to be intensive in low-skilled labor in the North (advanced countries) might be high-skilled labor-intensive in the South (developing countries). As a consequence, the skill premium increases in the South thereby deepening income inequality.

Although not exhaustive, the theoretical literature shows that the impact of FDI on income inequality is a matter of controversy. This has triggered empirical studies which are also inconclusive. Empirical results on the link between FDI and income inequality can be categorized into four main groups.

The first group of studies reports that FDI inflows increase income inequality in the recipient country. In a widely cited paper, Tsai (1995) investigates the effect of FDI inflows on income inequality in 33 developing countries during the 1970s. The results obtained by the author tend to vary according to geographical areas. Specifically, the results indicate that FDI worsens income inequality in East and Southeast Asian countries. Using a panel data made up of 88 countries over the period 1969-1994, Alderson and Nielsen (1999) find that Inward FDI stock deepens income inequality. In a similar fashion (panel data), Reuveny and Li (2003) for the case of 69 countries over the period 1960-1996, Choi (2006) for the case of 119 countries over the period 1993-2002, Basu and Guariglia (2007) for the

case of 119 developing countries over the period 1970-1999, Jaumotte et al. (2013) for 51 countries over the period 1981-2001, Herzer et al. (2014) for the case of Latin America, Asteriou et al. (2014) for the case of EU-27 during the period 1995-2009, and Huang et al. (2016) for the case of 39 middle-income countries over the period 1981-2006, report that FDI deepens income inequality. In country-specific context, Feenstra and Hanson (1997) for the case of Mexico in the period 1975-1988, Zhang and Zhang (2003) in the case of China over the period 1985-1998, and Mah (2012) on South Korea over the period 1982–2008, find that FDI worsens income inequality.

The second group of empirical studies finds that FDI reduces income inequality. For example, Herzer and Nunnenkamp (2013) assess the effects of FDI on income inequality in 8 European countries over the period 1980- 2000, and the results show a negative long-run relationship between FDI and income inequality. Also, Hyejoon and McLaren (2015) investigate the impact of FDI on inequality and poverty using a sample of 127 developing countries during the period 1977-2012. Without controlling for the endogeneity issue, they find no any effect of FDI on income inequality. They further control for the endogeneity issue, and find that FDI reduces income inequality and poverty. The authors emphasize the necessity to control for endogeneity issue while investigating the effect of FDI on income inequality. In single country studies, Jensen and Rosas (2007) find that FDI inflows reduce income inequality in Mexico during the period 1990-2000. An equalizing effect of FDI was also found by Ucal et al. (2015) in Turkey over the period 1970-2008. In the same vein, Bhandari (2006), and Chintrakarn et al. (2012) report that FDI improves income distribution in the United States. However, they conclude that the effect is not homogeneous across U.S. States.

The third group of studies did not find any link between FDI and income inequality. Examples of these studies are Sylvester (2005) with a sample of 29 developing countries over the period 1970-1990, Milanovic (2005) based on household surveys for 129 countries for the year 1988, 1993 and 1998, and Mah (2003) on South Korea for the period 1975-1995.

The fourth group of studies which emerge recently deviate from the standard approach to explore the non-linear relationship between FDI and income inequality. In particular, this group of studies investigates the role of absorptive capacity (domestic conditions) in modulating the impact of FDI on income inequality. Cho and Ramirez (2016) investigate the link between FDI and income inequality in the case of seven selected Southeast Asian countries over the period 1990-2013. The results show a non-linear relationship between FDI and income inequality. FDI raise income inequality in the short run while in the long run it reduces income inequality. In their study, they find that the inequality-reducing effect of FDI starts when FDI inflows (% of GDP) reach 5.6. Cho and Ramirez (2016) conclude that "the fact that the Gini coefficient reaches it maximum at a moderate level of FDI inflows suggests that the sample countries are endowed with substantial absorptive capacity" (p. 421). Wu and Hsu (2012) use infrastructure development as a proxy for absorptive capacity and investigate its role in the link between FDI and income distribution in 54 countries over the period 1980-2005. They employ a panel threshold regression technique, and the results indicate that FDI has little effect on income inequality in countries with better absorptive capacity while it deepens income inequality in countries with low levels of absorptive capacity. Using the same approach, Lin et al. (2014) find that

FDI has income inequality-increasing effect and this effect increases as the local financial development increases in the case of 42 countries during the period 1976-2005. In sum, the results show that local financial development defines the association between FDI and income inequality. Mihaylova (2015) examines whether the effect of FDI on income inequality depends on the level of human capital stock in ten Central and Eastern European countries over the period 1990-2012. Using a linear interaction model, the results show that FDI increases income inequality but the effect diminishes as the level of human capital stock increases. In particular, the author finds that FDI exacerbates income distribution when the level of human capital stock measured by the secondary school enrollment ratio is below 81%. Beyond this level, FDI improves income distribution.

Concerning the specific context of Africa, empirical studies are scarce. For example, using GMM estimation techniques, Anyanwu et al. (2016) find that FDI is among the factors that increase income inequality in 17 West African countries over the period 1970-2011. However, using OLS estimation method, Sharma and Abekah (2017) find that FDI reduces income inequality in 46 African countries over the period 1970-2014 while Kaulihowa and Adjasi (2017), by employing a Pooled Mean Group (PMG) model, report that FDI reduces income inequality in the short run, and increases it in the long run in the case of 16 African countries over the period 1980-2013. These contradictory findings call for a new empirical study with an improved methodology.

3. Model specification and data

3.1. Econometric model

Following Wu and Hsu (2012), we first consider the following linear regression:

$$INEQ_{it} = \beta FDI_{it} + \varphi X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where $INEQ$ stands for the income inequality indicator, FDI is foreign direct investment, X is the vector of control variables including the constant term, μ_i and ε represent respectively the country specific effect and the error term. FDI increases income inequality if $\beta > 0$. In contrast, FDI reduces income inequality if $\beta < 0$. Model 1 captures the linear relationship between FDI and income inequality. However, the predominant conclusion from the recent literature is that the link between FDI and inequality may vary according to the level of absorptive capacity in the host country. Consequently, we employ the panel smooth transition regression (PSTR) approach proposed by Gonzalez et al. (2005) to investigate the nonlinear relationship between FDI and income inequality. PSTR is the suitable threshold regression approach to explore not only the nonlinear relationship between FDI and income distribution but also to circumvent the problem of cross-country heterogeneity (Lin et al., 2014; Jude and Levieuge, 2016). For simplicity, we assume a two-regime PSTR model, and we have the following expression:

$$INEQ_{it} = \beta_0 FDI_{it} + \beta_1 FDI_{it} g(q_{it}\ ;\ \gamma, c) + \varphi_0 X_{it} + \varphi_1 X_{it} g(q_{it}\ ;\ \gamma, c) + \mu_i + \varepsilon_{it}, \quad (2)$$

where $g(q_{it}\ ;\ \gamma, c)$ is the transition function which is continuous and bounded between 0 and 1 ; q_{it} is the transition variable which is human capital stock in this study. As in

Gonzalez et al. (2005), and Fouquau et al. (2008), the transition function g(.) is specified as the following logistic function:

$$g(q_{it}\,;\,\gamma,c) = \frac{1}{1+\exp[-\gamma(q_{it}-c)]} \tag{3}$$

where $\gamma > 0$, is the slope parameter which represents the speed of transition from one regime to another, and c is the threshold parameter. For $\gamma \to \infty$, the transition function approaches an indicator function, which means that $g(q_{it}\,;\,\gamma,c) = 0$ if $q_{it} < c$, and $g(q_{it}\,;\,\gamma,c) = 1$ if $q_{it} \geq c$. However, when $\gamma \to 0$, the transition function tends to be a constant and the model becomes a linear panel regression model with fixed effects. In model 2, the coefficient of FDI is β_0 when $g(q_{it}\,;\,\gamma,c)$ tends toward 0, and $\beta_0 + \beta_1$ when $g(q_{it}\,;\,\gamma,c)$ tends toward 1. Between these two extremes, the sensitivity of income inequality to FDI is obtained as a weighted average of parameters β_0 and β_1. Thus, as in probit or logit model, the values of the parameters β_0 and β_1 are not directly interpretable. Only their signs are interpreted to indicate the effect of FDI on income inequality depending on the value of the transition variable. For a given transition variable q_{it} , the FDI coefficient for country *i* at time *t* is:

$$\frac{\partial INQ_{it}}{\partial FDI_{it}} = \beta_0 + \beta_1 \times g(q_{it}\,;\,\gamma,c) \tag{4}$$

Following Colletaz and Hurlin (2006), and Fouquau et al. (2008), a three-step procedure is adopted in order to estimate the parameters of the PSTR model. The first step is the linearity test. In this study, the linearity test consists of testing if the relationship between FDI and income inequality can be properly captured by a homogeneous linear panel model or by a PSTR model. Thus the null hypothesis of linear model (H_0) is tested against the alternative hypothesis (H_1) of PSTR model with at least one threshold or two regimes. This test is performed by using the Fisher LM test, Wald test, and the likelihood ratio test which are specified respectively as follows:

The Fischer LM test: $$LM_f = \frac{(SSR_0 - SSR_1)/K}{SSR_0/(NT - N - K)} \tag{5}$$

The Wald LM test: $$LM_w = \frac{NT(SSR_0 - SSR_1)}{SSR_0} \tag{6}$$

The likelihood ratio test $$LR = -2\left[\log(SSR_1) - \log(SSR_0)\right] \tag{7}$$

Where SSR_0 denotes the sum of squared residuals under H_0 (linear panel model with individual effects). SSR_1 stands for the sum of squared residuals under H_1 (PSTR model with one threshold or two regimes). It is worth noting that the Fischer LM test (LM_f) has an approximate $F(K, NT-N-K)$ distribution, while the Wald LM test (LM_w) and the likelihood ratio test (LR) follow a $\chi^2(K)$ distribution with K degrees of freedom. K , N , T represent respectively the number of explanatory variables, the number of countries and the number of years.

If linearity is rejected, then the relationship between FDI and income inequality is nonlinear, and hence, can be captured by a panel smooth transition regression (PSTR) model. In this case, the second step is the test of no remaining nonlinearity. It consists of testing whether a PSTR model with one threshold or two regimes is enough to capture the nonlinearity between FDI and income inequality. The null hypothesis (H_0) is a PSTR model with one threshold or two regimes while the alternative hypothesis (H_1) is a PSTR model with at least two thresholds or three regimes.

This test is also carried out using the Fischer LM test, the Wald LM test and the likelihood ratio test. If the null hypothesis (H_0) is accepted, the procedure ends, and we conclude that a PSTR model with one threshold or two regimes captures properly the relationship between FDI and income inequality. In contrast, if the null hypothesis (H_0) is rejected, the testing procedure continues until the first acceptance of the null hypothesis of no remaining nonlinearity. Once the number of thresholds and the number of regimes are selected, the final step is to apply the Nonlinear Least Squares (NLS) method to estimate the parameters.

Fouquau et al. (2008) conclude that "using the PSTR model limits the potential endogeneity bias, because, for each level of threshold variable, there is a particular value of the estimated regression parameter" (p.299). Despite this assurance, we still mitigate any potential endogeneity and reverse causation problems by using the first lag of FDI and hence the first lag of the threshold variable including other control variables(2). Thus the actually estimated PSTR model is:

$$INEQ_{it} = \beta_0 FDI_{it-1} + \beta_1 FDI_{it-1} g(q_{it-1}\,;\,\gamma, c) + \varphi_0 X_{it-1} + \varphi_1 X_{it-1} g(q_{it-1}\,;\,\gamma, c) + \mu_i + \varepsilon_{it} \quad (8)$$

3.2. Data

To investigate the effect of FDI on income inequality in African countries, we use an unbalanced panel data made up of 26 countries over the period 1990-2013. The year 1990 is chosen as the starting point of our study period because most of the African countries received significant amounts of FDI only from the 1990s following the waves of liberalization and privatization brought by the "Washington Consensus". The selection of the study period and the countries are also dictated by data availability, especially income inequality indicator. Due to data constraints and the fact that the yearly changes in income inequality are very small, the data is averaged over non-overlapping three-year periods as in Lin et al. (2014). Thus, as data permits, we use an unbalanced panel made up of 26 countries over 8 time periods (1990-1992, 1993-1995, 1996-1998, 1999-2001, 2002-2004, 2005-2007, 2008-2010, 2011-2013). The 26 countries selected accounted for 79.5% of the total FDI flows to Africa in 2013 and 83.5% in 2016. They accounted also for 80.2% of the total FDI stock in Africa in 2013 and 79.2% in 2016(3). This makes our sample more representative to assess the effect of FDI on income distribution in Africa. The list of the selected countries is shown in Table A1 in the Appendix.

Regarding the variables selected for the analysis, we follow the existing literature. The income inequality indicator used is the Gini index. We acknowledge that is not the best

measure of income inequality but it is the most preferred measure in the literature due to its availability. In addition, it is argued that the Gini coefficient is highly correlated with other existing income inequality indicators (see for example, Clarke, 1995). The data regarding the Gini index is sourced from the Standardized World Income Inequality Database (SWIID) developed by Solt (2016). The SWIID which is known as one of the most comprehensive and comparable datasets on income inequality, has been used by Bergh and Nilsson (2010), Lin, Kim and Wu (2014), Anyanwu et al. (2016), and Kaulihowa, and Adjasi (2017) among others.

FDI which is our main independent variable is measured as FDI stock in percentage of GDP as in Franco and Gerussi (2013), Herzer and Nunnenkamp (2013), Mihaylova (2015), and Kaulihowa and Adjasi (2017) because it captures well the long-run effects than the annual FDI inflows which are more volatile. The expected sign is uncertain as the literature has provided mixed results regarding the impact of FDI on income inequality. The data on FDI stock is collected from UNCTAD. The control variables are education (human capital), GDP per capita, trade openness, Government expenditure, inflation, and the initial income inequality. Due to data constraints, the secondary school enrollment ratio is used as a proxy for human capital stock, and it is expected to reduce income inequality. The logarithm of GDP per capita in purchasing power parity (2011 constant US dollar) is used to control for the effect of the level of economic development on income inequality (Kuznets effect). Based on the Kuznets hypothesis, we expect GDP per capita to increase income inequality in African countries as their GDP per capita is still lower than those of developed countries. Trade openness is measured as the sum of exports and imports in percentage of GDP. The effect of trade on inequality is a matter of controversy in the literature; the impact of trade on income inequality is therefore uncertain. Government expenditure as a percentage of GDP captures the effect of fiscal policy on income inequality. Especially the redistributive expenditure has a potential to reduce inequality as it favors more the poorer segments of the society. Government expenditure is therefore expected to reduce income inequality. Inflation measures the effect of macroeconomic instability on income distribution. High inflation affects disproportionately the purchasing power of the poor and therefore tends to increase inequality. A positive relationship between inflation and the Gini index is expected. Inflation is measured as the growth rate of the GDP deflator. Financial development measured as credit to private sector (% of GDP) is also included in the regression. Financial development can exacerbate income inequality if it results in skilled-biased employment (Demirgüç-Kunt and Levine, 2009). Also, financial deepening does not necessary mean financial inclusion; the effect of financial development on inequality is therefore uncertain. Finally, the initial inequality is included in the regression to capture the persistence of inequality across time. Gini index lagged one period is used as a measure of initial inequality. The initial inequality is expected to increase the current level of inequality in African countries. With the exception of FDI and the Gini coefficient, all the data is sourced from the World Bank.

Table 1 presents some descriptive statistics concerning the data used in this study. In the sample, the Gini index has a mean of 43.04%, while the secondary school enrollment ratio used as a proxy for human capital stock has a mean of 35.8%. The relatively low average of the human capital variable in the sample countries indicates the low level of human capital

stock in African countries. The mean of FDI stock as percentage of GDP is 21.7%, while the trade openness (import plus export as percentage of GDP) has a mean of 61.90%. This suggests that countries include in the sample are relatively opened to foreign trade. The correlation matrix is shown in Table A2 in the Appendix. The small size of the correlation coefficients between the explanatory variables indicates no risk of multicollinearity.

Table 1. *Descriptive statistics*

Variables	Observations	Mean	Standard deviation
Gini index	168	43.04	7.90
FDI stock (% GDP)	168	21.74	19.46
Human capital	168	35.82	23.96
GDP per capita*	168	7.78	0.88
Trade openness	168	61.90	22.27
Inflation rate	168	16.52	40.06
Government spending (% GDP)	168	14.82	5.28
Credit to private sector (% GDP)	168	22.27	27.83

Note: * indicates that the variable is measured as Log (variable).

4. Empirical results and discussions

4.1. Linear panel regression

This section presents and discusses the empirical results regarding the relationship between FDI and income inequality. Firstly, we estimate the linear relationship between FDI and income inequality using System-GMM to control for endogeneity and reverse causation, and the results are summarized in Table 2. the P-values associated with the Hansen test statistic of over-identifying restrictions and the Arellano–Bond test statistic for second-order autocorrelation are all higher than 5%. In other words, the instruments used are valid, and there is no second-order autocorrelation. This reveals the validity of the GMM estimates.

Table 2. *FDI and income inequality: System-GMM estimates*
(The dependent variable is the Gini index)

Variables	Coefficient	t-Statistic
FDI	0.072	4.29***
Initial inequality	0.703	3.48***
GDP per capita	0.122	0.55
Human capital	-0.033	-2.67**
Trade Openness	- 0.159	-4.76***
Gov.Spending	0.238	1.33
Inflation	0.046	2.61**
Credit to private sector	0.044	0.96
Constant	16.651	2.47**
Observation	142	
AR(2) test (p-value)	0.544	
Hansen test (p-value)	0.858	

Note: the t-statistics are based on robust standard errors. ***; **; * indicate respectively the significance levels at 1%, 5% and 10%.

The coefficient of FDI is positive and highly significant. This implies that FDI increases income inequality in African countries included in the sample. This finding tends to support the dependency theory which claims that FDI generates income inequality in developing countries. There are several plausible explanations for this inequality-increasing effect of FDI in the context of Africa. The large share of FDI flows to Africa go into the extractive

industries and to a lesser extent the services sector. Since these two sectors tend to be skilled labor intensive, increasing FDI inflows raise the demand for skilled labor. The increasing demand for skilled labor increases the wage gap between the skilled and unskilled workers, and subsequently increases the overall level of income inequality. This finding is consistent with the results obtained by Anyanwu et al. (2016) in the context of West African countries.

As expected, human capital or education reduces income inequality. The coefficient is negative and statistically significant. The coefficient of trade openness is also negative and statistically significant. In other words, openness to international trade has the potential to improve income distribution in African countries. This finding is in line with Wu and Hsu (2012). In line with our expectation, initial inequality, GDP per capita, and inflation appear with a positive coefficient. In other words, they increase income inequality; however, the coefficient of GDP per capita is not statistically significant. The positive coefficient of initial inequality indicates that inequality is persistent across time in African countries. The same conclusion was reached by Anyanwu et al. (2016) for the case of West African countries. In contrast to our expectation, the coefficient of government expenditure is positive, however, it is not statistically significant. This finding is in conformity with Odedokun and Round (2004), and Anyanwu (2011) who find no significant effect of government expenditure on income inequality for African countries. The positive sign and the non-significance of the coefficient associated with the government expenditures variable may be explained by the fact that the variable does not capture only the government redistributive expenditures which has a potential to influence significantly income inequality, but also other expenses such as expenditures on defense or security. However, due to data constraints we could not do otherwise than using this broad measure of government expenditures. Also, financial development measured as credit to private sector (% GDP) appears with positive coefficient. However, it is not statistically significant.

According to the recent literature, the effect of FDI on income inequality may be conditioned or shaped by some domestic factors, known also as absorptive capacity. If this is true, limiting the investigation method to a linear panel model may lead to a misleading conclusion regarding the effect of FDI on income inequality in African countries. We therefore explore the nonlinear relationship between FDI and income inequality by estimating a panel smooth transition model.

4.2. Panel smooth transition regression approach

Table 3 shows the results of the linearity tests which consists of verifying if the relationship between FDI and income inequality in African countries can be captured by a linear panel model or by a PSTR model (nonlinear panel model). As we mentioned earlier, human capital stock, measured as the gross secondary school enrollment ratio, is used as the transition or threshold variable in the PSTR model(4). The null hypothesis (H_0) that a linear panel model is suitable to investigate the link between FDI and income inequality in African countries is highly rejected at 1% level of significance by the LM test, LM_F test, and the LRT test. In other words, human capital exerts a nonlinear effect on the relationship between FDI and income inequality, and this can be properly captured by a PSTR model with at least one threshold or two regimes.

Table 3. *Linearity tests*

Threshold variable	Wald (LM)	Test	Fisher(LM_F)	Test	LRT	Test
	Statistic	P-value	Statistic	P-value	Statistic	P-value
Human capital	35.310	0.000	3.934	0.000	40.465	0.000

H_0: Linear panel model H_1: PSTR model with at least one threshold

In the second step, we identify the number of thresholds by performing the tests of no remaining non-linearity. The null hypothesis (H_0) of the test is that a PSTR model with one threshold or two regimes is suitable to capture the link between FDI and income inequality while the alternative hypothesis (H_1) is that a PSTR model with at least two thresholds or three regimes is suitable. The results presented in Table 4, show that the null hypothesis (H_0) cannot be rejected by all the tests performed. This implies that a panel smooth transition regression model with one threshold or two regimes is suitable to capture properly the nonlinear relationship between FDI and income inequality in the countries included in our sample. We estimate therefore a PSTR model with one threshold or two regimes by applying the Nonlinear Least Squares (NLS) as suggested by Gonzalez et al. (2005).

Table 4. *Tests of no remaining non-linearity: Tests for the number of regimes*

Threshold variable	Wald(LM)	Test	Fisher(LM_F)	Test	LRT	Test
	Statistic	P-value	Statistic	P-value	Statistic	P-value
Human capital	11.553	0.240	0.885	0.542	12.039	0.211

H_0: PSTR model with one threshold (two regimes) H_1: PSTR model with at least two thresholds (at least three regimes).

Table 5 shows the results obtained from the estimation of the PSTR model with one threshold or two regimes using human capital stock as a threshold variable.

Table 5. *PSTR model estimates*
(The dependent variable is the Gini index)

	$ß_0$		$ß_1$
FDI	0.0791***		-0.0936**
	(3.93)		(-2.42)
Initial inequality	0.715***		- 0.049
	(3.17)		(-0.49)
GDP per capita	0.0754		- 0.1114
	(0.22)		(-0.32)
Trade openness	-0.0020**		- 0.0994*
	(-2.66)		(-1.68)
Government	0.2158		0.0659
Spending	(1.52)		(0.41)
Inflation	0.0064**		0.0345***
	(2.67)		(3.45)
Credit to private sector	0.0714		-0.1193**
	(1.16)		(-2.29)
Human capital	-0.2101***		-0.2374 ***
(Education)	(-3.53)		(-3.59)
Threshold (c)		60.04	
Slope (γ)		35.03	
No. of country		26	

Note: t-statistics, based on standard errors corrected for heteroskedasticity are in parentheses. ***; **; * indicate respectively the significance levels at 1%, 5% and 10%. γ is the speed of adjustment from the low-human capital regime to the high human capital regime; C is the threshold value.

It is worth noting that, in the PSTR model, the signs of the estimated parameters are the most important since their values are not directly interpretable (Fouquau et al., 2008). The

results show that the coefficient of FDI is positive and statistically significant in the regime of low human capital stock ($ß_0$). However, this coefficient becomes negative and statistically significant in the regime of high human capital stock ($ß_1$). The threshold of human capital stock found is 60.04%. These results imply that, in countries where the human capital stock is below the threshold, FDI deepens income inequality whereas in countries where the human capital stock is above the threshold, FDI tends to reduce income inequality. In other words, the effect of FDI on income inequality is conditioned by the level of human capital stock in the sample countries.

The slope parameter (γ) which indicates the speed of adjustment from the low regime to upper regime is 35.03. The relatively small size of the slope parameter suggests that the transition from one regime to another is smooth and gradual. Our finding is qualitatively in conformity with Mihaylova (2015) who finds that FDI increases income inequality in Central and Eastern European countries where the human capital stock measured by the secondary school enrollment ratio is below 81%. Above this threshold, FDI tends to reduce income inequality.

These findings indicate that, using only a homogeneous linear panel model to investigate the effect of FDI on inequality may lead to a misleading conclusion, as this effect of FDI may vary from one country to another and changes over time depending on the level of human capital stock. This finding can be explained by the fact that FDI activities are associated with technology transfer, and since the adoption of superior technologies required skilled labor, increasing FDI inflows lead to higher demand for skilled labor which is initially limited. As a result, the wages of skilled workers increase, and consequently increase the wage gap between skilled and unskilled workers. However, as a large share of the population is getting access to education, the supply of skilled labor also increases. This gradual improvement in human capital stock and the adoption of new technologies by domestic firms narrow the wage gap between skilled and unskilled workers, and ultimately reduce the overall level of income inequality (see Figini and Gorg, 2011; Franco and Greussi, 2013).

The key message from these results is that the impact of FDI on income inequality is not homogenous across African countries. While FDI reduces income inequality in some African countries, it increases income inequality in other countries. Looking into our sample, countries that have their level of human capital stock above the threshold found in this study in 2013 are: Algeria, Botswana, Egypt, Ghana, Kenya, Morocco, Namibia, South Africa, and Tunisia. In other words, FDI contributes to reducing income inequality in these nine (9) countries while it contributes to deepening income inequality in the other countries included in the sample.

5. Conclusion

This paper investigates the effect of foreign direct investment on income inequality in 26 African countries over the period 1990-2013. Firstly, we estimate a linear panel model using System-GMM approach and the results show that FDI increases income inequality. Secondly, we go further in the analysis to examine whether the effect of FDI on income inequality in African countries depends on absorptive capacity. To this end, we use human capital as a proxy for absorptive capacity, and estimate a Panel Smooth Transition

Regression (PSTR) model which is suitable to deal with cross-country heterogeneity and the time variability issues. We find that the relationship between FDI and income inequality is nonlinear. It changes over time and across countries depending on the level of human capital stock. In particular, FDI increases income inequality in countries with low levels of human capital stock and reduces it in countries with high levels of human capital stock. In other words, FDI reduces income inequality in some African countries while it deepens inequality in others. These results show that the conclusion from previous studies assuming homogeneity and constant effect of FDI on income inequality across countries should be taken with caution. The major contribution of this study is the adoption of an improved methodology, namely the panel smooth transition regression approach to capture the dynamic relationship between FDI, human capital, and income inequality.

From a policy perspective, the findings suggest that African countries should improve their domestic conditions also known as absorptive capacity in order to benefit from the positive effects of FDI. In particular, increasing investment in education will allow a large portion of the population to acquire quality education thereby improving the level of human capital stock. This will not only mitigate the potential negative effect of FDI on income distribution, but also attract more FDI (Dutta and Osei-Yeboah, 2010), and enhance the growth gain from FDI (Borensztein et al., 1998).

Finally, as this study focuses mainly on the role of human capital in the link between FDI and inequality, future studies should consider other aspects of absorptive capacity such as local financial development, infrastructure development, and institutional development for a better understanding of the effect of FDI on income inequality in African countries.

Notes

(1) Africa is the World's second most inequitable region after Latin America (African Development Bank[AfDB], 2012). Also according to the World Bank (2014), Africa has now become a fast-growing destination of FDI.

(2) For similar approach, see Lin et al., 2014, and Jude and Levieuge, 2016.

(3) Author's calculations using UNCTAD online database.

(4) The transition variable, namely human capital has a direct effect on income inequality as shown in the GMM estimates. Thus it is included in the PSTR model as transition variable and also as explanatory variable in order to avoid erroneous switching (see, for example, Fouquau et al., 2008, p. 291).

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APPENDIX

Table A1. *List of countries in the sample*

Algeria	Gambia	Mozambique	Tunisia
Angola	Ghana	Namibia	Uganda
Botswana	Guinea	Niger	
Burkina Faso	Kenya	Nigeria	
Cameroon	Madagascar	Senegal	
Cote d'Ivoire	Malawi	Sierra Leone	
Egypt	Mali	South Africa	
Ethiopia	Morocco	Tanzania	

Table A2. *Correlation matrix*

	Gini	Initial Gini	FDI	Human capital	Trade openness	Government spending	Inflation	GDP per capita	Private credit
Gini	1.00								
Initial Gini	0.94	1.00							
FDI	0.33	0.30	1.00						
Human capital	-0.35	-0.35	0.29	1.00					
Trade openness	-0.31	-0.28	0.64	0.25	1.00				
Gov.spending	0.43	0.41	0.32	0.20	0.48	1.00			
Inflation	0.08	0.10	0.14	-0.09	0.34	0.33	1.00		
GDP per capita	0.34	0.33	0.35	0.66	0.42	0.33	0.02	1.00	
Private credit	0.41	0.42	0.25	0.60	0.06	0.25	-0.07	0.6	1.00