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Role of Initial Inequalities in Pro-Poor Growth. A Panel Smooth Transition Approach in Sub-Saharan Africa context

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Abstract

The prominent role of inequality in determining the effectiveness of growth on poverty reduction is no longer debated. This study aims to contribute to the understanding of this relationship looking at the case of 23 countries in sub-Saharan Africa over the period 1991-2017. Using data from POVCALNET of the World Bank, the study analyses the non-linearity and heterogeneity of the poverty-growth-inequality relationship using a Panel Smooth Transition Regression (PSTR) model. It finds that growth is pro-poor provided that initial inequality is low and that GDP is adjusted for the influences of inequality regardless of the level of development and initial poverty level of countries. The implication of this result is that measures to accompany growth and poverty reduction policies should be reinforced by specific measures aimed at having a more evident control over inequalities. Further studies to gain a better understanding of the structure and determinants of inequality in different contexts are needed.

Keywords: pro-poor growth, inequality adjusted GDP, inequality, Panel Smooth Transition Regression

I-Introduction

The fight against poverty appeared explicitly at the beginning of the 1990s (World Bank report 1990) in the agenda of the development community following the failure of the Structural Adjustment Program (SAP) of the 1980s. At the end of the 1990s, it became clear that the fight had to be strengthened at the global level by the adoption of common frameworks through a participatory process and a strengthened partnership between the developed and least developed countries. The adoption of the Millennium Development Goals (MDGs 2000-2015) at the global level and the drafting of Poverty Reduction Strategy Papers (PRSPs) from 1996 onwards by 39 developing countries in the framework of the (Heavily indebted Poor Countries HIPC) initiative is the strongest illustration of this.

Therefore, remarkable progress in poverty reduction, surpassing the MDGs' primary goal of halving the overall incidence of poverty in fifteen years (2000 to 2015)[2], have been observed at the global level. The number of poor people, which was 1.9 billion in 1990 (36% of the world's population) has fallen from 1.9 billion (36% of the world's population) to 736 million (or 10% of the world's population) in 2015, a significant drop of 25 percentage points.

Stylised facts, policy and research findings confirm the central role of a good understanding of the inequality-growth-poverty triangle (World Bank Report 2018). According to Bourguignon (2003), good management of the inequality-growth-poverty nexus is more a matter of good management of the inequality-growth nexus. In other words, the necessary condition for an effective fight against poverty is the implementation of growth policies biased in favour of the poor. This is where the notions of pro-poor growth[3] but also inclusive growth (OECD 2001) or even recently shared prosperity come into play. The World Bank reports (2016; 2018) on "poverty and shared prosperity" underscore the role of strong and sustained growth rates in the success of East and South Asia and the Pacific countries. Low and sharply declining initial inequalities, largely contributes to progress in the fight against poverty at the global level[4], as well.

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[2] According to the international poverty line of US$1.9 per day (at 2011 purchasing power parity)

[3]Ravallion and chen (2003)

[4] Between 1990 and 2015, extreme poverty fell from 62% to 3% and the number of poor people in East Asia and the Pacific declined by 57% on average, the income of the poorest 40% in these two regions increased by 4.7% and 2.6% per year, respectively.

In contrast, Sub-Saharan Africa countries have not experienced strong and sustained growth[5], but rather a high concentration of poverty and rising inequality[6]. The agenda of the international community, according to the MDGs is, to reduce world poverty from 10% in 2015 to 3% in 2030. To achieve this, it is clear that more and specific actions has to be taken for Sub-Saharan Africa.

Given the heterogeneity of countries and also the non-linearity of the poverty-growth-inequality relationship, the question which arises here is, how to combine growth and redistribution in order to improve the effectiveness of pro-poor policies in Sub-Saharan Africa context. This is all the more justifiable, as there is no absolute consensus on the definition of pro-poor growth. A second issue is to find out, under which conditions growth can be said to be pro-poor when inequalities matters, i.e. in what proportion the income of the poor must increase so that growth is found to be pro-poor.

The literature has been enriched with different conceptual approaches and measurement methods in this area. This research employs the absolute definition of pro-poor growth (PPG), which defines PPG as the situation whereby either the poverty index declines or the income of the poor (the poorest 40 per cent) increases as a result of economic growth. We chose the income of the poorest 40% as an indicator of poverty because for all 18 countries in our sample, the poverty rate averaged around 50% in 2015. Between the two dominant approaches in this field (index calculation and econometrics) we choose the econometric approach in order to avoid calculating a poverty line for each country.

Assuming a non-linear relationship between growth and poverty according to levels of development and levels of inequality, we use the PSTR model to analyse the impact of growth on poverty with a particular emphasis on the role of inequality. Actually, the PSTR model make it possible to determine the impact thresholds of inequality on pro-poor growth.

The main findings are as follows: growth is generally pro-poor in the sense that it is accompanied by an increase in the income of the poorest. Pro-poorness of growth varies according to countries and level of initial inequalities. Growth is mostly pro-poor not when initial inequalities are low and also when GDP is corrected for initial inequalities. Countries at a higher level of development, despite a lower prevalence of poverty, have the highest level of inequality and also the greatest impediment to transform GDP growth into higher incomes for the poor.

The rest of the paper is presented as follows: section 2 is devoted to a review of the literature on pro-poor growth and also on the role of inequality in the inequality growth-poverty triangle. Section 3 describes the methodology, the PSTR model and the data used. Section 4 presents the empirical results and discussion. Section 5 draws the general conclusion.

2-Poverty Growth and Income Distribution

2.1- pro-poor growth: definitions and measures

The emergence of the concepts[7] of pro-poor growth (broad-based growth, inclusive growth, shared growth, even pro-poor growth) since the beginning of the 1990s stems from the questioning, from the 1970s[8] onwards, of the trickle-down[9] theory which postulated a spontaneous redistribution in the more or less long term of the benefits of growth by the rich in favour of the poor. In spite of the almost unanimity on the bias in favour of the poor, the question remains as to what proportion of the poor's poverty or income would have to vary for growth to be qualified as pro-poor. Definitional approaches to this issue can be grouped around two axes. First there is the relative approaches (cantered on the criterion of reducing inequality) which stipulate that growth is pro-poor only when the income of the poor increases by a higher proportion than that of others ((Kakwani and Pernia (2000), White and Anderson (2000); Klasen (2003); Son (2003)).

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[5] With the exception of some countries such as Nigeria and Rwanda which have experienced rapid growth due to a surge in prices in the extractive industry (oil and mining), the number of people living in poverty in the region has increased from 278 million in 1990 to an estimated 413 million in 2015. While the average poverty rate in other regions was below 13 per cent in 2015, it was about 41 per cent in sub-Saharan Africa. Of the 28 poorest countries in the world, 27 are in sub-Saharan Africa, all with poverty rates above 30 per cent.

[6] According to the report Poverty Shared Prosperity (World Bank 2018), the number of people living in poverty in the region increased from 278 million in 1990 to an estimated 413 million in 2015.

[7] See World Bank Report (1990), OECD (2001,), United Nations via the MDGs (2000).

[8]See Chennery and Ahluwhlia (1974)

[9]Kuznet's theory of the inverted U (1955)

Second there are absolute approaches ((Ravallion and Chen (2003)) and also de Kraay (2004)) which stipulate that regardless of the presence of inequality, growth is pro-poor when it is accompanied by a decline in a given poverty measure (watt index or the FGT, for example, which is calculated from the prior fixing of a poverty line based on a given value judgement). The comparative study by Dorothée Boccanfuso (2009) following Kakwani and Son (2002) highlights the main criteria in determining the usual measures of pro-poor growth. These measures share the common characteristics of being index of measurement , be they aggregated or not, partial or not. These measures may or may not require the specification of a poverty line. They may or may not incorporate the criterion of monotonicity. A major consequence of this diversity is the lack of convergence in either the advantages and the drawbacks of theses measures. As a result there is no consensus on the evaluation of pro-poor processes. Another limitation of these measures is their exclusive focus on the monetary aspect at the expense of the multidimensional aspects of poverty. Whatever the limitations of these measures, any evaluation of the pro-poorness process, must absolutely consider what Bourguignon (2004) has called the inequality-growth-poverty triangle. The econometric approach compensates for these drawbacks and also has the particular advantage of being able to avoid poverty line calculation using value judgements (Ndene Ka. 2016).

2.2-The inequality-growth-poverty triangle and the econometric approach

The relationship between poverty and growth has been tested through several studies by estimating the growth elasticity of poverty. In other words, it is a question of seeing in what proportion a measure of poverty decreases following a proportional increase in economic growth. A group of authors of which Dollar, Kleinberg & Kraay (2002, 2016), Kraay (2004) are the most prominent argue that growth is the main driver of poverty reduction.

Kraay's (2004) study identified three potential sources of pro-poor growth. These are: (i) a high growth rate; (ii) a high sensitivity of poverty to growth, (iii) the capacity of a growth component (e.g. redistribution) to reduce poverty. According to the same study, 70% of the variation in poverty (i.e. 97% of the poverty rate, i.e. the P0 index) is attributable to income growth. The sensitivity of poverty to growth accounts for most of the remaining 30% while changes in relative incomes explain a small proportion of the poverty reduction. However, if one looks at a measure that gives a higher weight to the poorest of the poor (index P2 or P3, for example), income growth explains less and less of the poverty reduction.

The stylized facts of the last three decades (the case of Brazil, for example, and most countries in sub-Saharan Africa) argue for the inclusion of the role of inequality in the effect of growth on poverty reduction. For example, the study by Hull (2009) and Kwasi (2010) shows that in many cases GDP growth, whether high or low, does not translate into poverty reduction. This depends on the pattern of growth across sectors (in terms of employment and productivity intensity).

Thus, since the work of Datt and Ravallion (1992) and Kakwani (1993), special attention has increasingly been paid to the role of inequality. On the basis of country case studies and using the methodology of decomposing the poverty-average income-distribution identity, these two authors find that the distribution factor contributes substantially to poverty reduction in the same way as the growth factor. Most subsequent studies[10] ((e.g. Ravallion (1997, 2004) and Bourguignon (2004); World Bank, 2006b)) have highlighted the central role of income distribution in converting growth into poverty reduction. Indeed, there is a kind of inequality-growth-poverty triangle that must be understood and taken into account in any realistic policy to combat poverty (Burgundy 2004).

The question is to know what is the weight of each couple (growth-poverty or inequality-growth or inequality-poverty or even poverty-poverty) and what is the relative weight of each of the components taken individually.

The study by Ali de Thorbecke (2000), based on a cross-sectional analysis of country and regional data, estimates that poverty is more sensitive to inequality than to income growth. For some authors ((e.g. Ravallion (1997, 2004), Bourguignon (2003) Adams (2004), Fosu (2009)), it is rather the initial inequalities that count in the growth-poverty relationship. Indeed, this work is in line with Ravallion (1997) who, in a linear model, introduced the concept of poverty growth elasticity adjusted for the corrective factor of initial inequalities (an initial minus Gini). According to him, the Inequality-adjusted poverty growth elasticity is higher in countries where initial inequality is lower and vice versa.

[10] These include those of Ravallion, (1997, 2004); of Bourguignon (2003, 2004; 2019;); of Epaulard (2003); of Adams (2004); of Fosu, (2008, 2009, 2010 a, 2010 b 2010c); of Kalwij and Verschoor (2007)

Then Ravallion (2004), after taking into account the non-linearity of the elasticity of poverty growth and initial inequality, estimates that for countries with low initial inequality the elasticity is around 4.3%, while in countries with high inequality the elasticity is 0.6%. Bourguignon (2003) goes in the same direction under the assumption that the income distribution is of the normal log type.

According to Lopez and Serven (2004), in poor countries with low initial inequalities, poverty reduction is mainly achieved through the implementation of pro-growth policies. Conversely, in rich countries with high income inequality, an effective and balanced combination of pro-growth and pro-distribution policies is needed. In the same vein, Ferreira Leite and Ravallion (2010) argue that the low poverty reduction in Brazil (1990-2010) is not due to low economic growth rates but to the high presence of inequality. Moreover, the low growth elasticities of the economy are not due to the low growth rates of the economy, but to the high presence of inequality.

Following the study by Khan et al.(2014) conducted among 138 countries over the period 2005-2010, the empirical evidence of a poverty-growth-inequality triangle can be summarized as follows: (i) The impact of economic growth and income inequality on poverty reflects the fact that income inequality increases poverty while economic growth reduces it; (ii) The impact of inequality on the increase in poverty is somewhat larger than the effect of average income growth on overall poverty reduction in a sample of countries; (iii) Poverty itself is also likely to be an obstacle to poverty reduction; (iv) Inequality seems to predict lower future growth rates.

From this summary it appears that there is no consensus on the role of initial inequality in building a pro-poor growth process. Ravallion (2012) argues that it is rather the initial level of poverty that matters. He argues that there should be poverty convergence, i.e. countries starting with high levels of poverty should end up with higher levels of proportional poverty reduction. This is not the case because of the vicious circle of poverty. For him, high initial poverty means low consumption resulting in low pro-poor growth. The same idea is found in Breunig and Majeed (2016) who show that the negative impact of inequality on growth is concentrated in countries with the highest poverty rates. It thus appears that for poor countries to reduce inequality through given policies would mean increasing poverty, because such policies could make the majority of people living on the margins of the poverty line more likely to fall below it (Fosu, 2010c). According to Fosu (2015), the heterogeneity of results depending on the context makes it necessary to explore the inequality-growth-poverty triangle in greater depth through country-specific case studies rather than general studies. Moreover, to solve the problem of fixed effects, more and more studies in panel mode would be needed, as in the studies by Kalwij & Verschoor (2007) and Fosu (2009, 2010c, 2011). The present study is in the same vein by insisting on the context of sub-Saharan Africa, following Fosu (2015), but uses PSTR modelling in order to take into account the heterogeneity of countries and especially the non-linearity of the inequality-poverty growth relationship.

3 - SMOOTH TRANSITION PANEL MODELLING

This section is divided into two parts. The first presents the PSTR model and the second presents the approach to estimating the model's parameters.

3.1 PSTR model

The model used in this study is the PSTR of González et al. (2005) which is an extension of the PTR (Panel Threshold Regression) models proposed by Hansen (1999). As an extension of the PSTR methodology, Fok et al. (2005a) and Fok et al. (2005b) developed the PSTAR model (Panel Smooth Transition Autoregressive model) which is a threshold model in panel data with a dynamic structure that takes into account the lagged endogenous variable. However, in this model, the coefficients, threshold parameter and smoothing parameter are individual. This makes it impossible to determine an optimal homogeneous threshold for an economic and monetary union with common criteria. In addition to identifying a homogeneous threshold, the PSTR allows for individual heterogeneity and the temporal instability of the slope coefficients to be taken into account. Moreover, it avoids using a dummy variable to characterize membership in one regime or the other, so that our linearity test escapes Hansen's (1996) criticism that the test of equality between the coefficients associated with the two regimes involves a nuisance problem.

Recent theoretical developments by Fouquau et al (2008), Béreau et al (2012), Jude and Levieuge (2013), Yu (2013), Yu and Phillips (2014), Yohou et al (2016) reveal that threshold effects models of the PTR and PSTR type mitigate the endogeneity problem due to the temporal variability of the coefficients. However, we conduct robustness tests for comparison purposes by estimating a GMM model. The model to be estimated is thus as follows:

$$logRev_{it} = \mu_i + \beta_0 logGDPH_{it-1} + \beta_1 logGDPH_{it-1} G(1 - Gini_{it-1}; \gamma, c) + \beta_2 X_{it-1} + \varepsilon_{it} \quad (1)$$

where $logRev$ is the logarithm of the income of the poor, we will use the second quintile (income of the poorest 40%), μ_i is the vector of individual fixed effects. Log GDPH is the logarithm of GDP per capita. $X_{it-1} = (X_{it-1}^1, \dots \dots \dots, X_{it-1}^k)$ is the matrix of five control variables namely: the Gini coefficient, agricultural gross domestic product, inflation and health expenditure as a percentage of GDP and the logarithm of the primary school enrolment rate.ε_{it} being the error term and is assumed i.i.d.

$G(1 - Gini_{it-1}; \gamma, c)$ being the continuous and integrable transition function on 0 and 1. Theoretically, a smooth transition mechanism between regimes can be modelled from various transition functions as long as they are continuous and integrable on [0,1]. Both Gonzalez et al (2005) and Terasvirta (1994) use a logistic transition function, whose form is as follows:

$$G(1 - Gini_{it-1}; \gamma, c) = \left[1 + exp\left(-\gamma(1 - Gini_{it-1} - c)\right)\right]^{-1} \quad (2)$$

where c is the critical threshold of the coefficient ($1 - Gini_{it-1}$); γ, represents the assumed positive smoothing parameter and ($1 - Gini_{it-1}$), γ the transition variable in our study.

The sensitivity coefficient (marginal impact) of the income of the poor as a function of the impact of ($1 - Gini_{it-1}$) on **GDP**, for the ith country at date t is then defined by:

$$e_{it} = \frac{\partial Rev_{it}}{\partial PIB_{it-1}} = \beta_0 + \beta_1 G(1 - Gini_{it-1}; \gamma, c) \quad (3)$$

If the transition function $G(1 - Gini_{it-1}; \gamma, c)$ tends towards 0, the coefficients are summed to $\beta_0 (e_{it} = \beta_0)$ and conversely the coefficients are equal to the sum of the parameters $\beta_0$and $\beta_{1(e_{it}=\beta_0+\beta_1)}$when the transition function is equal to 1.

Between two extreme regimes, the non-linear effect of GDP per capita on the income of the poor is defined as a weighted average of the parameters β_0, $\beta_{1(e_{it}=\beta_0+\beta_1 G(1-Gini_{it-1};\gamma,c))}$. The transition speed between the two speeds always depends on the value of the smoothing parameter. When γ tends towards infinity, the PSTR model corresponds to a three-speed PTR model where the outer speeds are the same and different from the central speed. On the other hand, when γ tends towards zero, the PSTR model simplifies into a homogeneous fixed-effect model.

3.2 Estimation of PSTR model parameters

The estimation of slope coefficients, threshold parameters and model smoothing are done in two steps. The first step is to look for the possible presence of non-linear effects. The linearity test is an essential step in the analysis. Gonzalez et al. (2005) propose a test that consists in comparing two sets of hypotheses:

$H_0: \beta_1 = 0$ versus $H_1: \beta_1 \neq 0$ or $H_0: \gamma = 0$ versus $H_0: \gamma \neq 0$

Indeed, when γ=0 then the function g (.) has a value whatever the value taken by the threshold variable. The threshold effect thus disappears and the model is nothing but a linear panel. The same is true for $H_0: \beta_1 = 0$. The conduct of this test by standard approaches presents a problem known as the "Davies problems" in the economic literature. Indeed, the calculation of the standard Fisher test statistic involves the sum of the squares of the residuals of the non-linear model. However, to estimate this model, one needs to know the parameters. This is not the case at the time of the test. These are referred to as "unidentified nuisance parameters". To get around this problem, researchers generally estimate the unknown parameters. However, with this approach the distribution of the static of the test becomes unknown. Hansen (1996) proposes a solution to these problems, using a likelihood ratio test and a bootstrap procedure to approximate the asymptotic distribution of the law of this statistic. He then obtains the p-value of the test using a distribution function (Hansen 1999) or the bootstrap procedure. To avoid all these approaches in the presence of unidentified nuisance parameters under H_0, Gonzalez et al. (2005) propose replacing the transition function $G(1 - Gini_{it-1}; \gamma, c)$ by its first-order Taylor development around the point γ=0. The equations to be estimated then become:

$$logRev_{it} = \mu_i + b_1 logGDPH_{it-1} + b_2((1 - Gini_{it-1}) * logGDPH_{it-1}) + b_3 X_{it-1} + \varepsilon_{it}^* \quad (4)$$

Where $\boldsymbol{b_1} = \left[\boldsymbol{\beta_0} + \frac{1}{2}\boldsymbol{\beta_1} - \frac{\gamma c}{4}\boldsymbol{\beta_1}\right]$, $\boldsymbol{b_2} = \frac{\gamma}{4}\boldsymbol{\beta_1}$ et $\boldsymbol{\varepsilon_{it}^*} = \boldsymbol{\varepsilon_{it}} + \boldsymbol{\beta_1 R_1 logGDPH_{it-1}}$

with $\boldsymbol{R_1}$ being the rest of Riemann. Since $\boldsymbol{b_2}$ is proportional to the slope of the transition function, the nonlinearity test can be reduced to a: $\boldsymbol{H_0}: \boldsymbol{b_2} = \boldsymbol{0}$ versus $\boldsymbol{H_1}: \boldsymbol{b_2} \neq \boldsymbol{0}$.

Gonzalez et al (2005) propose a statistical test based on the Lagrange Multiplier (LM) and its Fisher version (LMF). An extension of these tests is carried out on the principle of the pseudo-LRT (pseudo-LRT) by Colletaz and Hurlin (2006). The three statistical tests are the following:

$$LM = TN(SSR_0 - SSR_1)/K \leadsto X^2(K)$$

$$LM = \frac{(SSR_0 - SSR_1)/K}{SSR_0/(TN - N - K)} \leadsto F(K, TN - N - K)$$

$$Pseudo - LRT = -2[log(SSR_0) - log(SSR_1)] \leadsto X^2(K)$$

Where SSR_0 denotes the sum of the squares of the residuals of the constrained model (under the null hypothesis, i.e. the linear panel model with individual fixed effects) and SSR_1 denotes the sum of the squares of the residuals of the unconstrained PSTR model, N the individual dimension, T the time dimension. The presence of non-linearity can also be searched for by describable methods or non-parametric estimation methods. When the presence of threshold effects is proven, i.e., b_2 statistically different from zero, the second step is to estimate the coefficients $\beta_0, \beta_1, \gamma, c$. To do so, first estimate γ and c. The solution proposed by Colletaz and Hurlin (2006) is then to create a search grid on these parameters by selecting several possible values for the smoothing parameter and for the threshold taken among the values of the transition variable. Since the sum of the squares of the residuals can be easily calculated, it is then sufficient to select the pair that minimizes it and use it as a starting value. Gonzalez et al (2005) propose the use of the simulated annealing algorithm as an alternative way to obtain the initial conditions. Using the estimators of γ and c, by means of model (4), it is possible to re-estimate the slope coefficients of model (1) using the non-linear least squares method (NLLSM).

4 - Data and Results

4.1. Data

The aim here is to test the role of inequality in the relationship between GDP per capita growth and poverty in sub-Saharan Africa over the period from 1991 to 2017. Poverty is here approximated by the income of the poorest 40% (Rev Q40) taken from the World Bank's POVCALNET databases. Rather than using the income of the poorest 20% we have chosen the Income of the 40% because the average poverty rate of our 23 countries is 50%. The Gini index is also taken from POVCALNET. Gross domestic product per capita is taken from Pen World data 9.1. The agricultural GDP per capita variable comes from the United States Department of Agriculture (USDA) database. Health expenditure as a percentage of GDP, inflation approximated by the consumer price index in annual variation and the primary school enrolment rate are taken from the World Bank's World Development Indicators database. The criterion for sample selection is the availability of data on income quintiles for at least four different years starting in 1991. All variables except for the income of the poor were lagged by one period. The number of countries in the sample is only 23 out of the 48 countries in sub-Saharan Africa over the period 1991 to 2017. Since the number of observations is not the same for all countries, we are faced with non-cylinder panels. The variables of the model are as follows:

Poverty proxied by the income of the poor. This is the explained variable. It is more precisely the log of the income of the poorest 40%. There is a positive link between the growth of the average income of the economy and the growth of the income of the poor (Dollard and Kraay 2002).

The average income of the economy proxied by the log of GDP. Most studies have shown that GDP growth has an impact on the growth of the average income of the economy and consequently on the growth of the income of the poor and thus reduce poverty.

Inequality: proxied by The Gini index: here reflects the average inequality in the economy. Inequality is assumed to have a direct negative impact on the income of the poor (Ravallion 2012). The effects of inequality on growth, on the other hand, are still subject to ongoing controversy. Some authors estimate a negative impact of inequality on growth, while in others the effect is positive. Some have a median position and believe that the relationship between inequality and growth is concave with the presence of two reversal thresholds. Before the first threshold (inequalities too low) the effects are positive and after the second threshold (inequalities too high) the effects are negative (Abigail McKnight. 2019). It captures the effect of GDP on the income of the poor, knowing that the distribution of the initial income (initial Gini*log GDP) has an impact on the level of GDP.

Unadjusted or Inequality-adjusted income: measured by the variable (1-Gini) *log GDP. It captures the effect of Inequality-adjusted GDP on the income of the poor, where the distribution of income impacts on the level of GDP. The lower the initial inequality (Gini tends towards 0), the greater the reduction in poverty (the increase in the income of the poorest 40%) is likely to be. Ravallion (1997) estimates that in terms of poverty reduction, it is therefore not the ordinary growth rate that counts but rather the growth rate corrected for inequality, i.e. the Growth Rate *(1-gini).

The other control variables: Primary education (school enrolment ratio) and public expenditure on health by increasing the human capital of the poorest are supposed to have a positive influence on poverty reduction and thus increase the income of the poor. Inflation is a tax that Erodes the purchasing power of the poorest in general, therefore is stopped reducing the real income of the poorest and therefore increasing poverty.

4.3. Results

4.3.1 Descriptive Analysis

Descriptive statistics for the two key variables (Gini and GDP) of the paper are presented in Table 1 below.

Table 1: Descriptive statistics

	Variables	Mean	Standard deviation	Minimum	Maximum	Observations
All countries	headcount P0	0.50496	0.20813	0.0596	0.9163	123
	Quintile (40%)	48.14896	21.47725	11.54616	117.0875	121
	Gini	45.86038	6.364059	34	59.8	525
	GDP/capita	68591.12	146533.6	3020.593	971995.3	621
Medium HDI countries	headcount P0	0.398231	0.194886	0.059651	0.8412149	59
	Quintile (40%)	60.7606	22.58791	15.74517	117.0875	59
	Gini	48.9702	6.886108	37.9	59.8	255
	GDP/capita	114313.9	200235.8	4056.662	971995.3	297
Low HDI countries	headcount P0	0.6033631	0.168575	0.1605996	0.9163282	64
	Quintile (40%)	36.14755	11.04834	11.54616	61.70046	62
	Gini	42.81942	4.03183	34	50.4	278
	GDP/capita	26678.59	28081.48	3020.593	167038.8	324

Source: Author from POVCALNET data

The countries have been grouped into three types[11] according to the level of their HDI, following the UNDP 2018 classification for African countries. On the whole, the average incidence of poverty and inequalities are high, i.e. 50% of the poverty rate (P0 index) and 45% (Gini index) respectively. This structure is heterogeneous according to the level of development of the country. In countries with a medium-high HDI, the average poverty rate is the lowest (P0=39.8%) while inequality is the highest (GINI = 48.9%). As for countries with a low HDI, their poverty rate is very high (P0= 60.3%), while their level of inequality is the lowest (GINI = 42.8%). At first glance, it seems that in Sub-Saharan Africa, out of the 23 countries in our sample, the higher the HDI (the higher the GDP per capita), the higher the income inequality, but the lower the poverty level.

[11]Group 1 (all countries): Botswana, Burkina Faso, Burundi, Cameroon, Côte d'Ivoire, Ethiopia, Eswatini, Ghana, Guinea, Kenya, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda, Zambia.

[11]Group 2 (Medium-high HDI countries): Botswana, Cameroon, Côte d'Ivoire, Eswatini, Ghana, Kenya, Mauritania, Nigeria, Senegal, South Africa, Zambia.

[11]Group 3 (Low HDI countries): Burkina Faso, Burundi; Ethiopia, Guinea; Madagascar; Malawi, Mali, Mozambique, Mali, Mozambique, Uganda

4.3.2 Simple panel regression result

As a first step in our modelling, we perform simple panel regressions including an interactive term between the initial Gini variable and GDP per capita and also between the variable (1- initial Gini) and GDP per capita. Both variables are lagged by one period as is the case in traditional conditional-effect econometric analysis. In the specification process, we consider 6 regressions for each interaction variable to test the robustness of the results and the sensitivity of our variables of interest (GDP per capita, Gini, interaction (GDP/Capita*Gini), and interaction (GDP/Capita*(1-Gni)) and our control variables. Regressions 1 and 4 concern our entire sample. Regressions 2 and 5 refer to the countries in our sample with medium and high HDI levels (lower-middle and upper-middle level of development according to the World Bank 2018 ranking). Finally, regressions 3 and 6 refer to the low HDI countries (poor countries according to the World Bank 2018 ranking) in our sample.

Table 1 shows the results of the simple panel regressions. First of all, we have approximated poverty by the income of the poorest 40%. Poverty is therefore supposed to decrease if the income of the poor increases. Moreover, we are interested in the speed of increase (elasticity greater than 1).

By considering the variables of interest GDP/capita, Gini and their interaction, we see that the increase in GDP/capita tends to improve the income of the poor, both overall and according to groups of countries. The coefficient of the GDP effect shows a positive sign in general but is only statistically significant in equation 3. A 1% increase in GDP leads to an increase in the income of the poor of 0.013% (equation 1) and 0.014% (equation 4) in general. The income of the poor is therefore sensitive to the increase in GDP, but to a lesser extent. However, when we look at the groups of countries according to development, we see that on average the income of the poorest 40% of the population in countries with a medium-high HDI is much more sensitive than that of the whole. A 1% increase in GDP generates an increase in the income of the poor of 0.612% and 0.594% respectively under equations 2 and 5. A 1% increase in GDP generates an increase in the income of the poor of 0.24% and 0.35% respectively for equations 2 and 6. In the case of low HDI countries, the income of the poor is more sensitive than average but less than in medium-high HDI countries. The simple fact that the income of the poor increases as a result of growth, even if the increase is less than proportional, allows us to affirm, following Ravallion and Chen (1997), that growth is pro-poor on the whole but displays heterogeneity according to the level of development of the countries.

Moreover, it can be affirmed that initial inequalities have a negative impact on the income of the poor for all the countries in our sample, given the negative sign of the coefficient of the Gini variable. Naturally in countries with a medium-high HDI, inequality has a higher effect than in the whole and also in comparison with countries with a low HDI. In low HDI countries the impact of inequality on the income of the poor is small and insignificant, which would be in contradiction with Ravallion (2012) if we assume that income reduction is equivalent to poverty increase.

Considering the interactive term initial Gini*GDP per capita, it appears that the effect of initial inequality on the growth-poverty relationship is negative overall and statistically significant in equations 1, 2 and 3. This is consistent with previous results (Bourguignon 2003, Fosu 2009, 2015, Ndene Ka. 2016)) and this regardless of the group to which the country belongs. On the other hand, in equations 4, 5 and 6 relating to the role of the Inequality-adjusted GDP effect ((1-gini) *log GDP), the results are reversed. A 1% increase in log Inequality-adjusted GDP results in an increase in the income of the poor of 0.018% overall, and of 0.012% in countries with low GNI and a statistically insignificant decrease of 0.004% in countries with low HDI. Although the Inequality-adjusted impact on the income of the poor is small, the fact that it is positive shows the critical importance of Inequality-adjusted GDP in poverty reduction.

With respect to the control variables, the results are broadly in line with our expectations and theory. The agricultural GDP variable has a positive and statistically significant effect on the income of the poorest 40% as a whole as well as on the levels of development.

Overall, primary school enrolment rates have a positive and significant effect on the income of the poor, but not significant when countries are considered according to their level of development. The effect of health spending on the income of the poor is also positive overall but not significant in the case of Low HDI Countries. Inflation generally has a negative effect, but overall, not significant, except in medium-high HDI countries.

In conclusion, the linear regressions of the interactive panels gave us a first insight into the growth/inequality relationship via the role of inequality. It appears that pure growth is pro-poor and that inequality can be a brake on overall poverty reduction. The role of initial inequality in the impact of growth on poverty reduction is therefore crucial.

There is, however, heterogeneity over time, whether countries belong to a development category or not. As simple panel modelling does not make it possible to get around this difficulty, we secondly use the PSTR model in order to relax the strong hypothesis of intertemporal and individual heterogeneity.

Table 2: simple panel regressions Results

Dependent Variable	Log quintile 2 (40% of the poorest)					
	equation 1	equation2	equation 3	equation4	equation 5	equation 6
Gini	-0.036***	-0.070**	-0.028	0.030***	-0.070**	-0.028
	(-48.02)	(-2.55)	(-0.77)	(50.19)	(-2.55)	(-0.77)
log GDP/capita	0.013**	0.612**	0.029	0.014***	0.594**	0.454*
	(2.25)	(2.13)	(0.08)	(3.07)	(1.99)	(1.88)
Gini* GDP/capita	0.021*	-0.012**	0.004*			
	(61.32)	(-2.08)	(1.76)			
‘						
(1-Gini) * GDP/capita				0.018***	0.012**	-0.004
				(73.30)	(2.08)	(-0.57)
Agricultural productivity Growth	0.047*	0.051*	0.070**	0.044*	0.051*	0.070**
	(1.32)	(1.73)	(2.28)	(1.48)	(0.13)	(2.28)
log Primary school enrolment ratio	0.089***	0.365	0.007	0.069***	0.365	0.007
	(2.96)	(0.92)	(0.04)	(2.72)	(0.92)	(0.04)
Health expenditure% GDP	0.015***	0.093***	0.018	0.013***	0.093***	0.018
	(4.43)	(2.97)	(0.74)	(4.74)	(2.97)	(0.74)
Inflation	0.000	-0.003*	-0.000	-0.000	-0.003*	-0.000
	(1.26)	(-0.88)	(-0.20)	(-1.54)	(-0.88)	(-0.20)
Constant	1.684***	5.471***	2.063***	-1.391***	5.471***	2.063***
	(44.79)	(3.39)	(9,67)	(-31.84)	(3.39)	(7.63)

Source: Author

Note: Values in parentheses () are t-student. ***, ** and * denote significance at 10%, 5% and 1% respectively.

4.2.1 PSTR MODEL results

• ***linearity tests Results of the PSTR modelling***

As shown in the previous section, estimating the PSTR requires first testing the linearity hypothesis. For regressions, we adopt the same approach as for simple panel regressions, allowing the linearity tests to determine the appropriate specifications. Table 3 groups the linearity tests for the different specifications. We note that all three linearity tests strongly reject the null hypothesis of linearity of the relationship between the income of the poorest 40% and the variable of GDP per capita as a function of the level of income inequality in the six regressions. However, the non-linearity tests that have been carried out do not allow us to reject the null hypothesis of one regime against the hypothesis of the alternative of at least two regimes, thus suggesting a transition process between two regimes.

Tableau 3: linearity tests Results

Dependant Variable	Log quintile 2 (40% of the Poorest)											
	equation1		equation2		equation 3		equation4		equation5		equation6	
Tests	Linearity	r=1 versus r=2	Linearity	r=1 versus r=2	Linearity	r=1 versus r=2	Linearity	r=1 versus r=2	Linearity	r=1 versus r=2	Linearity	r=1 versus r=2
Wald (LM)	25,793	14,538	17,703	16,007	39,666	7466	25,793	14,538	17,703	16,007	39,666	7466
p-value	0,000	0,024	0,007	0,014	0,000	0,188	0,000	0,024	0,007	0,014	0,000	0,188
Fischer (F)	4,332	2,207	3,145	2,339	9,331	1,327	4,332	2,207	3,145	2,339	9,331	1,327
p-value	0,000	0,043	0,008	0,042	0,000	0,256	0,000	0,043	0,008	0,042	0,000	0,256
Pseudo LRT	27,193	14,969	19,739	17,647	45,019	7,631	27,193	14,969	19,739	17,647	45,019	7,631
p-value	0,000	0,020	0,003	0,007	0,000	0,178	0,000	0,020	0,003	0,007	0,000	0,178

Source: Author

• ***estimations Results of PSTR modelling***

Tables 4 and 5 show the results of the PSTR modelling, according to the configuration of the previous simple panel case equations. Thus 6 equations, where the first three of them (Table 4) relate to estimates with initial Gini as a transition factor. The three others (Table 5) relate to (1- initial Gini) as a transition factor. The smoothing parameters are relatively stable overall, from one table to the other. Coefficients values of smoothing parameters are low suggesting progressive smoothing process, both globally and for each group of countries. In the case of the first 3 equations[12] (Gini being the transition variable), the inequality thresholds (respectively 36.13, 41.5 and 38.5) are relatively low compared to those of the last 3 models (46.06, 54.11 and 59.59 respectively) where the variable (1-Gini) is taken as the transition variable. This suggests that the transition takes place faster in the case where there is no inequality control than in the case where there is a control (1-Gini). The high values of these thresholds suggest that a high level of control of income inequality through GDP growth policies is required for improving the incomes of the poor.

Table 4: Model 1: PSTR estimation results (Gini as the transition variable)

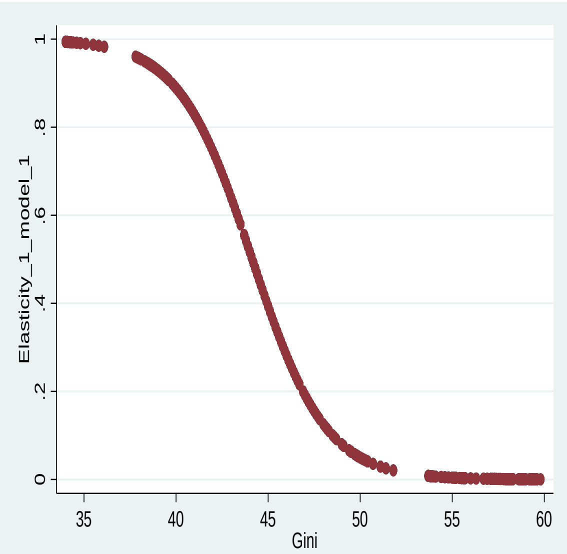
dependent Variables	Log quintile 2 (40% of the poorest)		
Transition Variable	Gini		
	equation 1	equation 2	equation 3
Gama	0.5025	1.8549	2.7326
Thresholds	36.1393	41.3881	38.4079
$\alpha \log GDP/capita$	0.9921***	0.9805***	0.9382***
	(4.2381)	(4.2900)	(3.7957)
$\beta \log \log GDP/capita \times f$	-0.0226 ***	-0.0542***	-0.04190***
	(-2.1835)	(-2.7142)	(-9.4386)
Control Variables			
Gini	-0.0003	-0.0095	-0.1167***
	(-0.0286)	(-0.8563)	(-4.3050)
agricultural productivity growth	0.3130*	0.4348***	1.3108***
	(1.9479)	(4.5618)	(2.8644)
log primary school enrolment ratio	1.1471*	0.4646***	-1.9773***
	(1.9434)	(3.4276)	(-6.4837)
Health expenditure % GDP	0.1262***	-0.1151***	0.0546
	(3.9425)	(-3.1246)	(1.5446)
Inflation	0.0025	-0.0046***	-0.0293***
	(0.9781)	(-3.8821)	(-8.3754)

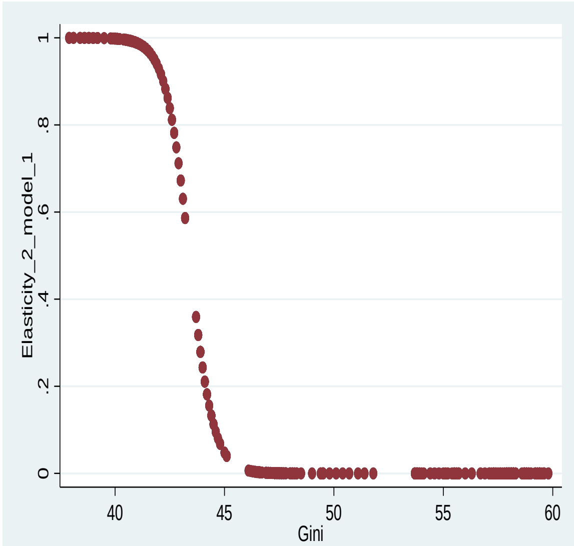
Source: Author

Note: Values in parentheses () are t-student. ***, ** and * denote significance at 10%, 5% and 1% respectively.

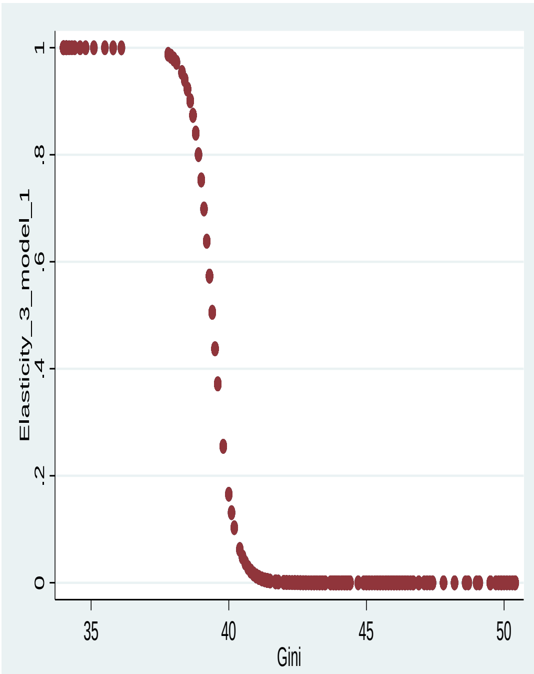
[12]See table 4 (Table of PSTR estimation results (Gini) as a transition variable)

Figure1: Model 1: marginal effects of GDP on poverty (Gini as transition factor)





Graph1: Model 1: Elasticity 1: low HDI countries Graph2: Model 1: Elasticity 2: medium HDI countries



Graph 3: Model 1: Elasticity 3: low HDI countries

Graph 1 to 6 show the evolution of marginal effects, the first 3 graphs[13] (equation 1,2 and 3) representing the marginal effects of GDP unadjusted for inequality on the income of the poor, while the last 3 graphs (equation 4, 5 and 6) represent the marginal effects of GDP adjusted for inequality on the income of the poor.

Globally, the process can be analysed in 3 steps. Two horizontal phases and a decreasing intermediate phase depending on the smoothing parameter. for the first three models, the process begins with a horizontal phase slightly below unity, reflecting positive but constant marginal effects (0.9209; 0.9865 and 0.90382 respectively) of unadjusted GDP on the income of the poor. This confirms the fact that when inequality is low, the effect of GDP on the income of the poor is generally non-negative and maximum. This is so until inequality reaches a level of about 36.14%, 41.38% and 38.40% respectively.

[13]See Figure 1: Model 1: marginal effects of GDP on poverty (Gini as transition factor)

Then comes the downward phase (from 36.14% to 54%, 41.38% to 46% and 38.40% to 42% respectively) for Models 1, 2 and 3. Here the level and growth of initial inequality begins to impact on the efficiency of GDP in a direction that is not favourable to the growth of the income of the poor. Indeed, here, the marginal effects of GDP unadjusted for inequality remain positive but decreases as inequality reaches the respective thresholds of 54%, 46% and 42% in the case of models 1, 2 and 3 respectively. Above these thresholds and beyond, inequality has a constant negative impact on the marginal effects of unadjusted GDP, which explains why these effects become constant but negative again (-0.0226, -0.0542 and -0.0419).

In other words, growth is pro-poor in the first 2 phases of the process, i.e. before the inequality thresholds of 36% (all countries), 42% (medium-high HDI countries) and 38% (low HDI countries) respectively and also in the declining phase. From the third phase, the horizontal phase, growth is not pro-poor. In some, GDP growth alone increases the income of the poor, while considering initial inequalities into account generates a more mixed result. As a result, Ravallion ((1997, 2003)) recommandes the consideration of GDP corrected for initial inequalities, in order to better perceive the capacity of GDP growth to be transformed into an increase in the income of the poor. Equations 4, 5 and 6 (Table 5) attempts to capture this reality.

Adjusting GDP for initial inequality is equivalent to writing (1- initial Gini) *log of GDP. In the case of equation 4, 5 and 6 (Table 4), the variable (1- initial Gini) is taken as a transition function, so the effect of GDP on the income of the poor is corrected for initial inequality. When the initial Gini is high, the effect of log GDP growth on log income growth of the poor is reduced and vice versa, as inequality increases.

The process still consists in 3 phases as before. Initially, the marginal effects of Inequality-adjusted GDP are positive and constant (0.9983; 0.9817 and 0.9507 respectively) i.e. before the first inequality thresholds of about 45% (for the whole), at 55. % (medium HDI countries) and 59% (low HDI countries). An explanation is that the level of initial inequality is so low that even when it increases, this cannot prevent GDP growth from being converted into increased income for the poor. Then comes the descending phase where the level of initial inequality begins to affect the process by which GDP growth is transformed into income growth of the poor as inequality grows to the thresholds of 64%, of 59%; and 62% respectively. Marginal effects are found to grow at a decreasing rate as inequality increases. Above these thresholds, the marginal effect of GDP tends towards zero but remains positive and constant because the initial inequality no longer affects the efficiency of GDP growth to be converted into increased income for the poor. Equations 5 and 6 reflect the same process except that in equation 5 (medium HDI countries) the transition is smooth, while it is less smooth in equation 6 (low HDI countries). Growth is therefore pro-poor when the effect of Inequality-adjusted GDP is considered.

These results confirm those of Ravallion (1997, 2003) who states that when the initial level of inequality is high the poor will derive very little or no gain from growth (the income of the poor will increase very little or not at all). When the Gini index is equal to unity (maximum inequality) then the income of the poor will not increase as a result of growth; when initial inequality levels are high, their effect on elasticities will gradually become smaller and smaller as inequality increases.

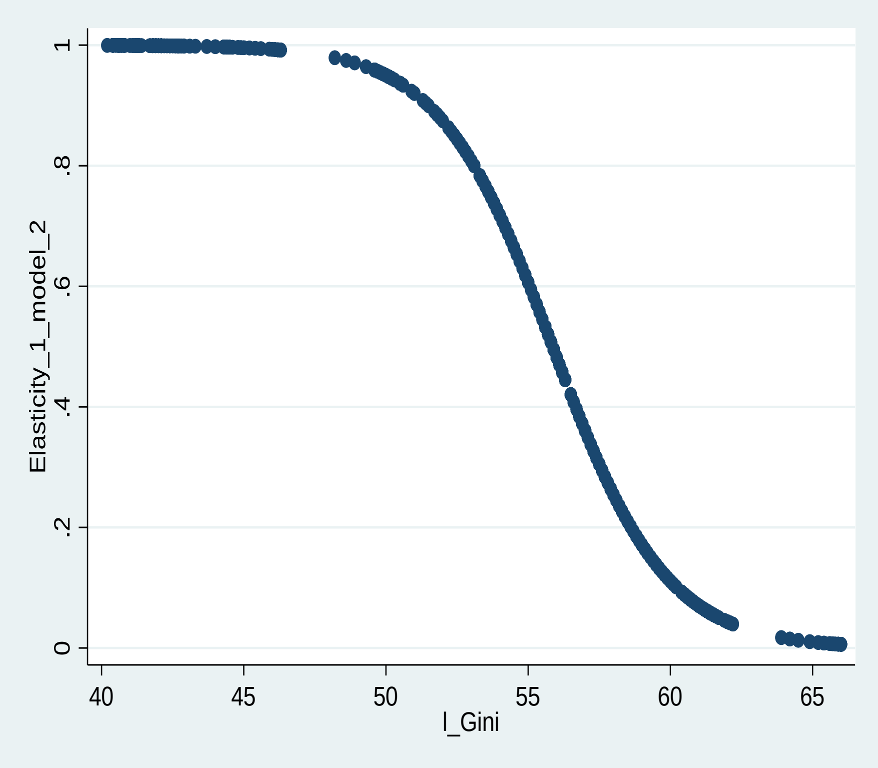
Table 5: Model 2: PSTR estimation results ((1-gini) as a transition variable)

Dependent variable	Log quintile 2 (40% of the poorest)		
Transition Variable	1-Gini		
	Equation 4	Equation 5	Equation 6
Gama	0.5025	1.8549	2.7325
Thresholds	46.0608	54.1119	59.0921
$\alpha \log GDP/capita$	0.9983***	0.9817***	0.9507***
	(3.6572)	(4.6246)	(5.6771)
$\beta \log GDP/capita * f$	0.0226 ***	0.0848***	0.01510***
	(3.1835)	(2.7140)	(2.4387)
de control Variables			
Gini	-0.1041***	-0.0563***	0.0079
	(-4.1179)	(-5.4233)	(0.6146)
Agricultural productivity growth	0.2416**	0.2653	0.1375
	(2.4061)	(1.5413)	(1.0507)
log primary school enrolment ratio	0.9688**	2.5532***	0.1602
	(2.2742)	(7.5801)	(0.7387)
Health expenditure % GDP	0.0811***	-0.1972***	0.0112
	(8.0583)	(-5.1439)	(1.0949)
Inflation	0.0032**	-0.0156***	0.0026**
	(2.1425)	(-4.8813)	(2.4797)

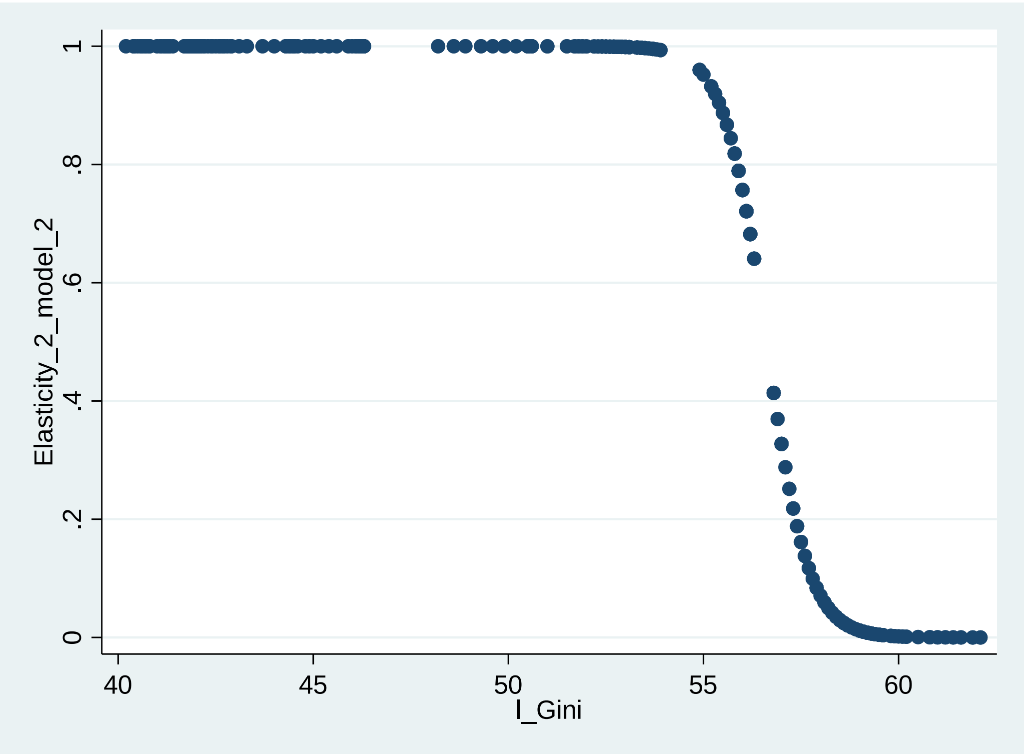
Source: Author

Note: Values in parentheses () are t-student. *, ** and *** denote significance at 10%, 5% and 1% respectively

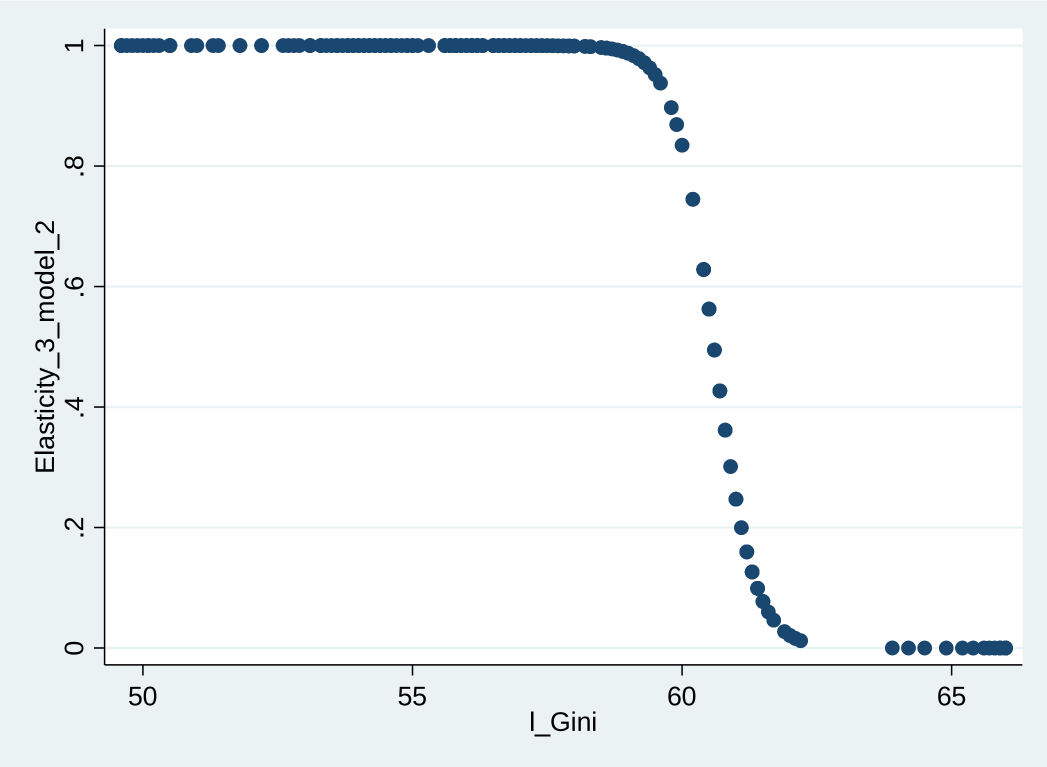
Figure 2: Model 2: marginal effects of GDP on poverty (1-Gini as transition factor)



Graph 4: Model 2: Elasticity 1: All countries



Graph 5: Model 2: Elasticity 2: Medium HDI countries



Graph 6: Model 2: Elasticity 3: low HDI countries

4. Conclusion and discussion

The objective of this study is to analyse the effect of initial inequalities on the capacity of economic growth to reduce income poverty. Given that the average poverty rate of our sample is 50%, we choose to approximate income poverty by the income of the poorest 40%, which means that an increase in this income is synonymous with a reduction in poverty.

The study was carried out in 23 countries in sub-Saharan Africa using data from the World Bank's Povcalnet, covering the period from 1991 to 2017. Given the heterogeneity and non-linearity of the relationship between GDP growth and poverty reduction, we use a PSTR-type model in order to capture first the separate effect of GDP, then that of inequality and then the combined effect of growth and inequality on poverty. In general, GDP growth alone tends to increase the income of the poor less than proportionally, while inequality (GINI) tends to reduce the income of the poor. The final result of the combination of the two effects on the income of the poor depends on the extent to which initial inequalities are taken into account in the growth process. When GDP growth is not adjusted for initial inequality, its ability to be converted into increased income for the poorest 40 per cent of the population is mitigated. The process of converting the increase in GDP into an increase in the income of the poor, tends to be initially slowed down, then finally weakened by the negative effect of initial inequalities. Conversely, when GDP is corrected for the negative influences of inequality, growth tends to be more effective in reducing poverty.

However, this process is distributed in a heterogeneous and non-linear way, depending on countries classification by standard of living. Countries with a medium-high Human Development Index (HDI) have the lowest poverty rate (36%) and the highest level of inequality (GINI = 48.9%). In these countries the ability of GDP growth to be converted into higher income for the poor is higher than in low HDI countries. This is reflected in the lower transition thresholds than those of low HDI countries. Indeed, in low HDI countries the poverty rate is the highest (P0= 60%), the level of inequality the lowest (42%) and for which the efficiency of GDP growth to be converted into increased income for the poor seems to be low.

The initial poverty level, therefore seems to be an obstacle to GDP growth conversion into poverty reduction (increase in the income of the poor).

The main conclusion of this study is therefore that growth is generally pro-poor when the initial inequality is low, and this is the case regardless of the initial poverty level. As inequality rises, growth has less and less positive effect on the income of the poor, especially when GDP is considered unadjusted for inequality. When GDP is initially adjusted for the effects of initial inequality, the inequality thresholds required for slowing the process are pushed back.

In addition, the efficiency of the transformation of GDP growth into increased income for the poor is greater. This suggests the strengthening of support policies aimed at having greater control over income inequality in terms of policies that foster economic growth and poverty reduction as well.

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