SPECIALISED MASTER IN INTERNATIONAL AND DEVELOPMENT ECONOMICS

Rapid GDP growth in African countries and income distribution

Fokou Tetougueni, Alex Brice

Award date:
2019

Awarding institution:
University of Namur

RAPID GDP GROWTH IN AFRICAN COUNTRIES AND INCOME DISTRIBUTION

Thesis presented by
Alex Brice FOKOU TETOUGUENI

Supervisor(s)
Mary Van Overbeke (UCL)

Tutor(s)
François Woitrin (UNamur)

Academic year 2018-19

Project presented as part of the requirements for the award of the Specialized Master in International and Development Economics

Département des Sciences économiques/UNamur • Rempart de la Vierge 8 • 5000 Namur
Ecole d'économie de Louvain/UCL • Place Montesquieu 3 • 1348 Louvain-la-Neuve

ABSTRACT

"This study presents an empirical analysis of the evolution of income inequality between 1990 and 2015. It also provides a recent literature review on the relationship between income inequality and economic growth. Finally, it makes econometric estimates on the impact of income inequality on per capita GDP and investigates some transmission channels through which income inequality affect economic growth. The model used for the purpose is a dynamic model based on Panel data from African Countries. The main finding is that, an increase in income inequality would lead to an increase in GDP per capita up to a certain level at which, any increase in income inequality would reduce GDP per capita. We also found that fertility rate and investment are the channels through which income inequality would influence significantly and negatively per capita GDP.*"*

LIST OF ABBREVIATIONS

Abbreviation	*Name*
AEO	African Economic Outlook
AfDB	African Development Bank
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
IMF	International Monetary Fund
OECD	Organisation for Economic Cooperation And Development
SAP	Structural Adjustment Programmes
SCN	System of National Account
SWIID	The Standardized World Income Inequality Database
UNDP	United Nations Development Programme
WB	World Bank

TABLE OF CONTENTS

LIST OF TABLE

LIST OF GRAPHS

INTRODUCTION

Background

Inequality is usually perceived as the fact that a human being is treated differently from others, particularly with regard to status, opportunities and rights. From the economic point of view, inequality is a result of a misallocation of an economy's resources (income or wealth). It is most often mentioned in the periods of intense economic activity (industrialization) during which the labour force who works in order to support their family are exploited by the bourgeoisie that operates the production enterprises. Simon Kuznets (1955) was one of the first economists who established a relationship between income inequality and economic growth. Through an inverted U-shaped, he explained that this relationship depends on a country's development stage. Indeed, income inequality increases during the early phase of economic growth and decreases during its later stage. After Kuznets' work and with the development of new databases of inequalities measure at the end of the 20th century, works on the issue moved from a simple descriptive relationship to the causal effects of income inequality on economic growth and vice versa, giving rise to divergent schools of thought.

The first view is income inequality would be beneficial for economic growth (Lee, 2006), (Wahiba & Weriemmi, 2014), (Suwoto & Zhai , 2016), (Yang & Greaney, 2017). This idea stems from the thinking of classical economists suggesting that, at the early stage of industrialization, while marginal propensity to save increases with wealth, an unequal society will promote income distribution in favour of individuals with a high marginal propensity to save, thus increasing aggregate savings, capital accumulation and as well economic growth (Galor & Moav, 2004).

However, other economists suggest that income inequality would be negatively associated with economic growth. This negative relationship would result from the fact that, income inequalities reduce investment opportunities (Kennedy & Al., 2017), generate macroeconomic volatility (Qin & Al., 2009), create a difference in term of fertility (De la Croix & Doepke, 2003), lead to imperfect credit markets (Gründler & Scheuermeyer, 2018) and contribute to social instability (Odedokun & Round, 2001), (Delbianco , et al., 2014).

These different points of view, although contradictory, are consistent with the socio-economic and political context of the area covered by their studies. The challenge for economists is now to determine the factors that would influence the relationship between economic growth and income inequality. This would allow to suggest economic policies aimed at reducing inequalities while promoting economic growth. The idea behind is to identify the channels through which income inequalities would affect economic growth. Five transmission channels were investigated in recent studies ((Barro, 2000), (Alesina & Rodrik , 1994), (Delbianco , et al., 2014), (De la Croix & Doepke, 2003)), including credit market imperfections, political economy, social unrest, savings rate and endogenous fertility.

Most economists consider that an individual's savings rate increases with the level of income. Under this assumption and the fact that the marginal propensity to save is higher for rich

households than poor households (Dynan, et al., 2004), an increase in inequality would be beneficial for economic growth in the economies where the return on human capital is lower than the return on physical capital, while equality is beneficial for economic growth in economies where the relative return on human capital is high (Galor & Moav, 2004).

An unequal redistribution of income in a society would encourage poor people to engage in crimes, riots and other disruptive activities, which would create a social climate that is not attractive to investors and would lead to a decline in economic activity (Alesina & Perotti , 1996), (Delbianco , et al., 2014).

According to the economic literature, because of the borrowing constraints in credit markets due to the lack of collateral, poor households are not able to finance investments in education, even when these investments offer relatively high rates of return. On this basis, high inequality would increase the number of people affected by this credit market constraint and, consequently, reduce investment in education throughout the economy, which in turn should delay economic growth (Barro, 2000).

When there are income inequalities in a society, the authority in place in most cases for political reasons, used redistributive policy (fiscal policy) which involves collecting taxes from those who have enough for the less fortunate. In the presence of high income inequality, a tax policy aimed at improving income distribution will negatively affect the accumulation of capital and savings and thus leads to retard economic growth (Alesina & Rodrik , 1994).

Some demographic variables, particularly fertility when used as an endogenous variable, have also been shown to influence significantly income redistribution and therefore economic growth. In fact, when the variation in fertility in the different groups or classes of the population is large, it will contribute to reduce the growth rate of human capital and increase inequalities of the next generation (poor families generally constitute a fairly large fraction of the population and invest little in the education of their children), thereby dropping the economic growth (De la Croix & Doepke, 2003).

Africa as a whole has not been the subject of much study to establish a relationship between economic growth and income inequality, although if we observe the facts, it could lead to a more in-depth analysis of this relationship.

In fact, since the end of the twentieth century, despite the sluggishness of the world economy, the higher volatility of commodity prices, pervasive corruption and political instability in several countries in Africa, GDP growth has on average increased sharply[1]. The strongest economic performance was observed before the world economic recession in 2008, where on average GDP growth was 6% over the 2006-2008 period with a GDP per capita around 4% (AfDB & OECD, 2010).

This achievement was mainly related to the combination of several factors such as the proper management of revenues related to the sale of commodities in a period of sharp rises in world

[1] The average gross real domestic product (GDP) rising from 2% during the period 1980-90s to more than 5% between 2001-14 (AfDB, et al., 2016).

prices, debt relief, sustained aid and foreign direct investment (FDI) inflows (AfDB & OECD, 2010). It was the consequence of the implementation at the end of 20th century, in almost all African countries, of some strategies (Country Strategy Papers, The Poverty Reduction Strategy Paper, Sector-Wide Approaches strategies, etc.) which aim to accelerate economic growth while reducing inequalities through improving the wellbeing of the populations.

However, this upturn in the African economy has not been able to create better conditions for improving the welfare of its population through a fair wealth redistribution. In fact, the number of impoverished (people living on less than US$ 1.90 a day) in Sub-Saharan Africa increased considerably by 49% between 1990 and 2015 even though the head count ratio in Africa declined from 54.3% in 1990 to 41% in 2013 (ECA & United Nations, 2017). The share of Sub-Saharan Africa poor in the total poor in the world has also increased sharply from only 15% in 1990 to more than 50% in 2013 (ECA & United Nations, 2017).

Income inequality within African countries according to the Gini index, has also increased from 41.1% between 1980-1989 to 43.9% between 2000-2009 (AfDB, 2012). Comparatively to the other region in the world, the Gini index in Africa is the second highest just behind Latin America and the Caribbean region. In 2010, six countries in Sub Saharan Africa were in the top ten of the most unequal income distribution countries in the world (AfDB, 2012). Africa is also marked by very large differences in income inequality across countries fickle from 0.31 from Niger to 0.65 in South Africa (ECA & United Nations, 2017). In terms of income distribution between the rich and the poor, the African population living on less than US$ 2 a day (61% of the total population) held only 36.5% of the region's total income in 2011 (AfDB, 2012).

Besides the contrast between economic growth and rising income inequality, the African population has seen a very sharp upward trend over the past 30 years compared to other regions of the world. According to the United Nations (2015), the size of the African population has increased from 478 million in 1980 to 1.2 billion in 2015 with an average population growth rate near 2.6% per year. This population of which 60% is under 25 years old in 2015, is expected to double in 2050. This demographic growth has caused a rapid urbanization with huge disparities between the populations living in urban area who have many advantages in terms of adequate infrastructures of education, health and the best job opportunities (better wages) compare to those living in rural areas with very little infrastructure amenities and where agriculture is the main activity. On the same time, Africa experienced a significant sectorial transition between 1990 and 2012, moving from a predominantly agricultural economy to one based on services. This transition, which is certainly part of the development process, has not been regulated by government institutions, allowing the creation of very low-productivity informal activities in the tertiary sector, consider as the main source of employment in most countries in Africa (ECA & United Nations, 2017).

Problematic

With that evidence, economic growth in Africa has not led to a significant reduction of income inequality. Despite the increase of economic growth, most of the population in Africa has not seen an improvement of its wellbeing (especially in rural zones).

Moreover, a study conducted by Delphin Go et al. (2007) shows that income inequality is negatively associated with economic growth in Sub Saharan Africa. It should be noticed that this study covered the period 1980-2000, in which some Gini coefficients used were not representative of the entire population of the countries concerned. So using a fairly recent database of income inequality it is likely that more robust and even contradictory results will be obtained. This is why our main research question is "***Does income inequality promote or hinder economic growth in African countries?***"

Recognizing that the population boom in Africa is a major concern of international institutions dealing with population issues because of the consequences it may generate, we are going to determine "***if the dynamic of the population could influence the effect of income inequality on economic growth?***"

Motivations

One of the main reasons for choosing this topic is that most studies on the relationship between economic growth and income inequality in recent years have so far focused on the effect that economic growth would have on income inequality and vice versa. Very few have attempted to identify the factors that could influence this relationship even though these studies focused on all countries in the world where African countries are very poorly represented. However, Odedokun and Round (2001)'s study has attempted to determine the factors through which income inequality would impact economic growth in Africa. Although this study focused on African countries, the methodological approach it proposes (transversal growth model), which is highly criticized by the current literature on the subject, is different from ours (dynamic panel model). In addition, this study dates from 2001, at that time very few African countries had data on income inequality and moreover it detected only one factor that could influence the relationship between economic growth and inequality over the many factors proposed in the literature.

Objectives

This study aims not only to describe how the relationship between economic growth and income inequality has evolved in recent decades in Africa, but especially to find the impact of income inequality on economic growth as well as the main transmission channels for this impact. Particular emphasis will be placed on demographic variables such as Fertility rate, infant mortality rate and life expectancy at birth.

The following specific objectives must be achieved:

- ✓ provide the review of the theoretical and empirical literature on the relationship between income inequality and economic growth;
- ✓ present the different measures of inequality (its properties, advantages and limitations) in order to justify the choice of the measure to be used in the empirical part of this work;
- ✓ describe dynamic panel model on which most of the results of this study are based and indicate the theoretical reasons behind the choice of the different variables that will be used in this model;
- ✓ analyse the changes in income inequality over the lasts decades;
- ✓ investigate the growth effect of income inequality and its transmission channels.

Methodology and results

To achieve our objectives, we used a Dynamic Panel regression model proposed by Gründler & Scheuermeyer (2018). The results obtained show a non-linear relationship between income inequality and GDP per capita. An increase in income inequality would have a significant and positive impact on per capita GDP up to a certain level of income inequality at which any increase in income inequality would be detrimental to economic activity. We have also found that fertility rate and investment are the channel through which income inequality would influence significantly and negatively per capita GDP.

Content plan

This project is structured into two parts with two chapters for each. In the first part of this study, we will present the theoretical and empirical information found in the literature on which most of the results that will be assessed in the second part of this paper are based. The first chapter will provide theoretical and empirical reviews depicting on the first hand the impact of income inequality on economic growth and in the second hand the transmission channels through which income inequality affect economic growth. The second chapter of this part will present the different measures of income inequality and methodological approaches showing the impact of socio-economic variables on income inequality.

The second part will provide on its first chapter, a format of the data used, its processing as well as descriptive analysis showing the evolution of income inequality over the last two decades. It also describe the variables used and their correlation with Gini index. On its second chapter, the main results are analysed.

Part I: LITERATURE REVIEW

Chapter 1. ECONOMIC GROWTH AND INCOME INEQUALITY

There is a multitude of studies highlighting the link between income distribution and growth. These studies, whose results are sometimes contradictory, attempt to justify the causal link between an unequal distribution of income and economic growth in relation to the environmental, socioeconomic and political context of a country. The purpose of this chapter is to outline the theoretical fundamentals on the feature of the relationship between economic growth and income inequality as well as the main factors influencing this relationship.

I.1. Definitions and concepts

This section will provide the key concepts that are useful for a better understanding of the study.

I.1.1. Economic growth

Economic growth is considered as an indicator to measure the improvement of economic activity over time. It quantifies the increase in the total value of goods and services produced in a country between two periods (Firebaugh & Beck, 1994). In this study, economic growth refers to the growth rate of Gross Domestic Product (GDP) per capita. GDP is a comparative measure that provides an assessment of a country's economic performance. According to the System of National Accounts 2008, GDP can be derived from three different approaches: production, expenditure and income of the factors of production. Based on the production approach, it is determined as the sum of the gross value added of all resident institutional units engaged in production process plus any taxes less subsidies on products. Under the expenditure approach, GDP is considered as the sum of the final use of goods and services (except intermediate consumption goods) measured at acquisition price minus the value of imports of goods and services. In the last approach, GDP is equal to the sum of the primary incomes distributed by the resident producer units.

I.1.2. Population growth

The population growth is defined as a positive change (an increase) in the number of individuals living in a given group, community, country or region between two periods. The study of structural change in population size over time and space is presented as population dynamics (Turchin, 2003). The process of population dynamics is generally influenced by three different components such as fertility, mortality and migration. Analytically, the population at a given period should be equal to the population of the previous year, to which new births and net migrations would be added and deaths would be removed. To formalize it:

$$P_t = P_{t-1} + B_t + M_t - D_t \qquad (1)$$

P_t = Population at the period t or population of the current year
P_{t-1} = Population at the period t-1 or population of the year before
B_t = Number of children who are born in the period t
M_t = Net migration at period t which refers to the difference between the total number of immigrants and emigrants at period t
D_t = Total population who die at period t

From the equation (1), the growth rate of the population should be equal to the sum of the birth rate and the net migration rate minus the mortality rate given by the equation (2):

$$p_t = b_t + m_t - d_t \qquad (2)$$

Demographic transition is generally achieved when, during its development process, a country manages to reduce its previously high mortality rate and birth rate and maintain the gap between these rates at a relatively low level so that population growth is at a close to nil level.

I.1.3. Income inequality

Inequality is generally the fact of being treated differently from one's fellow human being, particularly with regard to status, opportunities and rights. Presented in this way, this term has a social dimension (inequality of opportunity) and an economic dimension (income inequality) (OECD, 2015). The inequality of opportunities is derived from Sen's (1970) study on capabilities in which he states that well-being must be defined in terms of the ability of people to value their freedom to choose and act. Income inequality is observed when individuals do not have the same amount of material wealth or the same global economic living conditions. It refers to the way in which the income or wealth of an ethnic group, community, country or region is redistributed to the richest. In other words, it represents the extreme concentration of wealth in the hands of a relatively small proportion of the population.

I.2. Relationship between economic growth and income inequality

Although the first studies on the relationship between economic growth and income distribution, were carried out in the middle of the 20th century, it still arouses interest among economists. The initial approach was to establish a simple correlation between economic growth and income distribution, but today the focus is more on causality effect. One of the very first studies on this issue were established by Simon Kuznets (1955). In a context of data scarcity, he established a relationship between long-term growth in Gross National Product (GNP) per capita and income distribution through an inverted U-shape. He suggests that, during the first stage of a country's development, an increase in income inequality contributes to rise economic growth, until reaching a maximum at which any increase in income inequality would lead to a decrease in growth at the last stage of the economic development period. In his view, the relationship between economic growth and income inequality exists but depends on the phase of economic cycle initiated by the country. In the aftermath of Kuznets' work, economists have tried to develop models to establish the impact of income inequality on economic growth and vice versa. As a result, the relationship between economic growth and income inequality can be positive, negative, non-linear (in the form of an inverted curve) or not unique (Andrei & Craciun, 2015). One of the reasons for these divergent views would be that most studies on the subject were based on country data from cross-sectional surveys over a relatively short period of time, neglecting the heterogeneity of the measure of income inequality and for which no consideration was given to cultural and institutional difference (Kennedy & Al., 2017). The purpose of this section is to present the most relevant literature with respect to these different points of view.

I.2.1. Positive effect

The classical economists are the main advocates of the theory that inequalities would be beneficial to economic growth. Their argument is based on the fact that, in the first stage of industrialization, since marginal propensity to save increases with wealth, inequalities redistribute resources to individuals with a higher marginal propensity to save, thereby increasing aggregate savings, capital accumulation and economic growth (Galor, 2012).

An analysis carried out over the period 1951-1992 covering the first 14 countries who joined the European Union shows that inequality increases with the level of development of the countries before reaching its optimum (Lee, 2006). The study found that foreign direct investment (FDI), demographic and educational variables are the factors that contribute to increase income inequality in Europe during its development process.

Yang and Greaney (2017) show that in the case of China, the United States and Japan, growing income inequality helped these countries to stimulate their economic growth.

An empirical study of income inequality analysis in 225 countries in 2011 shows that a 1 point increase in the Gini index would lead to an 11% increase in GDP growth (Suwoto & Zhai , 2016). Thus, as inequalities increase, much of the wealth is concentrated in the hands of the highest income and will contribute to increase economic growth.

I.2.2. Negative effect

Income inequalities generally tend to fall with a country's development process and contribute to stimulate economic growth. This is usually observed at the end of the development process, in a situation where economic growth is driven by capital. In this case, a more equitable distribution of income, in the light of credit constraints, can foster investment in human capital and contribute to economic growth (Galor & Moav, 2004) and (Galor, 2012).

A study which consist to examine the relationship between sub-national income inequality and economic growth in Australia using a series of Gini indices calculated on the basis of individual tax statistics published by the Australian Tax Office (ATO) shows that from the mid-1980s onwards, inequality had a detrimental and time-lagged impact on the economy, while investments in physical and human capital had a positive impact on it (Kennedy & Al., 2017). The authors found at the 1% significant level, an additional increase in income inequality of 10% would reduce economic growth by 2.76% all other things being equal. In addition, this study reveals that a positive relationship between economic growth and human capital by supporting additional investment in education would improve skills which could contribute to reduce income inequality.

Through a simulation model applied to China's data, D. Qin et al. (2009) found that a significant change in income inequality in urban, rural or urban-rural areas negatively affects macroeconomic stability as it causes volatility in consumption and investment.

In a study conducted on a wide range of harmonised data, a negative effect of income inequality on economic growth was highlighted (Gründler & Scheuermeyer, 2018). The authors find that less equal societies tend to have a less educated population and higher fertility rates, especially

when the availability of credit is low. As a result, they argue that credit market imperfection and endogenous fertility could be considered as channels through which income inequalities would influence economic growth. They also note that inequality also appears to hinder investment in physical capital. In addition, the negative impact of income inequality is observed in developing and middle-income countries, in which the potential for inequality is severe due to capital market imperfections and the lack of public goods provision.

Odedokun and Round (2001) has reviewed the transmission channels of the relationship between economic growth and income inequality in 35 African countries. This study reveals that the high level of income inequality among people has contributed to delay economic growth in Africa. The study also notes that the growth delay effect appears to have been greater in the case of rural inequalities.

A case study conducted with data from Tunisia over the period 1984-2011 shows that an increase in income inequality has a negative effect on economic growth in a context of openness in trade (Wahiba & Weriemmi, 2014). Indeed, the acceleration of the process of trade liberalization as the result of free trade agreements between Tunisia and the European Union induces a negative relationship between economic growth and income inequality.

An econometric study conducted by Delbianco et al. (2014) on the relationship between economic growth and income inequality in 20 countries in Latin America and Caribbean over the period 1980-2010 shows that, in general, an increase in income inequality (Gini coefficient) has led to a decline in economic growth.

I.2.3. Nonlinear or non-monotonic relationship

According to Robert Barro (2000), there is no uniform and ungeneralised relationship between economic growth and inequality in all countries. This relationship depends on whether the country is a low-income or high-income country. Indeed, economic growth tends to decline with inequality when GDP per capita is below $2,000 (1985 U.S. dollars) and it tends to increase with income inequality when GDP per capita is above $2,000. These results have been confirmed by Shin's (2012) work, in which he demonstrates that income inequality has a negative effect on economic growth as a country's first stage of development, but income inequality has a positive effect on economic growth nears its steady state.

Using an empirical model controlling for differences in initial income, it has been shown that faster economic growth in the short and medium term increases income inequality, regardless of the country's initial level of development. But in the long run, growth leads to increased inequality in developed countries and reduced inequality in developing countries (Chambers, 2010).

I.3. Factors that affect the link between income inequality and economic growth

The previous section has shown through several empirical examples that income inequality would have an impact on economic growth. It also presented the different frameworks that could justify positive or negative effects. According to economic theory, these frameworks are called the mechanisms through which inequalities would impact economic growth. Barro

(2000) lists four main mechanisms: credit-market imperfections, political economy, socio-political unrest and saving rates. Other channels have also been recently identified such as endogenous fertility (De la Croix & Doepke, 2003), mortality rate (Miyazawa , 2006) and trade liberalization (Wahiba & Weriemmi, 2014). This section will provide the theoretical intuition behind each channel.

I.3.1. Marginal propensity to save

The general Keynesian theory argues that income has two possible uses for an individual: consumption and saving (investment). On this basis, a strong positive relationship between the savings rate and lifetime income has been established (Dynan et al., 2004). The study conducted by these authors also suggests that the marginal propensity to save is higher for rich households than poor households. Indeed, the income of the poor is initially very low and can only be used to satisfy the basic needs (consumption), unlike the income of the rich, which is generally quite high, thus giving them an extra margin that can be used for investment purposes. As a result, an income distribution in favour of the highest income earners would increase the level of investment and foster economic growth. The effects of income inequality on economic growth lie in the evolution of private savings and capital formation, two variables that are assumed to increase in response to high inequality. As highlighted by Galor and Moav (2004), at the beginning of the industrial revolution, when physical capital accumulation was the main source of growth, inequality stimulated development by channelling resources to individuals with a higher propensity to save. This positive effect occurs because, in the early stage of industrialization, physical capital was scarce, the rate of return on human capital was lower than the rate of return on physical capital and the development process was mainly driven by capital accumulation. Moreover, as a society grows, it requires skilled people to manage modern equipment and develop technology. Human capital accumulation becomes the main engine for fostering economic activity. Knowing that human capital is embedded in individual investments and investments in human capital are subject to decreasing marginal returns, the overall return on human capital investment is maximized if investment in human capital is widely distributed among individuals in society. Consequently, a more egalitarian society in which the relative return on human capital is high will be beneficial for economic growth (Galor & Moav, 2004).

Evidences presented by some studies (Barro (2000), Odedokun and Round (2001)) find that the Gini coefficient does not seem to have an explanatory power on private savings and investment showing somewhat the limits of this mechanism. Odedokun and Round (2001) also indicate that the income share of the richest 20%, the income share of the poorest 40% and the income share of the next 40% do not have a significant effect on private savings and investment at the 5% threshold.

I.3.3. Fiscal policy or political economy

When there are income inequalities in a society, the authority in place in most cases for political reasons (in order to gain the trust of the people for future elections) takes measures aimed at a more equitable redistribution of income. The most frequently implemented tool is the use of the fiscal policy which involves collecting taxes from those who have enough for the less fortunate. In the presence of high income inequality, a tax policy aimed at improving income distribution

will have a negative effect on the accumulation of capital and savings and will therefore delay economic growth (Alesina & Rodrik , 1994).

The Odedokun and Round (2001) work on Africa suggests there is no evidence that high inequality triggers pressures for governments to increase spending on public goods provision. The same study shows that by observing income distribution at rural and urban levels, high inequality reduces the tax rate, which contradicts the claim that high inequality leads to high tax rates.

Fiscal redistributive measure has a negative effect on GDP per capita in United States, Japan and South Korea (Yang & Greaney, 2017). The study shows that it play an important role for reducing income inequality in Japan.

I.3.4. Credit-market imperfections

According to the economic literature, owing to borrowing constraints in credit markets as a result of the lack of collateral, poor households are not able to finance investments in education, even when these investments offer relatively high rates of return. Under these circumstances, an undistorted redistribution of assets and income from the rich to the poor tends to increase the quantity and the average productivity of investment, thus increasing the rate of economic growth (Barro, 2000). Through this mechanism, high inequality would increase the number of people affected by this credit market constraint and, consequently, reduce investment in education throughout the economy, which in turn should delay economic growth.

The credit market imperfection approach also suggests that the effect of inequality on economic growth depends on the level of income inequality in the country (Galor & Moav, 2004). In fact, while capital markets and legal institutions tend to improve as the economy develops, the effects of capital market imperfections are more important in poor economies than in rich ones. Consequently, the expected effects of inequality on economic growth would be greater in poor economies than in rich ones.

It has been noticed that the effect of this channel would be weaker if education were supported by the State or made compulsory, as in the case of primary education in some countries (Odedokun & Round, 2001). These authors reveal in the case of African countries where primary education is generally subsidized by governments, high inequalities had little effect on enrolment rates in primary schools but have reduced enrolment rates in secondary and higher education.

I.3.5. socio-political instability

An unequal distribution of income within a society generates social discontent, which in turn leads to revolution, mass revolt, threatened property rights, coups, socio-political and economic instability. The unstable socio-political and economic environment as a result would lead to a negative relationship between economic growth and income inequality by creating a climate that discourage investors and then detrimental for long term growth (Delbianco , et al., 2014). In fact, an increase in inequality implies that some groups do not meet their most fundamental needs, while others are becoming increasingly richer, creating socio-political instability and social unrest which are detrimental for investments as well as long-term economic growth.

Odedokun and Round (2001) show that high level of inequality is associated negatively with political stability in African countries. However, when a middle class emerges in an economy, this helps to strengthen social cohesion as well as fostering political stability (Alesina & Perotti , 1996).

I.3.6. Population dynamic

According to the traditional theory of economic growth developed by Thomas Malthus (1798), population is a significant factor in improving the standard of living (GDP per capita) of human beings. From Malthusian theory, the only means for improving the standard of living is population control. An economy based on agriculture with constant technology and no reserve of cultivable land, the growth of the population leads to underemployment and an increase a share of people living in abject poverty (Hirschman, 2004). As well, there is no improvement in the standard of living of population in the long run given that all the country should converge toward the same steady state. When population size is small, the standard of living will be high, then contribute to encourage people to have more kids that will lead to reduce the standard of living and, people with large size of population will reduce intentionally fertility which will lead to an improvement of standard of leaving in the long run (Galor & Weil, 2000). Therefore, we will have more equity society in the long run. The major explanation of Malthusian theory hold true before 1800, characterize by slow growth in population, no trend in standard of living, no improvement in agriculture technology and in medicine. Malthus' predictions were not true if we rely on the theory of endogenous and exogenous growth. Indeed, after the industrial revolution, economic growth was in part driven by growth in the stock of capital overtime and was not limited by fixed factor of production such as land as Malthusian model has said.

With the ongoing technological innovations in medicine, the mortality rate is increasingly under control, resulting in a fairly significant increase in the world population, further reviving the debate on the impact of population dynamics on economic growth and, consequently, on income inequality. It has been established in the light of current population dynamics that the downward trend in overall income inequality observed in previous years will be reversed in the near future (Rougoor & Van Marrewijk, 2015). By using the Gini index, this study has shown that income inequality will fall to its lowest level in 2027 and then rise again. This would be the result of the combination of the strong economic growth of some developing countries (East Asia) that are already rising to the level of the most advanced economy and the rapid population growth in Africa.

Demographic transition can contribute to economic expansion. Indeed, it has been shown that the economic miracle observed in East Asia was due to the demographic transition that has led to the growth of the working age population at a faster rate than population growth, resulting in an increase in per capita productive capacity (Bloom & Williamson, 1998). In the remainder of this section, the issue will be to show how some key variables of demographic transition could influence economic growth as well as income inequalities.

- ✓ ***Fertility***

The decision to have children is generally a result of the opportunity cost and the family's income. In a society where child labour is permitted, families with a relatively low income

(poor) will tend to have many children because they consider children as a potential labour force to support the family and will invest very little in human capital. But relatively wealthy families will focus on quality, not quantity. They will generally have very few children with a very high level of education. This trade-off between the quality and quantity of children induces a non-monotonous relationship between income inequality and fertility and shows that fertility depend on the distribution of population incomes and the private costs of education (Docquier, 2004). As a result, the fertility response to an income shock is positive in countries where a large majority of the population does not have access to education or any other form of investment in human capital and negative in middle-income countries. In addition, when the variation in fertility in the different groups and classes of the population is large, this leads to a reduction in the growth rate of human capital and an increase in inequalities of the next generation because poor families generally constitute a fairly large fraction of the population and invest little in the education of their children (De la Croix & Doepke, 2003). Thus, the difference in fertility between rich and poor negatively affects economic growth. Lower fertility can also have beneficial effects on a country's long-term economic growth by allowing more investment in children's health and education, as it offers parents real opportunities to increase their financial savings (Bloom et Al., 2007). Odedokun and Round (2001) have shown that high inequality could be one of the reasons for the high level of fertility rates in African countries.

- ✓ ***Life expectancy***

The main logic behind economic theory on life expectancy suggests that the longer an individual's life span, the more time the individual has to accumulate. This idea draws its substance from the life cycle theory of Franco Modigliani (1963) explaining how an economic agent chooses his level of consumption and his level of savings over the course of his life. Indeed, at the beginning of adulthood, individuals have low incomes, lower than their consumption function, which implies that they must disregard their savings. During his working life, the individual can repay his debts and build up savings that will be used to finance the consumption of the old age period. It has also been shown that an individual's life expectancy depends strongly on the income level of the family in which the individual lives. Individuals from poor families tend to live shorter lives than those from relatively wealthier families. Under this principle, a drop in mortality rate could affect the distribution of income and then contribute to influence economic growth (Miyazawa , 2006). This author has shown through an accidental bequests model which considers fertility as an endogenous variable that, in the early stages of population ageing, a reduction in the mortality rate of older people promotes economic growth and worsens inter and intra-generational inequalities. An empirical study similar to this one found that an increase in the share of the working-age population leads to an increase in the growth rate of Gross Domestic Product (GDP) per capita with positive effects on poverty reduction. Indeed, on average, an increase of 1 percentage point in the share of the working-age population is linked to a 1.6 percentage point increase in the growth rate of GDP per capita; as well, a reduction of 1 percentage point in the Child Dependency Ratio is associated with a 0.5 percentage point increase in the GDP per capita growth rate and a reduction of 0.34 percentage points in poverty (Cruz & Ahmed, 2018).

Chapter 2. INCOME INEQUALITY MEASURES AND MODEL SPECIFICATION

This chapter will be subdivided into three sections. The first section will briefly describe the main feature of the most commonly used measures of income inequality in the literature, the advantages and the limits of each of them will be provided to justify their use in some studies. Special emphasis will be made on the GINI index in order to explain the motivations which allows us to choose this measure. The second sections will present how improvements in the construction of income inequality indicators have contributed to reducing errors in measuring the estimation of the relationship between economic growth and income inequality and allowed an estimation of this relationship through a Panel model. A brief description of the data we will use in our regression model will be provided as well. The last section will describe the Panel model used in this study.

II.1. Income inequality measures

Several indicators are considered in the literature as a measure of income inequality. These measures, which in general use statistical methods to perform the most objectively possible calculation of the subjective phenomenon, are classified into two categories: objective measures (positive measures) which do not explicitly use a concept of social well-being and those that are based on an explicit formulation of social welfare and losses resulting from unequal distribution (normative measures) (SEN, 1972). Positive measures include range, relative mean deviation, variance, coefficient of variation, income quintile ratios, Hoover index, Gini coefficient, and Theil's entropy measure. Normative measures are presented as Dalton's measure and Atkinson's measure.

Normative measures generally deal with inequalities from the point of view of their effect on social welfare. They take into account normative perspectives such as ethics, welfare or utility levels. The logic behind these measures stem from the notion that any measure will inevitably imply an implicit normative judgment in the sense that there are some distributions that are better for someone than for others (Jorge A., 2011).

- ***The range***

This measure consists in classifying the population according to the relative share of the income of each individual and making the difference between the highest and the lowest income. The range is defined as the gap between the highest and the lowest income.

Consider a distribution of income y_i over n persons, with $i = 1,\ldots\ldots,N$ and μ the average level of income.

$$\sum_{i=1}^{N} y_i = N\mu$$

The relative share of income for an individual i is x_i. It is defined by: $y_i = N\mu x_i$

Thus, the range is given by this expression: $E = (\max_i y_i - \min_i y_i)/\mu$

For the equal distribution of income $\boldsymbol{E = 0}$. If one person receives all the income, then $\boldsymbol{E = N}$. the values of *E* lies in general between 0 and N.

The main disadvantage of this measure is that, it only takes into account the extreme values. Therefore, it ignores the important feature of the contrast that can appear between the extreme values.

- ***The relative mean deviation***

This measure is considered as one of the simplest measure of inequality. Unlike the first measure presented, it takes into account all the values of the distribution. It is defined as the sum of the absolute values of the difference between the income of each individual and the average income views as a proportion of the total income. Its formula is given by:

$$\boldsymbol{M = \sum_{i=1}^{N} |\mu - y_i| / N\mu}$$

For the perfect equality $\boldsymbol{M = 0}$ and when one person held all the income $\boldsymbol{M = 2(N-1)/N}$.

The main trouble with the relative mean deviation is that, it is not at all sensitive to regressive transfers (transfers from poor people below the mean income to richer ones that are also below the mean income). In fact, if, for instance, the average income is $ 100 and an individual (A) who earns $ 20, transfers a portion of his income to another individual (B) with income $ 90, this increase in inequality will not be observed by the relative mean deviation formula, giving a potentially inaccurate result of income inequality for this particular case.

- ***The variance***

The variance is the sum of square of the gap (difference between income of each individual and average income) over the size of the population. It is considered as the statistical measure of dispersion.

$$\boldsymbol{V = \sum_{i=1}^{N} (\mu - y_i)^2 / N}$$

This measure solves the problem of insensitivity to regressive transfers evoked by the relative mean deviation by squaring the difference between average income and real income. The main default of this measure is the fact that this measure depends on the mean level income. As a result, it is possible for a less egalitarian distribution with lower average income to have the same variance than a more egalitarian with a higher average income.

- ***The coefficient of variation***

The coefficient of variation does not have this deficiency related to the mean level income because it is the result of the square root of the variance divided by the average income. One of the qualities of this measure is that it is sensitive to income change at any level and in any sense.

$$\boldsymbol{C = V^{\frac{1}{2}} / \mu}$$

One of the weaknesses of this measure as well as the variance is that, it is computed in relation only to average income, while the more complex measures like the Gini coefficient takes into

account the differences between all the different group of individuals and not just the average (Jorge A., 2011).

- ***Income shares and Income quintile ratios***

This measure is one of the categories of the inequality indices consisting of a comparison between different income groups. This comparison usually focuses on the extreme value of the distribution, for example, the top 10% income over the bottom 10% income or any ratio between the highest and lowest incomes. This class of index was the most used by early economists who worked on the relationship between economic growth and income inequality like Simon Kuznets (1958) on his work on the famous inverted U-shape.

The limits of this measure are various. Firstly, it is sensitive only to the changes occured in the income groups for which it is computed, so it does not describe the overall changes in the entire distribution. Secondly, this measure does not provide an absolute measure of income inequality as it does not fall into an absolute scale of measurement. Finally, it may be biased due to outliers in the distribution and does not weigh the included observations.

- ***Atkinson index***

Atkinson index is a class of inequality measure based on social welfare. It is defined as the level of income per capita for which, if all people benefited from them, would make total welfare exactly equal to the total welfare generated by the actual distribution of income (SEN, 1972). Its theoretical properties are similar to those of Gini index. It is determined from the formula below:

$$A_\varepsilon = \begin{cases} 1 - \left[\frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i}{\bar{y}}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} & si\ \varepsilon \neq 1 \\ 1 - \frac{\prod_{i=1}^{N}\left(y_i^{\frac{1}{N}}\right)}{\bar{y}} & si\ \varepsilon = 1 \end{cases}$$

Where, ε is a weighting parameter which measures aversion to inequality. For any distribution of income, the value of this index must lie between 0 and 1.

"*The main disadvantage of this measure is that, maximizing utilities does not take into account the distribution within the individuals as well as the transfers that may occur among them, thus it does not provide a useful tool for evaluating inequality and its dynamics within groups*" (Jorge A., 2011).

- ***Theil's entropy measure***

It is one of the measure of income inequality belonging to the notion of entropy and derives from the information theory. The generalized formula of this measure is given by:

$$GE(\propto) = \frac{1}{\propto(\propto -1)}\left[\frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i}{\bar{y}}\right)^{\propto} - 1\right]$$

Where:

- $\boldsymbol{\alpha}$ represent the weight given to the distances between incomes at different parts of the income distribution. It can take any real value. For lower values of α, the index is more sensitive to changes in the lower tail of the distribution, and for higher values, the index is more sensitive to changes that affect the upper tail;
- $\bar{y}$ is income (expenditure) per capita;

In most study on income distribution, $\boldsymbol{\alpha}$ is equal to ***1***. The formula derive from this is:

$$T_T = GE(\alpha = 1) = \frac{1}{N}\sum_{i=1}^{N}(\frac{y_i}{\bar{y}} * \ln(\frac{y_i}{\bar{y}}))$$

The value of this index varies between 0 (higher level of inequality or maximum redundancy) and 1 (total equality).

One of the main feature of this index is its property of decomposability which allows him to break down a country's index of income inequality into regional sub-indexes (according to the geographical structure of the country) in order to obtain a more detailed vision of the phenomenon. This property allows also to aggregate the sub-indexes over groups into a general index. This index satisfies Pigou-Dalton transfer condition.

But the weakness of this measure is that "*it is an arbitrary formula, and the average of the logarithms of the reciprocals of income shares weighted by income shares is not a measure that is exactly overflowing with intuitive sense*" (SEN, 1972).

- ***The Hoover index***

This measure is defined as the proportion of income that should be redistributed from the top half of the income distribution to the bottom half one, in order to achieve maximum distribution equality. Its value lies from 0 to 1, where 0 represent the perfect equality (no redistribution is necessary) and 1 the maximum income inequality (all the income would be redistributed).

The formula of this measure is as given:

$$H = \frac{1}{2}\sum_{i=1}^{N}\left|\frac{E_i}{E_{total}} - \frac{A_i}{A_{total}}\right|$$

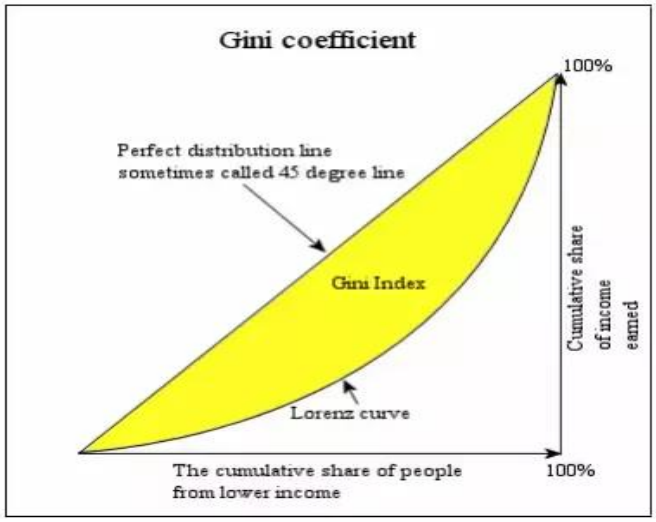
Where:

- E_i is the income of the i^{st} quintile;
- N is the number of quintile;
- A_i is the size of the i^{st} quintile;
- E_{total} is the sum of income for all quintile;
- A_{total} is the total size of the population.

- ***The Gini index***

The GINI index was developed by an Italian Statistician Corrado Gini on his published paper in 1912 "Variability and Mutability". It is one of the most widely used measure of income distribution between individuals and households. It is define as "*the "area between a given Lorenz curve and the Lorenz curve for an economy in which everyone receives the same among of income expressed as a proportion of the area under the curve for the equal distribution of income*" (Dorfman, 1979). Lorenz curve is a graphical representation of the distribution of income or wealth among population. It shows, by classifying the population from the poorest to the richest, the cumulated percentage of income (or expenditure) attributable to each share of the population. The value of Gini coefficient varies between 0 (perfect equality which means that 0% of the population enjoy 0% of the income) and 1 (complete inequality which means that one person holds the totality of income in the society). The diagonal of the Lorenz curve represent the perfect distribution of income.

Figure 1: Graphical representation of Gini index



Source: (Nithesh , 2019)

The more general and simplified formula of the Gini coefficient was developed by Deaton in 1997 which is given by this expression:

$$Gini = \frac{N+1}{N-1} - \frac{2}{N(N-1)\mu}\left(\sum_{i=1}^{N} P_i\, Y_i\right)$$

Where $\boldsymbol{P_i}$ is the income rank $\boldsymbol{P}$ of an individual $\boldsymbol{i}$, with an income of $\boldsymbol{Y_i}$, in a way that the poorest individuals receive a rank of $\boldsymbol{N}$ and the richest of $\boldsymbol{1}$.

This measure is the most widely used in the literature on income inequality studies because it is straightforward index, easy to understand, not complicated to compute, its datasets are available and easy to represent by the Lorenz curve. This approach also seems more direct than the indices presented above, by verifying the quality of sensitivity to transfers from the rich to the poor at all levels (SEN, 1972). Another advantage of this measure is that it can be used to

compare the income distributions of different population groups, whether they are countries, regions, or any other geographical and ethnical area.

Moreover, the Gini Index is unique in the way that, it satisfies the four important principles that any measure of inequality should meet to be considered a reliable measure (Jorge A., 2011), such as:

- ✓ ***The scale independence***: it does not consider the size of the economy or whether it is a rich or poor country. In fact, if the level of income increases by a fixed amount, then the overall value of the inequality measure will stay unchanged;
- ✓ ***Population size independence***: means that the Gini coefficient should not be influenced by the size of the population in the country. In fact, if population changes, the measure should not change, ceteris paribus;
- ✓ ***The anonymity principle***: it does not matter who are the higher or lower earners;
- ✓ ***Pigou-Dalton sensitivity principle or transfer principle:*** if income is transferred from a poor individual to a richer one, it should be translated into an increase in the measure of inequality, independently to the size of the transfer or the relative position of the poor regarding to the rich.

Nevertheless, Gini coefficient presents some limits such as:

- For different sets of distributions, its value can be the same. In fact, the Lorenz curve can have different shapes that capture the same area under the curve and thus reflect the same Gini coefficient;
- Gini coefficient is observed at a fix period or point of time and its value does not give information for changes in income over the life of a person. On that way, Gini coefficient fails to account a long time change in income or age distribution and mobility within income;
- The total Gini index of the society cannot be easily decomposable across group as the sum of Gini coefficients of its subgroups.

II.2. Data

Income inequality is considered to be one of the indicators subject to measurement errors. The main problem with this indicator is that it comes from cross-national surveys where the definition of key variables and the choice of the degree of precision in data collection generally differ from one country to another (Forbes, 2000). In fact, coverage is generally limited (the study is sometimes focused on a particular area that is not representative of the entire population of the country), the choice of target variable is different (income versus final consumption expenditure) and the observation unit is often not the same (household or individual). Forbes (2000) reveals that most empirical studies acknowledge that inequality statistics are prone to measurement errors, and also believes that since there is no good instrument for inequality, it is difficult to remedy this problem.

Deininger and Squire (1996) are the ones who contributed for the improvements in income inequality data used in most of the research today. These authors have been smart enough to

build a database that brings together a more coherent and comprehensive data set on inequality. Their approach initially consisted in collecting all possible variables on the distribution of income. Subsequently, observations were filtered according to the following three minimum quality standards: the data must be based on household surveys, the population covered must be representative of the whole country, and the measurement of income must be complete, i.e. also include income from self-employment, non-wage income and non-monetary income. As the results of this work, the compilation of a data set containing a fairly large number of observations and covering a larger number of countries, which is intended not only to minimize the error in measuring inequality and any bias coefficients, but also to increase the effectiveness of the estimates (Forbes, 2000).

The results of the Deininger and Squire (1996) work enabled the World Bank to develop the current World Income Inequality Database (WIID) which can be used freely by users. The WIID undergone several revisions and is now in its fourth revision. The informations of economic inequalities (Gini coefficients and distribution shares) provided by this database are extracted from the historical databases of the World Bank, the Asian Development Bank and UNICEF. They are also based on the main databases currently available, such as the Luxembourg Income Study (LIS), a socio-economic database for Latin America and Caribbean (SEDLAC), the Economic Commission for Latin America and Caribbean (ECLAC), Eurostat, OECD and PopalNet (World Bank), as well as national statistical offices and a wide range of independent research documents. This database contains ***11,101*** observations covering the period from before 1960 up to 2017.

In this study, the indicators for measuring income inequality (Gini Index and income share) were derived from WIID4. This database gives us access to indicators on income inequalities of African countries over a relatively long period of time. For comparative purposes, the Gini index considered is based on consumption. In fact, according to the economic literature, consumption is less susceptible to variations relative to income and it is difficult to collect accurate income data in developing countries in general and in Africa in particular because the economy is mainly driven by agricultural activity. Moreover, due to the lack of data, we only select countries with values over at least two consecutive periods and we pool the data over a 5-year period from 1990 to 2015. The Gini coefficients used are those that corresponded as much as possible to the Gini index observed in the WIID4 database for the years 1990, 1995, 2000, 2005, 2010 and 2015. In the absence of information at these periods, we used the value of the closest available year as suggested by De la Croix and Doepke (2003). At the end of the process, 39 countries were selected.

Other sources of information have also been used for this study: the World Development Indicator Database for the World Bank, the IMF database on International Financial Statistics, the Worldwide Governance Indicators and the Worldwide Governance Indicators. These sources enabled us to obtain demographic data (fertility, populations, mortality, and migration) as well as socio-economic data (gross domestic product per capita, access to education, access to the credit market, international trade, etc.). The table below summarizes all the information of the variables used in this study.

Table 1: Data definition and source

Variables	***Definition***	***Sources***
Inequality (G)	Income Inequality measure by GINI INDEX, PPP (constant 2011 international $)	World Income Inequality Database (WIID4)
Q1, Q2 and Q5	Share of income held respectively by the poorest 20%, the poorest 40% and the 20% of the richest	World Development Indicator (WDI)
Kuznets_ratio	the ratio of the share of income going to the upper 20% and the share of income going to the lowest 40%	World Development Indicator (WDI)
Income (lnY)	the natural logarithm of real Gross Domestic Product per capita, PPP (constant 2011 international $)	World Development Indicator (WDI)
Population (Ln_Population)	Total population	World Development Indicator (WDI)
Fertility	Fertility rate, total (births per woman)	World Development Indicator (WDI)
Mortality	Infant Mortality rate (per 1,000 live births)	World Development Indicator (WDI)
Life_exp	Life expectancy at birth, total (years)	World Development Indicator (WDI)
Migration (LnM)	the natural logarithm of The number of net inflow of migrant at mid-year (both sexes)	United Nations
Primary*	Gross School Enrolment in Primary Education (%)	World Development Indicator (WDI)
Secondary*	Gross School Enrolment in Secondary Education (%)	World Development Indicator (WDI)
Tertiary*	Gross School Enrolment in Tertiary Education (%)	World Development Indicator (WDI)
Yr_schooling	Average Years of Schooling in the Primary and Secondary Education	World Development Indicator (WDI)
Trade	Imports + Exports of goods and services (% of GDP)	World Development Indicator (WDI)
Investment	Gross fixed capital formation (% of GDP)	World Development Indicator (WDI)
Expenditure	Gross national expenditure (% of GDP)	World Development Indicator (WDI)
GFCE	General government final consumption expenditure (% of GDP)	World Development Indicator (WDI)
FCE	Final consumption expenditure (% of GDP)	World Development Indicator (WDI)
FDI	Foreign direct investment, net inflows (% of GDP)	World Development Indicator (WDI)
Saving_rate	Gross domestic savings (% of GDP)	World Development Indicator (WDI)
Inflation	Annual growth rate of the Consumer Price Index (%)	World Development Indicator (WDI)
credit	Credit Market Imperfection measure by Private credit by deposit money banks and other financial institutions to GDP (%)	International Financial Statistics (IFS), International Monetary Fund (IMF)
Pol_Stab	Social unrest measure by the Estimation of Political Stability and Absence of Violence/Terrorism	The Worldwide Governance Indicators, 2018 Update
Urbanization	Urban population (% of total)	World Development Indicator (WDI)

* ***Gross enrolment ratio*** is a statistical measure used in the education sector, and formerly by the UN in its Education Index, to determine the number of students enrolled in school at several different grade levels (primary, secondary, tertiary, etc.). This ratio is used to show the number of students who live in the country compared to those who qualify for the particular grade level. It is defined as the total enrolment within a country 'in a specific level of education, regardless of age, expressed as a percentage of the population in the official age group corresponding to this level of education. This ratio can be over 100% as it includes students who may be older or younger than the official age group. Indeed, it includes students who are repeating a grade, those who enrolled late and are older than their classmates, or those who advanced quickly and are younger than their classmates.

II.3. Model specification

This section presents an econometric model that will allow us to establish the relationship between economic growth and income inequality as well as to determine the variables that may influence the impact of income inequality on economic growth. Until the end of the 20th century, previous work on the relationship between economic growth and inequality focused on a static analysis of the phenomenon due to the unavailability of data from cross-sectional surveys on income inequality for some countries. Indeed, the available data did not have a time dimension large enough to use the panel and while these data were used they created selection and bias errors.

Moreover, in the past, several authors have used a cross-sectional regression model of growth to find the channels through which income inequality may affect economic growth. However, it is important to note that this model has been criticized by the literature. One of the criticisms of this regression method is that cross-sectional estimates do not take into account country-specific characteristics, such as differences in technology, tastes, climate or institutions, whose omission may distort the coefficient of the explanatory variables. In addition, it does not adequately deal with the treatment of some explanatory variables that should be considered endogenous according to theory (Castelló-Climent, 2010). Given that these considerations are very important in models linking economic growth and income inequality, Forbes (2000), Castelló-Climent (2010) and Gründler and Sheuermeyer (2018) suggested the use of the Generalized Moment Method to overcome these weaknesses. As a result, our initial equation is as follows:

$$\ln y_{i,t} = \beta \ln y_{i,t-\tau} + \gamma G_{i,t} + \delta X_{i,t} + \varepsilon_t + \alpha_i + \theta_{it} \quad (1)$$

Where $y_{i,t}$ is the real GDP per capita in country i measured at year t, τ is a 5-year span, $G_{i,t-\tau}$ measures income inequality in country i lagged 5 years, β, γ and δ represent the parameters of interest that are estimated, ε_t is a time-specific effect, α_i stands for specific characteristics of every country that are constant over time, and θ_{it} collects the error term that varies across countries and over time. In order to reduce any omitted variable bias, matrix $X_{i,t-\tau}$ includes k explanatory variables, suggested in the literature as important determinants of the growth rates. The country dummy variables are included to control for the time-invariant omitted variable bias, and the period dummy variables are included to control for aggregate shocks, which could affect aggregate growth at any period but are not captured by the explanatory variables.

a) Fixed/random effect specification

The equation (1) can easily be estimated by an OLS fixed/random effect. However, working with macroeconomic data, an unobserved heterogeneity of country fixed effects as we mentioned previously often generates biases if it is not properly accounted for. A simple way to overcome this problem would be through the use of an intra-group estimator or a first difference approach as suggested (Gründler & Scheuermeyer, 2018). Nevertheless, the intra-group estimator is likely to be biased for the estimation of a dynamic panel, while the transformations of the first difference neglect the cross-sectional information contained in the

data and amplify the gaps in the unbalanced panels. Consequently, efficiency gains are possible when estimating the model in a Generalized Method of Moments (GMM) context.

b) Arellano and Bond specification

A common approach to account for both unobserved heterogeneity and endogeneity in models with lagged dependent variables is the GMM estimator proposed by Arellano and Bond (1991). Define that $\Delta k \equiv (k_{it} - k_{it-1})$ and $\Delta_2 k \equiv (k_{it-1} - k_{it-2})$, the basic idea of this approach is to adjust Equation (1) to:

$$\Delta \ln y = \beta \Delta_2 lny + \gamma \Delta G + \delta \Delta X + \Delta \varepsilon + \Delta \theta \quad (2)$$

This model use sufficiently lagged values of y_{it}, G_{it} and X_{it} as instruments for the first-differences. However, the differential equation (2) deals with the inherent endogeneity by transforming the data to remove the fixed effects. This disadvantage is particularly serious in the context of inequality studies, as most of the variation in inequality data comes from the cross-sectional rather than the time dimension (Gründler & Scheuermeyer, 2018). In addition, first difference transformation magnifies gaps in unbalanced panels.

According to Blundell and Bond (1998) and Bond et al (2001), the GMM difference estimator can produce poor quality outcomes if time series are persistent or if the relative variance of the fixe effects α_i is high. This is because the staggered levels in these cases only provide weak instruments for the first subsequent differences, resulting in a large finite sample bias.

c) Blundell and Bond specification

In order to solve the problem of the GMM difference, Blundell and Bond (1998) provide a tool to overcome this bias on the assumption that there is a slight stationary restriction of the initial conditions of the underlying data generation process. This assumption is $E(\alpha_i \Delta y_{i2}) = 0$, which holds when the process is mean stationary, i.e. $y_{i1} = \alpha_i/(1-\beta) + v_i$ with $E(v_i) = E(v_i \alpha_i) = 0$.

In this case, additional orthogonality conditions for the level of the equation (1) can be exploited, using the offset values of Δk and $\Delta_2 k$ as instruments. In this way, the GMM system retains some cross-sectional information by levels and exploits the information contained in the data more efficiently.

Tests were proposed by Roodman (2009) to detect possible violations of these assumptions. These are Sargan, Hansen or difference in Hansen tests: they assess the validity of the additional moment restrictions for each of the GMM system regressions. The system GMM estimator uses lagged variables as internal instruments for endogenous regressors.

One of the main problems of the GMM System is the large number of instruments it generates since those instruments are by definition automatically provided by the lagged variables of the model as well as the difference of the dependent variable and the endogenous variables. To

solve this problem, as suggested by Roodman (2009), we use a collapsed instrument matrix. Intuitively, this matrix contains an instrument for each offset and instrumentation variable.

Given the advantages of the GMM system proposed by Blundell and Bond since this method provides good quality of results, we will use this approach to generate our results. The specification we have chosen can be estimated by using GMM in one or two steps. While one-step GMM estimators use weighting matrices independent of the estimated parameters, two-step GMM estimators weight current conditions by a consistent estimation of their covariance matrix. In that way, all our specification should be with two-step GMM estimators.

To run our model, we used the ***Xtdpdsys*** function (the Arrelano-Bober/Blundel-Bond function for estimating dynamic panel data) implemented in the Stata software.

To assess the quality of our results, the following elements and tests were used. The first is Wald's chi 2 or F-statistics test to determine the overall significance of the model. The second is the compliance with the rule of Thumb which require to keep the number of instruments lower than the number of groups; in our case the number of countries. The third test is the first and second auto-correlation test. The latter test assumes that a first-order auto-correlation should be confirmed because of the lagged dependent variable and the second auto-correlation test rejected. Finally, the Sargan[2] test should confirm the validity of the instruments used. The Error Standard is also proposed for each estimated coefficient to show the average distance that the observed values fall from the regression line.

[2] Since we do not have the Xtabond2 function proposed by Roodman (2009) which generates the Hansen and Hansen difference tests which are supposed to be much more powerful, we used Sargan's test.

Part 2: DESCRIPTIVE ANALYSIS AND ESTIMATIONS

Chapter 3. EVOLUTION OF INCOME INEQUALITY IN AFRICA

In this chapter we analyse the evolution of income inequality between 1980 and 2015. We also describe the data from the selected sample. At the end of this chapter some correlation between Gini index and some socio-economic variable are investigated.

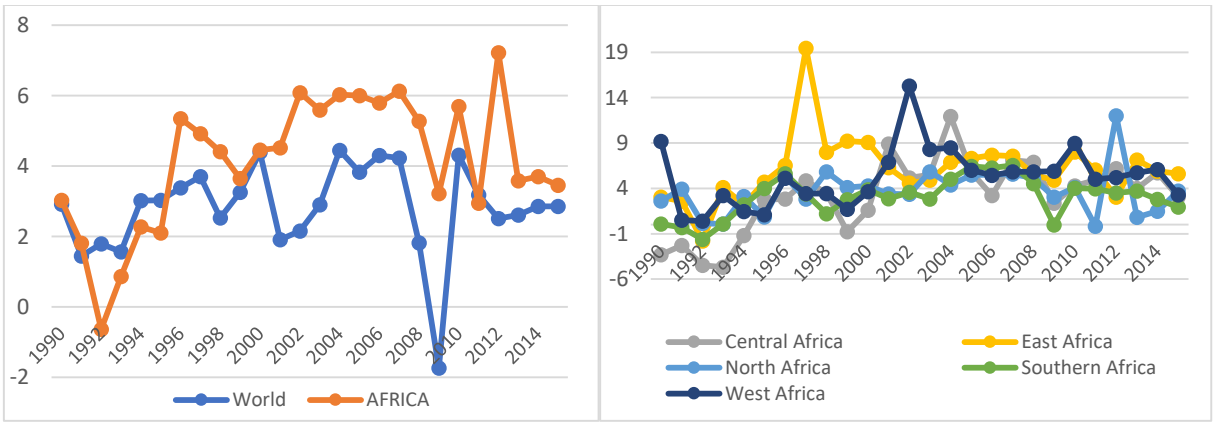
III.1. General overviews of income inequality in Africa over the period 1980-2015[3]

This section discusses the changes in income inequality over the past few decades. In the first time evolution of economic growth is provide in order to show the link with income inequality variables.

III.1.1.Economic and population growth in Africa

The economic activity in Africa experienced a remarkable evolution between 1992 and 2012, going from a negative growth rate of the Gross Domestic Product (-0.6%) in 1992 to more than 7% in 2012. The most stable period of economic activity was between 2002 and 2007, when GDP growth averaged 6% over the period. This period of stability corresponds to the years during which some countries were admitted to the Heavily Indebted Poor Countries initiative, which lead to the alleviation in their previous debt. Moreover, just after the world financial crisis in 2008, there was a very high volatility in the GDP growth rate, which in turn led to a slowdown in economic activity. Indeed, the GDP growth rate felt from 6.1% in 2007 to 3.5% in 2015. The high volatility is attributed to a combination of several factors such as falling commodity prices, socio-political crises in North Africa (Arab Spring) and increased attacks by Islamic movements (Boko Haram).

Figure 2: Annual real GDP growth rate (%)



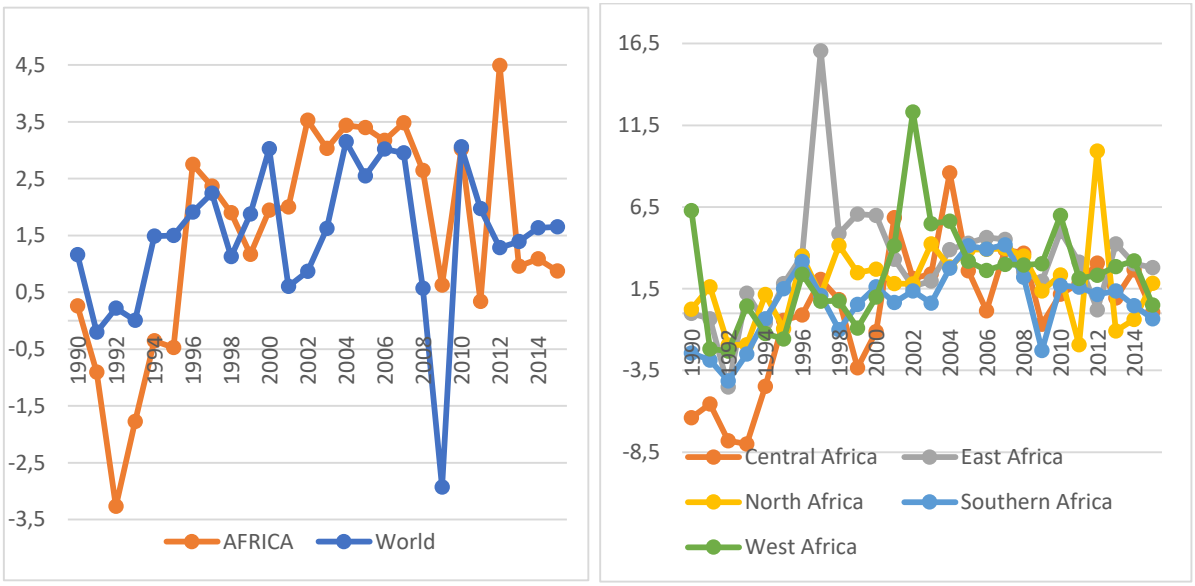
Source: AfDB and WID, 2018

The per capita GDP growth rate follows the same pattern as the GDP growth rate. Over the observation period, these two growth rates for Africa are generally higher than the average of the world growth rates. There is a very strong disparity in the annual economic growth for the different regions of Africa. The Northern and Southern African regions are characterized by

[3] This section includes GDP and GDP per capita data for all African countries, while the Gini index, income shares and pseudo Kuznets data for 50 African countries (countries such as Equatorial Guinea, Eritrea, Libya and Somalia have no value on these indicators)

very low volatility in GDP growth rates, unlike other regions of Africa. This is normal given that the middle highest income countries in Africa are found in these regions.

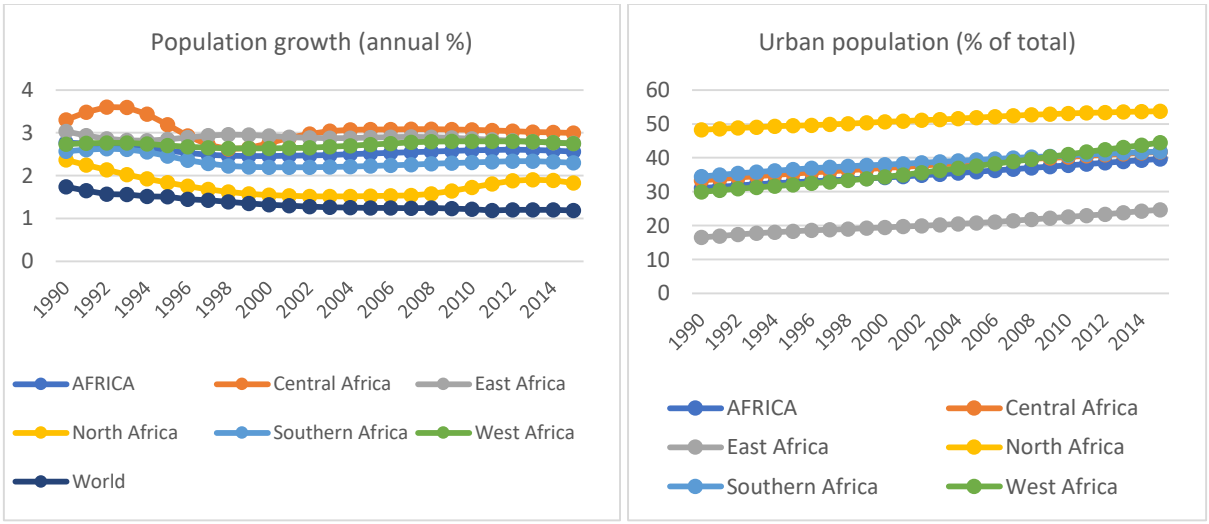
Figure 3: Annual real per Capita GDP growth rate (%)



Source: WID, 2018

The size of the African population has sharply increased from 478 million in 1980 to 1.2 billion in 2015 with an average population growth rate near 2.6% per year. The annual growth rate of the African population has almost double that of the world population over the period 1990-2015. This growth rate is relatively small for Northern and Southern Africa regions and large in the other regions. This increase in the African population has led to a very high level of urbanization. The proportion of people living in urban areas has increased from 31% in 1990 to nearly 40% in 2015. The urbanization rate is very relatively high in Northern Africa (54% in 2015) and particularly low in Eastern Africa (25% in 2015).

Figure 4: Annual population growth rate in Africa over 1990-2015

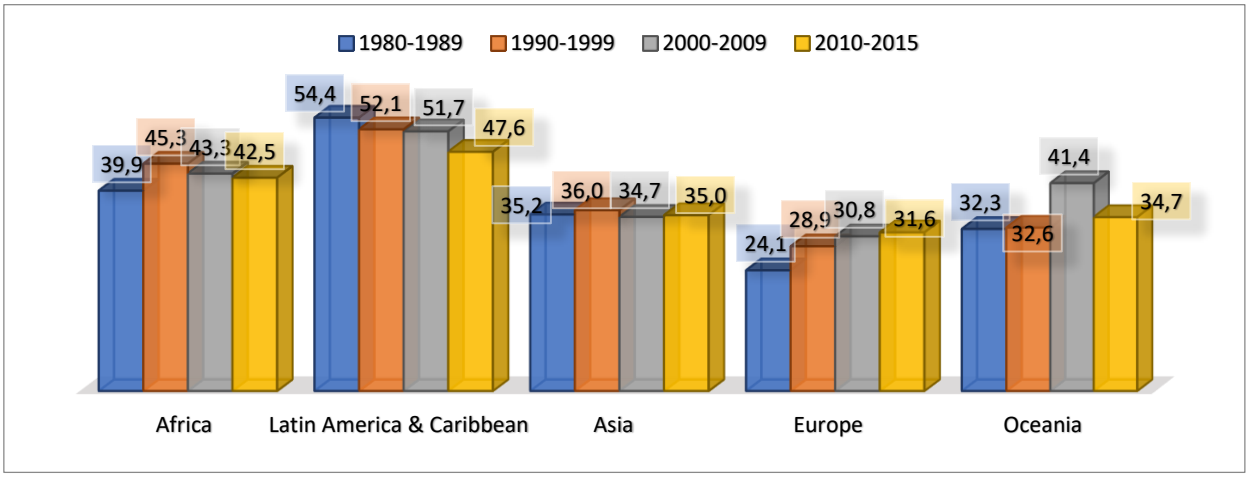


Source: WID, 2018

III.1.2.GINI index

The evolution of GINI index over the period 1980-2015, shows that it has gradually declined since the beginning of the 20th century. This drop, which is estimated at 2.8%, corresponds to the period of economic slowdown in Africa (early 2000s up to 2015), as the Figure 2 above shows. In addition, during periods of rapid economic growth (1990-1999), the GINI index increased significantly from 39.9% over the period 1980-89 to 45.3% over the period 1990-99. Both situations suggest a positive relationship between GDP per capita and the GINI index. Moreover, it can be noticed that in spite of the decline in the GINI index since the early 2000s, its value over the period 2000-2015 remains higher than the value it had over the period 1980-1989.

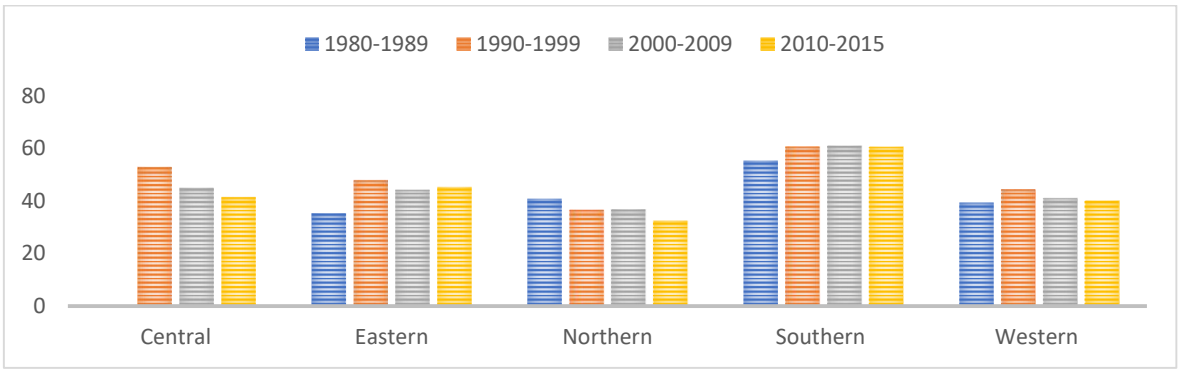
Figure 5: Evolution of world regional GINI index over 1980-2015



Source: WIID4 and our estimation, 2018

Compared to the rest of the world, the GINI index in Africa is the second highest just behind Latin America and the Caribbean. The region in the world with relatively low initial GINI index levels (Europe and Oceania) have seen an increase in this index while those with high initial index levels (Africa, Asia and Latin America and the Caribbean) have experienced a decrease in this index.

Figure 6: Evolution of African sub regional GINI index over 1980-2015

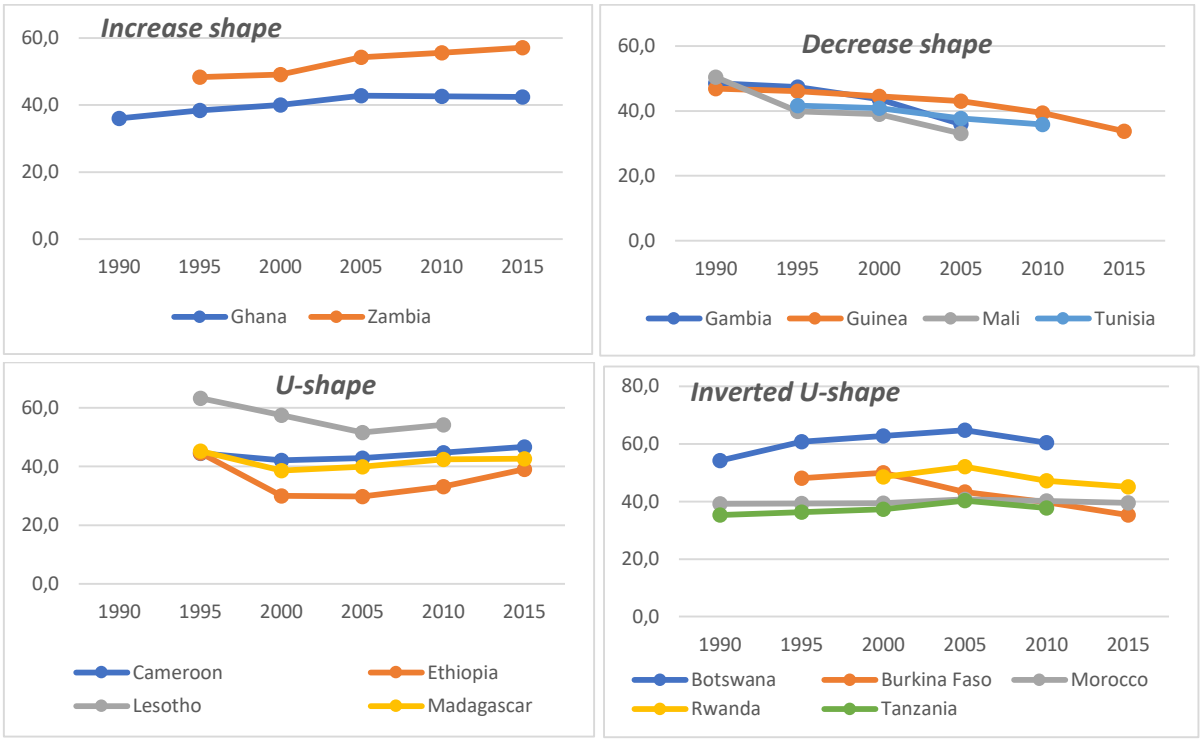


Source: WIID4 and our estimation, 2018

For the five sub regions of Africa, except Eastern and Southern which have seen an increasing change, the pattern is rather downward in the other regions. The southern African region has the highest levels of income inequality and the Northern African region has the lowest levels.

The evolution of GINI index among each country take at individual level over the period 1990-2015 is depicted by five pattern such as an increasing pattern (Ghana, Zambi), a decreasing pattern (Gambia, Guinea, Mali, Tunisia), a U-shaped pattern (Cameroon, Ethiopia, Lesotho, Madagascar), an inverted U-shaped pattern (Botswana, Burkina Faso, Morocco, Rwanda, Tanzania) and non-uniform shape (Egypt, South Africa, Niger).

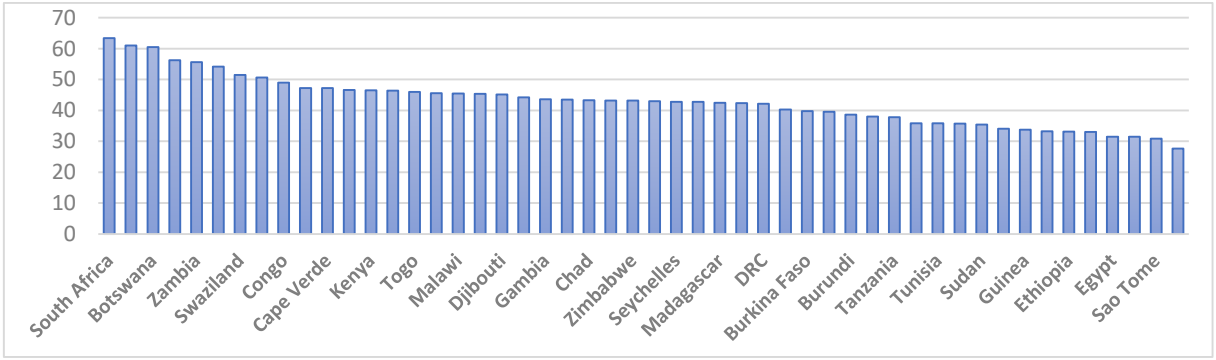
Figure 7: Evolution of income inequality within country over the period 1990-2015



Source: WIID4 and our estimation, 2018

There is a very wide disparity in the distribution of income inequalities across countries, fickle from the highest levels in South Africa (63.38), Namibia (60.97) and Botswana (60.46) to the lowest levels in Niger (31.45), Sao Tomé and Principle (30.82) and Algeria (27.62).

Figure 8: Distribution of Income inequality in Africa

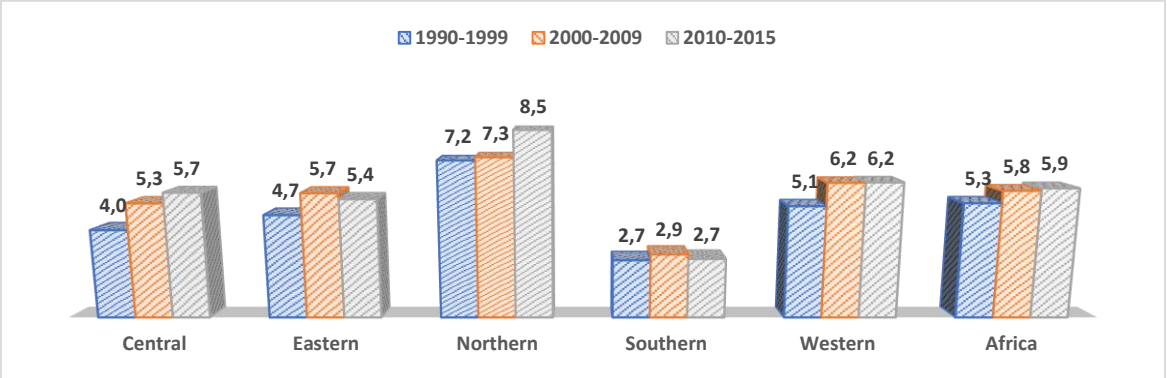


Source: WIID4, 2018

III.1.3.Income share

In this section, we just focused on the first, second and the fifth quintile which represent respectively the share of income held by the poorest 20%, the poorest 40% and the richest 20%. The analysis of these indicators over the period 1990-2015 reveals a significant improvement in the standard of living of the African population. Indeed, gradually over time, the poor earn more income and the share of income held by the rich declines.

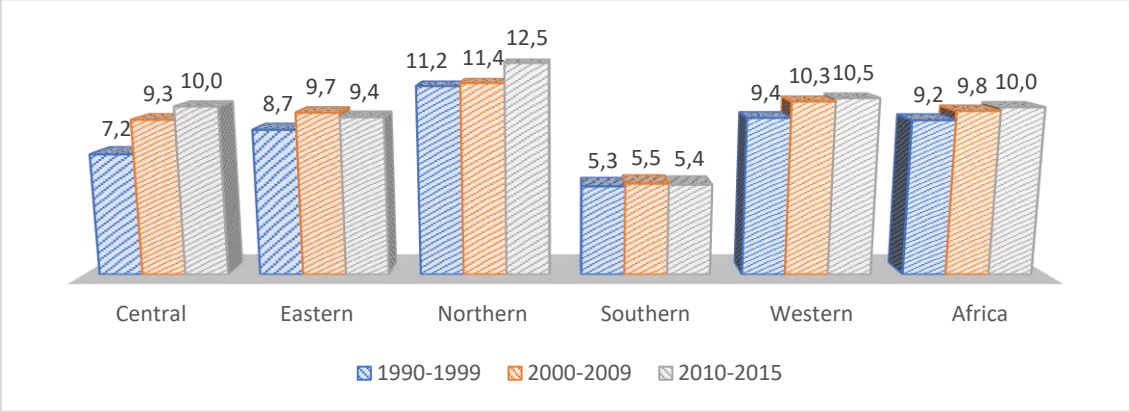
Figure 9: Income share held by 20% of the poorest



Source: WIID4, 2018

The income share held by 20% of the poor population increased by 11% between 1990-1999 and 2010-2015. This significant improvement in the standard of living of the poorest population group is attributable to the Central, North and West African sub-regions, which experienced respectively an increase of 42%, 18% and 22%. The southern part of Africa remains where the poorest 20% are the least well-off (as they hold on average less than 2.8% of total income over the period) while in the northern part the poorest 20% hold relatively large share of income (they hold on average 7.7% of total income over the period).

Figure 10: Income share held by 40% of the poorest

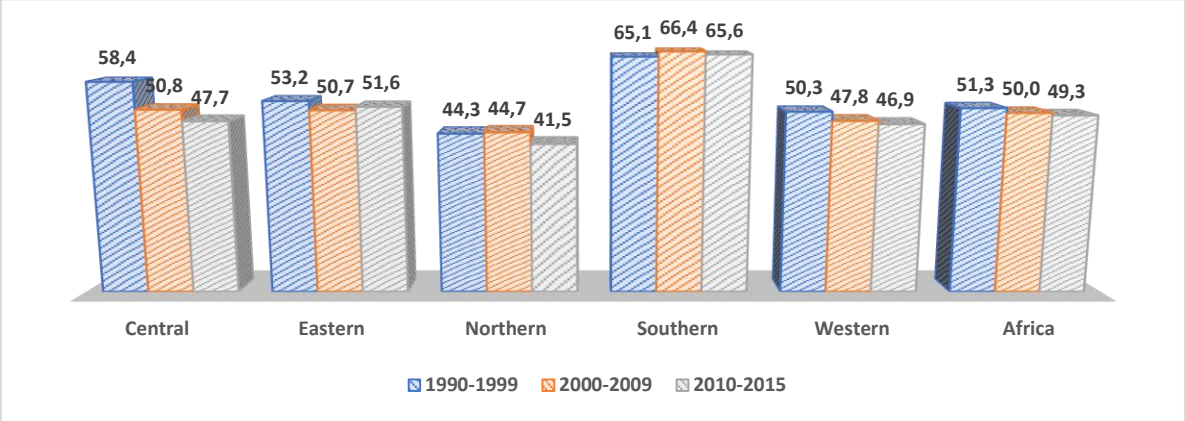


Source: WIID4, 2018

The 40% of the poorest population in Africa holds only 10% of total income over the period 2010-2015 as shown in Figure 10 above. Aside from the Southern part of Africa where the share of income held by the poorest 40% remained almost stable over the observation period, the other sub regions of Africa have made an improvement in the distribution of income in favor of this group of the population. The highest performance was achieved in Central Africa, where

the income share held by the poorest 40% of the population increased from 7.2% over the period 1990-1999 to 10.0% over the period 2010-2015.

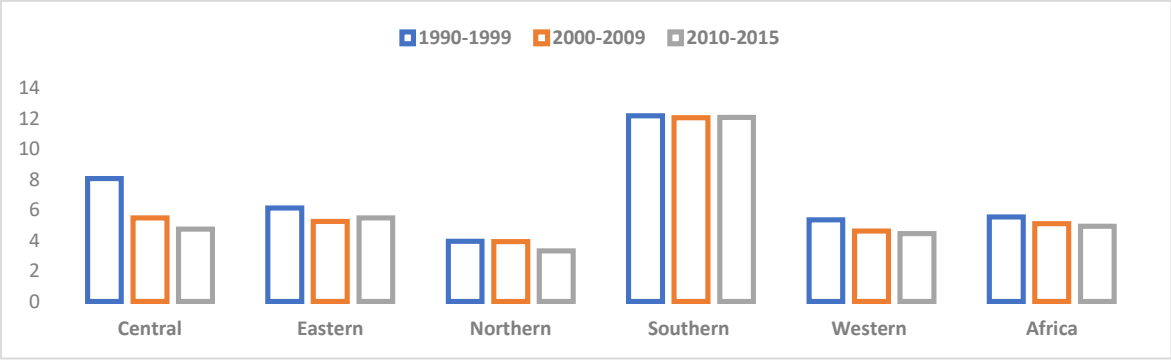
Figure 11: Income share held by 20% of the richest



Source: WIID4, 2018

Compared to the initial period (1990-1999), the share of income held by the richest 20% of the population is decreasing significantly in all regions of Africa except the Southern region. Over the observation period, 50% of Africa's wealth is on average held by the richest 20% of the population.

Figure 12: Pseudo Kuznets Ratio over 1990-2015



Source: WIID4, 2018

The Pseudo Kuznets ratio reflects the high level of income inequality in Africa. This ratio reveals that, over the period 1990-2015, the income held by the richest 20% of the population was on average five times higher than that of the poorest 40% of the population. It is also observed that the gap between rich and poor tends to narrow over time. The gap between rich and poor is very pronounced in southern Africa (the income held by the richest 20% is more than 12 times higher than that of the poorest 40%). Central Africa is the region of Africa that has made remarkable progress in reducing income inequalities. Indeed, between 1990-99 and 2010-15, the gaps between rich and poor were almost halved.

III.2. Descriptive analysis for the selected data sample

This section describes our data sample on which the econometric results are based, presents the evolution of the variables used over the observation period and detects their possible correlation with the Gini index.

III.2.1. Brief summary of the data

The data used in this work cover 39 countries from all five sub-regions of Africa over the period 1990-2015. Six time periods have been defined for analysis purposes: 1990, 1995, 2000, 2005, 2010 and 2015. The information on the Gini index and income share for these periods is closer to the observation year. The values of the socio-economic variables for the six periods were defined as follows in order to contain the temporal effects (volatility) that could appear as a result of an observed shock during the observation year:

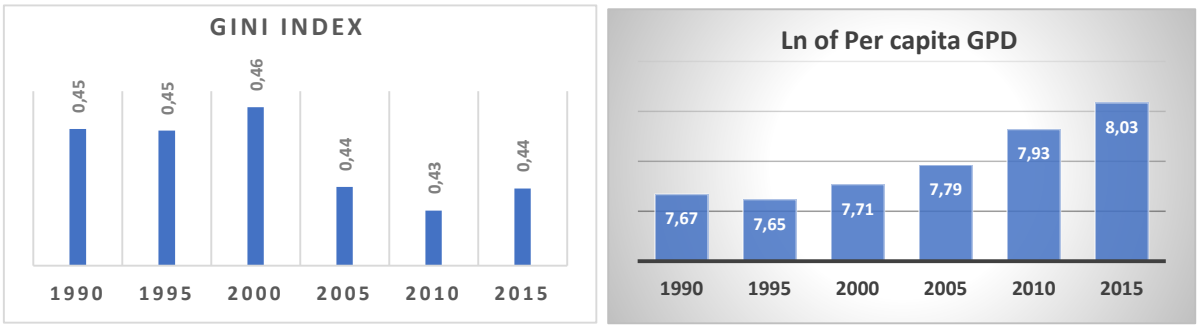
- ✓ 1990 is the initial year of observation (no change);
- ✓ the value observed in 1995, 2000, 2005, 2010 and 2015 corresponds respectively to the average value over the period 1991-1995, 1996-2000, 2001-2005, 2006-2010 and 2010-2015.

The selected variables are considered by the economic literature to be the main determinants of economic growth. These variables were proposed as well by Gründler & Scheuermeyer (2018) as the channels through which income inequality would affect a country's economic activity. The main statistics (number of observations, mean, standard deviation, minimum and maximum) of all these variables over the six time periods are displayed clearly in Table 6 in the Appendix.

III.2.3. Descriptive statistics of the indicators over the period 1990-2015

The information from the 39 selected countries show that Gini index follow a non-linear pattern while per capita GDP has increased between 1990 and 2015. Gini index was relatively high until early 2000 and recently it is declining.

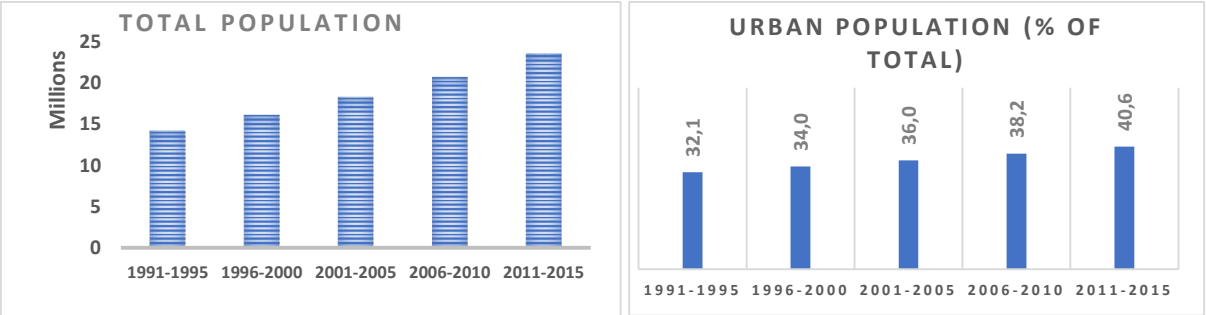
Figure 13: Evolution of Gini Index and per capita GDP



Source: WIID4, 2018

We also observe a rapid increase in the population size with an increase in urbanisation between 1991 and 2015.

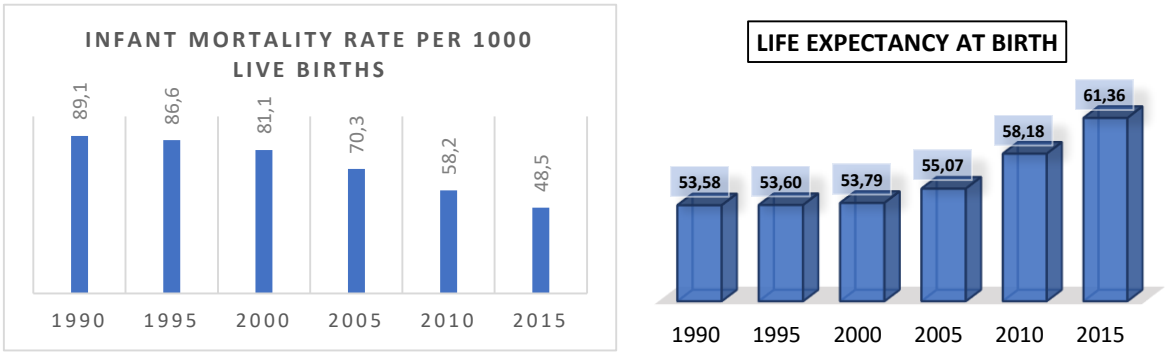
Figure 14: Population and Urbanisation



Source: WIID4, 2018

This increase in population is mainly the result of a combination of two factors, which include a reduction in infant mortality and progress in health, reflected here in a population with an increasingly long life span. Indeed, life expectancy increased by almost 10 years between 1991-1995 and 2011-2015, from 53.6 to 61.4. In addition, infant mortality was nearly halved between 1991-95 and 2011-15.

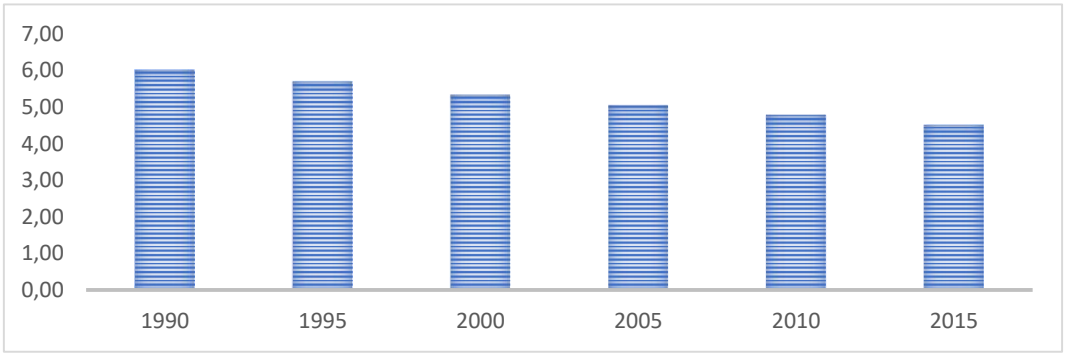
Figure 15: Evolution of life expectancy at birth and infant mortality over the period 1980-2015



Source: WIID4, 2018

The number of births per woman has decreased over the observation period, although it remains high compared to other regions of the world (more than 5 births per women on average).

Figure 16: Evolution Fertility rate

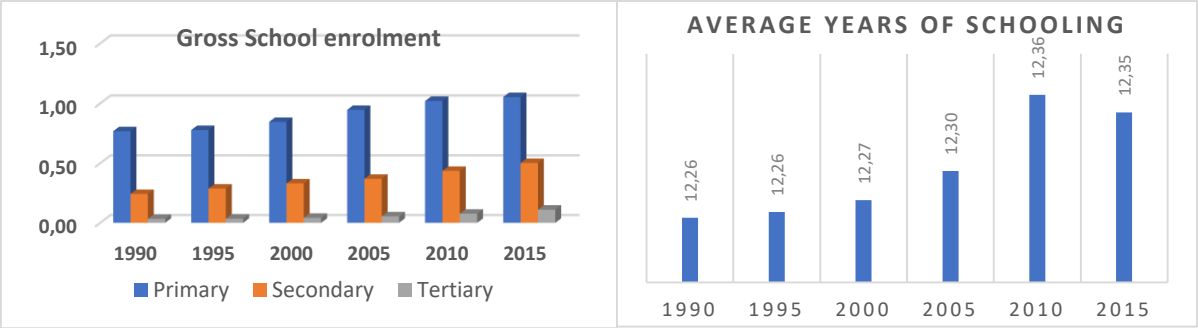


Source: WIID4, 2018

Our sample of data suggests a significant improvement in the level of education system over the past 25 years. In fact, the gross school enrolment in primary, secondary and tertiary level of education has increased significantly between 1990 and 2015. However, it is noted that students

in primary and secondary spend more time in the education system. In fact, although the average year of schooling spent in primary and secondary education decreased between 2005-2010 and 2010-2015, there was a significant increase between 1990 and 2015.

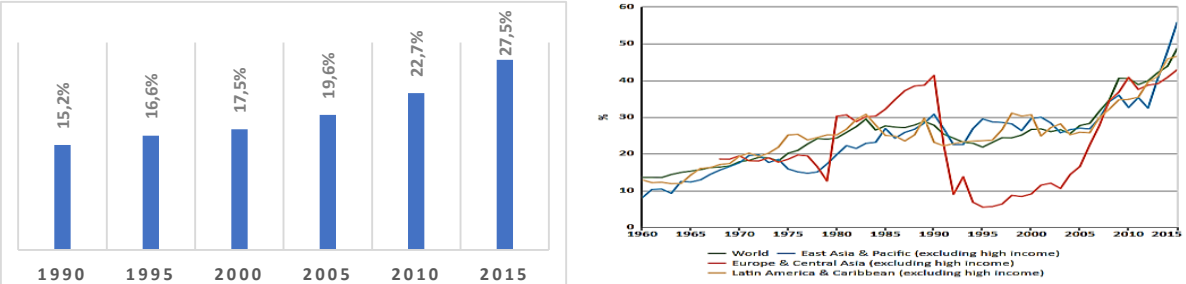
Figure 17: Gross School enrolment in primary Education



Source: WIID4, 2018

Access to the credit market in Africa, although it seems to have improved significantly between 1990 and 2015 (it has almost doubled), it is still low compared to the rest of the world.

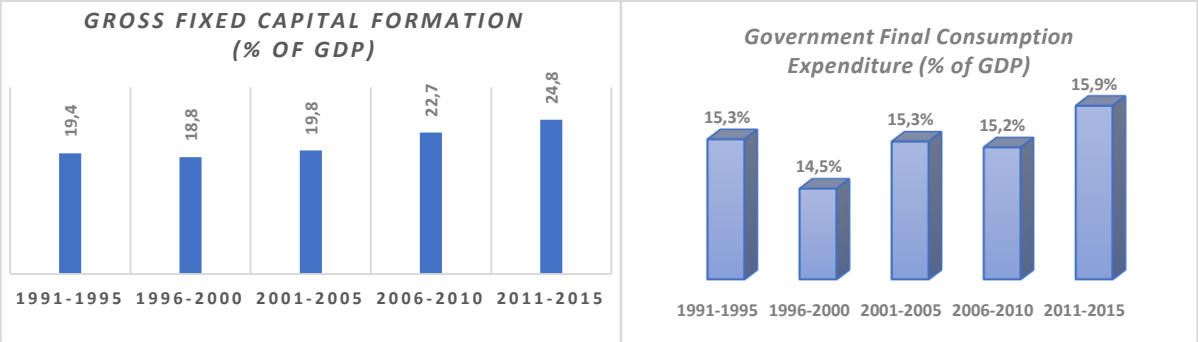
Figure 18: Evolution of access to the credit market by Sub-region between 1980 and 2015



Source: WIID4, 2018

The share of investment in GDP increased slightly between 1990 and 2015, but it remains fairly low (less than 25% of GDP over the period 2010-2015). General government final consumption expenditure as a proportion of GDP was relatively stable between 1990 and 2015.

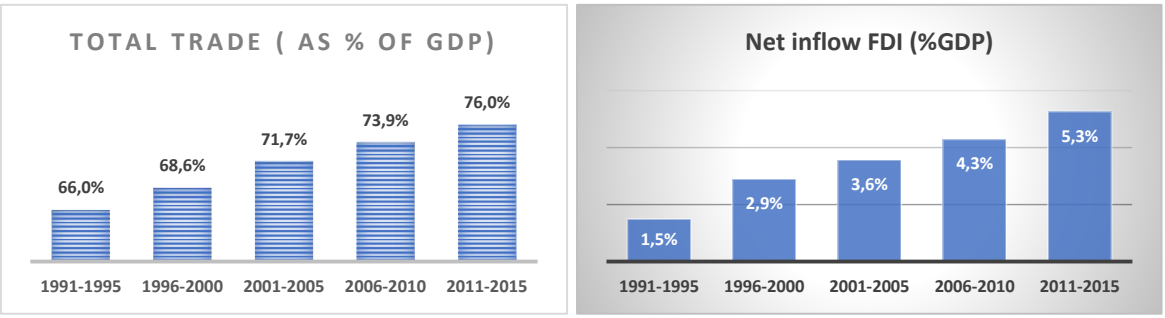
Figure 19: Evolution of Investment and public spending between 1990-2015



Source: WIID4, 2018

The net inflow of foreign direct investment as a percentage of GDP has more than tripled between 1991-1995 and 2011-2015. Concerning the degree of openness of the African economy, the data provided by our sample shows that trade has increased significantly between 1990 and 2015.

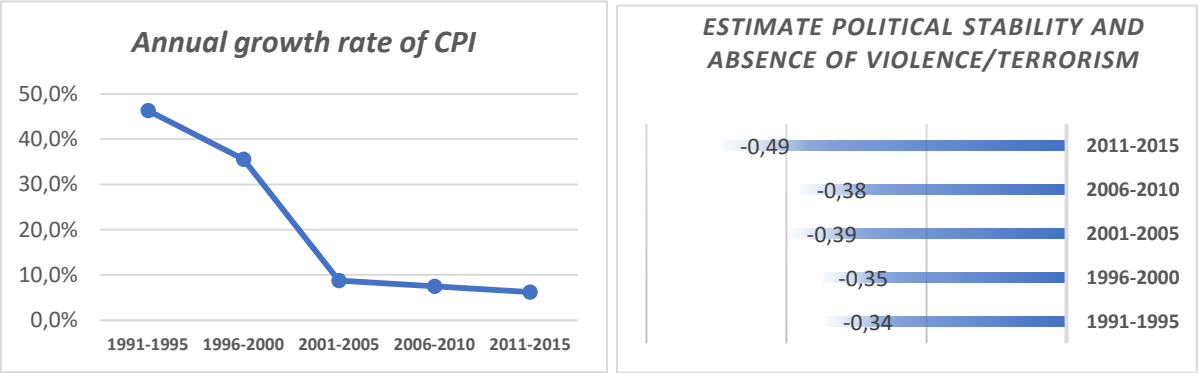
Figure 20: Evolution of Trade and Net inflow of Foreign Direct Investment between 1990-2015



Source: WIID4, 2018

Inflation is increasingly under control in Africa according to our data sample. Indeed, at the beginning of the 1990s (1991-1995) it was very high at around 50%, it had been stabilized since the beginning of the 2000s with an annual average value lying within the range of 6 to 9%. African countries seem to be more and more instable[4]. In fact, it is observed that the level of instability has increased between 1990 and 2015 by around 44%.

Figure 21: Evolution of Inflation and political stability between 1990 and 2015



Source: WIID4, 2018

III.2.3.Correlation between Income Inequality and Transmission Channels

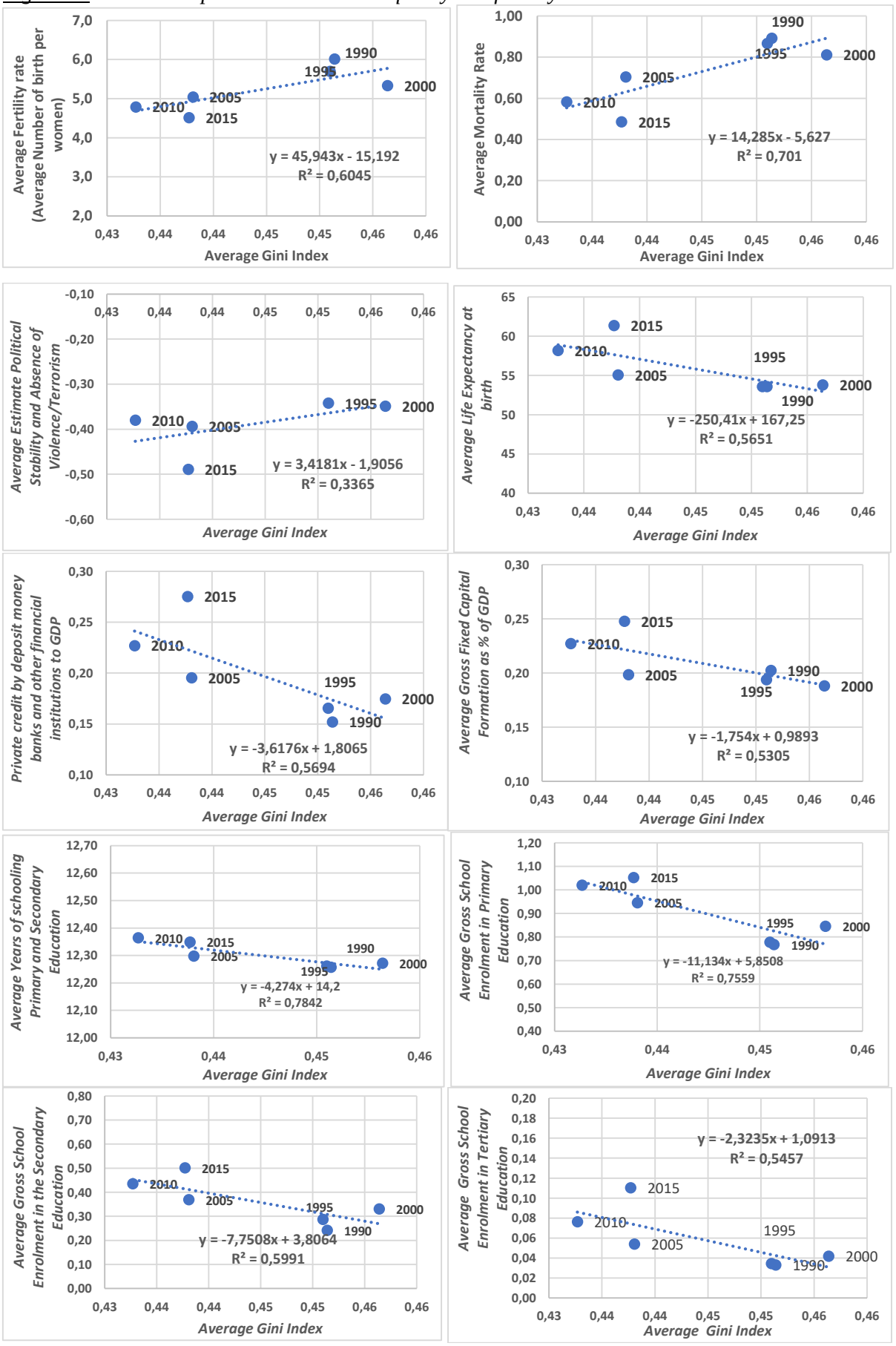
The purpose of this section is to identify graphically among the variables presented in the literature as determinants of growth, those that are likely to be correlated with the Gini index over time[5]. The graph shows that all the main determinants of growth are correlated with the Gini index. Fertility, infant mortality and political stability are positively correlated with the Gini index. As a result, an increase in income inequality would lead to a higher number of births per woman, a rise in infant mortality and a decline in the risk of instability in the country.

On the other hand, life expectancy, investment, the quality of the education system and access to the credit market are negatively associated with the Gini index. This suggests that an increase in income inequality would be detrimental for investment, reduce access to the credit market and worsen the quality of the education.

[4] The indicator used to measure the political stability here is "***Political stability and absence of violence***". This index measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. Its value is between -2.5 and 2.5. Higher values correspond to better governance.

[5] It should be noted that the statistical inference is somewhat biased due to a relatively small number of time periods.

Figure 22: Relationship between Income inequality and fertility



Chapter 4. GROWTH IMPACT OF INCOME INEQUALITY

This section presents all the results obtained by the Dynamic Panel model. The first part is devoted to determining the relationship between economic growth and income inequality. The second part examines the influence of the different transmission channels on this relationship. And the last two parts investigate the sensitivity of the model, the economic insight and the implications in terms of economic policies.

IV.1. Impact of income inequality on economic growth

In the previous chapter, we described the variables presented in the literature as the main determinants of economic activity.

IV.1.1. Results of the determinant of growth

The model presented in Table 2 below identifies, in light of such variables, the main factors that could impact per capita GDP growth rate, with a particular emphasis on the Gini index. This table has six specifications and all these specifications are controlled by the average year of schooling, the general government's final consumption expenditure, inflation and the openness of the economy. Our variable of interest (Gini index) is considered endogenous in this model in order to solve the problem of the reverse causality that could exist between GDP per capita and the Gini index.

In order to ensure that the model in column (1) can be considered as a reference model, we need to verify that the impact of the selected control variables on the per capita GDP growth rate is consistent with economic theory. We observe that the effect of the control variables on the growth rate of GDP per capita is as expected, although they are generally not significant. Indeed, the estimations reveal that an increase in the average year of schooling, general government final consumption expenditure and inflation would be detrimental to economic growth while the openness of the economy to international trade would be beneficial to economic growth.

Column (1) of table 2 gives the result of the net effect of the Gini index on the per capita GDP without any suspected transmission channel variables. This result suggests that Gini index has a positive and significant impact on the per capita GDP. In fact, an increase of Gini index of ten percent points lead to 7.3% increase in GDP per capita.

Columns (2) to (6) show that by adding successively the suspected transmission channel variables, the relationship between per capita GDP growth and the Gini index remains positive even though Gini index is not significant for the specifications (3) and (4).

Column (2) shows us that by introducing the infant mortality rate into our initial model, the coefficient of Gini index increase by 64%. It also appears that an increase in the infant mortality rate by ten percent points, is significantly and negatively associated with a decline in the GDP per capita by 33 percent.

The results in column (3) show that life expectancy does not significantly influence the GDP per capita. Adding this variable in the initial model, the coefficient of Gini index becomes insignificant. Therefore, life expectancy does not seem to be a transmission channel through which income inequality affect positively economic growth.

Table 2: *GMM regressions with Dependent variable: Logarithm of Real per capita GDP*

	(1)	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***
lnGDP_PCt-1	1.060***	1.007***	1.022***	0.989***	1.011***	0.924***
	(0.0569)	(0.0392)	(0.0760)	(0.0596)	(0.0406)	(0.0555)
GINIt	0.733*	1.203***	0.933	0.247	0.959**	0.586*
	(0.438)	(0.531)	(0.709)	(0.564)	(0.417)	(0.307)
Mortalityt		-3.295***				-0.633
		(1.226)				(1.254)
Ln(Life_exp)t			0.207			0.0916
			(0.314)			(0.183)
Ln(Fertility)t				-0.3718***		-0.237**
				(0.145)		(0.112)
Pol_Stabt						0.0192
						(0.0122)
Investmentt					0.896***	0.564**
					(0.295)	(0.250)
creditt						0.0610
						(0.124)
Yr_schoolingt	-0.0513	-0.0142	-0.0995	0.0537	-0.0355*	0.0334
	(0.0319)	(0.0241)	(0.0802)	(0.309)	(0.0212)	(0.0343)
GFCEt	-0.521	-0.7049	-0.794	0.0277	-0.721	-0.330
	(0.677)	(0.512)	(0.743)	(0.866)	(0.467)	(0.391)
Inflationt	-0.650***	-0.209	-0.624**	-0.189	-0.689***	-0.321
	(0.246)	(0.259)	(0.261)	(0.275)	(0.189)	(0.236)
Tradet	0.181	0.0738	0.181	0.0296	0.0409	-0.00317
	(0.138)	(0.104)	(0.127)	(0.134)	(0.0990)	(0.0859)
Observations	127	127	127	127	124	122
Countries	37	37	37	37	37	36
Sargan P-value	0.1932	0.4739	0.1964	0.1266	0.2416	0.7309
AR(1) P-value	0.0260	0.0177	0.0204	0.0165	0.0520	0.0420
AR(2) P-value	0.2161	0.5095	0.1239	0.6032	0.7835	0.7040
Instruments	20	21	21	21	21	26

Notes: This table summarize two-step system GMM estimations through Blundell and Bond specification model. The Wald test shows that the model is globally significant. Sargan test gives the p-value for over identifying restrictions. AR(1) p-value and AR(2) p-value report the p-values of the first and second order autocorrelation tests. Instruments illustrates the number of instruments used by the model. Robust standard errors are in the brackets. * p<0.1, ** p<0.05, *** p<0.01.

The results in column (4) suggest that an increase in the number of births is highly and significantly associated with the decline in GDP per capita. Indeed, ten percent increase in fertility rate would significantly reduce the per capita GDP by 3.7 percent. It is also noted that adding fertility rate in our initial model, reduce the coefficient of the Gini index.

Column (5) shows that investment would be one of the drivers of economic activity. Indeed, investment has a positive and extremely significant impact on GDP per capita growth. We observed that an increase in ten percent points in Investment is likely to increase a per capita GDP by 9.0 percent. It can also be seen that adding investment in our initial model rise the coefficient of the Gini index.

We have also investigated the change in the coefficient of the Gini index by adding variables such as access to the credit market and political stability in our initial model. It appears that although by adding these variables the coefficient of the Gini index decline, they are not significant at 15% threshold as well as the Gini index.

Column (6) describes the overall model of the determinants of economic growth. The results of this model reveal that the coefficient of the Gini index is underestimated compared to the initial model. In view of the fact that fertility rate and investment remained significant in the reduced and global model, they are considered to be transmission channels through which income inequality affects economic growth.

IV.1.2. Sensitivity of the model by other income inequality indicators

The previous section provided enough evidence on the effect of the Gini index on the per capita GDP. This section examines whether other inequality indicators could also have an impact on GDP per capita. The results will then in turn be compared with the Gini index to identify the more relevant indicator of income inequality in Africa. Four indicators are used for comparison purposes because they provide the best description of income inequality in the African context. These are the income share held by the poorest 20% of the population, the income share held by the poorest 40% of the population, the income share held by the richest 20% of the population and the Pseudo kuznets ratio. The other explanatory variables for all the specifications in table 3 below include investment, infant mortality rate and fertility rate in addition to the four control variables used in the previous section.

The results presented in columns (1) to (5) of Table 3 show that among the four other income inequality indicators, only the share of income held by the richest 20% of the population is statistically significant.

The significance of the coefficient of the income share held by the richest 20% of the population is positive and higher than that of the Gini index. The results in column (4) show that, a ten percent points increase in the share of income held by the richest 20% lead to increase the per capita GDP by 10.7 percent.

Table 3 : *GMM regressions with Dependent variable: Logarithm of Real per capita GDP*

	(1)	***(2)***	***(3)***	***(4)***	***(5)***
lnGDP_PCt-1	0.979***	0.978***	1.012***	0.975***	0.971***
	(0.0395)	(0.0543)	(0.0702)	(0.0385)	(0.0406)
GINIt	0.829*				
	(0.5000)				
Poorest20		-2.265			
		(2.208)			
Poorest40			-2.956		
			(2.107)		
Richest20				1.067**	
				(0.528)	
Kuznets_ratio					0.0091
					(0.01006)
Mortalityt	-1.497	-1.450	-1.388	1.663	-1.339
	(1.240)	(1.096)	(1.034)	(1.337)	(0.928)
Ln_Fertilityt	-0.196**	-0.241**	-0.199*	0.187*	-0.249***
	(0.0975)	(0.0997)	(0.115)	(0.0963)	(0.0659)
Investmentt	0.523**	0.469*	0.521**	0.489**	0.502**
	(0.227)	(0.278)	(0.252)	(0.233)	(0.252)
Yr_schoolingt	0.0245	0.0671*	0.055	0.0138	0.0605**
	(0.0312)	(0.0388)	(0.0432)	(0.0313)	(0.0293)
GFCEt	-0.458	-0.0868	-0.386	-0.642	-0.339
	(0.535)	(0.650)	(0.6405)	(0.489)	(0.566)
Inflationt	-0.284	-0.278	-0.3512	-0.250	-0.185
	(0.197)	(0.193)	(0.233)	(0.0,204)	(0.173)
Tradet	-0.0182	-0.0529	-0.0209	0.0041	-0.0693
	(0.0745)	(0.127)	(0.0992)	(0.0699)	(0.0901)
Observations	124	124	124	124	124
Countries	37	37	37	37	37
Sargan P-value	0.4817	0.2012	0.2497	0.5416	0.5348
AR(1) P-value	0.0356	0.0437	0.0285	0.0322	0.0262
AR(2) P-value	0.6281	0.5078	0.7492	0.7199	0.6294
Instruments	23	23	23	23	23

Notes: This table summarize two-step system GMM estimations through Blundell and Bond specification model. The Wald test shows that the model is globally significant. Sargan test gives the p-value for over identifying restrictions. AR(1) p-value and AR(2) p-value report the p-values of the first and second order autocorrelation tests. Instruments illustrates the number of instruments used by the model. Robust standard errors are in the brackets. * p<0.1, ** p<0.05, *** p<0.01.

IV.2. Transmission channels

In the previous section, it was revealed that the coefficient of the Gini index is likely to change significantly (increase or decrease) under the influence of control variables such as investment and fertility rate. This means that these variables are the transmission channels through which income inequality would impact economic growth. In Chapter 1, economic theory suggests a possible causal association between these suspected transmission channel variables and income inequality. To remove any doubt and ensure that this causal relationship could exist, the purpose of this section will be to examine the effect of the Gini index on these transmission channel variables.

IV.2.1. Estimation of the transmission channels model

The correlation made in the previous third chapter foreshadowed a positive relationship between income inequality and fertility and a negative relationship between income inequality and investment. The issue now is to determine if this association is a causal relationship.

To do this we used a two steps GMM as in the previous section with Blundell and Bond specification. The dependent variables for each model are fertility and investment. The Gini index are lagged by one period in order to capture the impact of income inequality on transmission channels and not the reverse.

The results in Table 4 below show that a ten percent points increase in the Gini index would reduce investment by 1.3 percent points. The investment channel suggests that, an increase in income inequality would lead to reduce investment opportunities and therefore negatively affect economic growth. This result illustrates the fact that this channel fail to explain a positive effect of income inequality on economic growth.

The fertility channel suggests that an increase in income inequality would lead to an increase in the number of births per woman. In fact, a ten percent points increase in Gini index would lead to an increase in fertility rate by 1.2 percent. Moreover, it has been established that an increase in fertility rate is negatively and significantly with GDP per capita. This clearly illustrates that fertility rate channel fail to explain the positive effect of income inequality on per capita GDP.

Table 4: GMM regressions for Transmission channels of income inequality.

	Fertility	***Investment***
	(1)	***(2)***
lnGDP_PC$_t$	-0.00089	0.0165
	(0.00913)	(0.0116)
GINI$_{t-1}$	0.1174*	-0.128*
	(0.06943)	(0.0742)
Observations	146	131
Countries	39	38
Sargan P-value	0.0072	0.1905
AR(1) P-value	0.0654	0.1344
AR(2) P-value	0.2280	0.4146
Instruments	13	13

Notes: This table summarize two-step system GMM estimations through Blundell and Bond specification model. The Wald test shows that the model is globally significant. Sargan test gives the p-value for over identifying restrictions. AR(1) p-value and AR(2) p-value report the p-values of the first and second order autocorrelation tests. Instruments illustrates the number of instruments used by the model. Robust standard errors are in the brackets. * p<0.1, ** p<0.05, *** p<0.01.

IV.2.2. Investigation of the non-linear relationship

In the previous chapter, it has been shown that income inequalities follow a non-linear evolution over time. Given this and in view of the previous results, this raises questions about the linearity of the relationship between income inequality and economic growth.

The results in Table 5 below give more evidence about a non-linear relationship between economic growth and income inequality. We observe that an increase in income inequality would lead to an increase in GDP per capita until the Gini index reaches a maximum value (0.474) at which any increase in income inequality would lead to a decline in GDP per capita. This result imply an inverted U-shaped relationship between income inequality and economic growth in Africa.

The latter result highlights the negative relationship between income inequality and economic growth as income inequality become high. Thus, in the presence of high income inequality, the fertility rate and investment would be appropriate transmission channels to explain the negative impact of income inequalities on economic growth.

Table 5: *GMM regressions with Dependent variable: Logarithm of Real per capita GDP*

	(1)	***(2)***	***(3)***	***(4)***
lnGDP_PCt-1	0.928***	0.9022***	0.935***	0.964***
	(0.0367)	(0.0381)	(0.0504)	(0.0353)
GINIt	2.839*			
	(1.498)			
GINI2t	-2.994**			
	(1.426)			
Poorest20t		3.719**		
		(1.750)		
Poorest20_2t		-3.530**		
		(1.505)		
Poorest40t			1.136**	
			(5.351)	
Poorest40_2t			-6.259*	
			(3.368)	
Richest20t				9.673*
				(5.366)
Richest20_2t				-8.130**
				(3.824)
Investmentt	0.571***	0.527***	0.605***	0.481***
	(0.182)	(0.195)	(0.2034)	(0.1724)
Ln(Fertility)t	-0.393***	-0.431***	-0.3919***	-0.383***
	(0.0820)	(0.0833)	(0.0794)	(0.0759)
Pol_Stabt	0.0247*	0.0238*	0.0231	0.0014
	(0.0143)	(0.0139)	(0.0168)	(0.018)
Yr_schoolingt	0.0415	0.0379	0.0489	0.0494**
	(0.0363)	(0.0381)	(0.0342)	(0.02068)
Observations	133	133	133	133
Countries	39	39	39	39
Sargan P-value	0.3223	0.3428	0.2726	0.6549
AR(1) P-value	0.1230	0.1060	0.1194	0.0665
AR(2) P-value	0.4000	0.5039	0.3697	0.3021
Instruments	28	28	28	28

Notes: This table summarize two-step system GMM estimations through Blundell and Bond specification model. The Wald test shows that the model is globally significant. Sargan test gives the p-value for over identifying restrictions. AR(1) p-value and AR(2) p-value report the p-values of the first and second order autocorrelation tests. Instruments illustrates the number of instruments used by the model. Robust standard errors are in the brackets. * p<0.1, ** p<0.05, *** p<0.01.

IV.3. Investigation of the result

IV.3.1. Economic explanation

The main finding of this study is the non-linear relationship between economic growth and income inequality. Indeed, an increase in income inequality leads to an increase in GDP per capita up to a certain level of income inequality (0.474) at which, any increase in income inequality would contribute to reduce the GDP per capita. This result highlight an inverted U-shaped relationship between income inequality and economic growth. This result is in line with the work of Kuznets (1957) who found a positive relationship between economic growth and income inequality as economic activity intensifies to a threshold at which any increase in income inequality would reduce economic growth. The economic insight behind this result is that, in the presence of high inequality in Africa, when a rise income inequality is not likely to undermine political stability, it can be conducive to domestic investment (few people who have a large share of income would invest in more productive activities). Then, lead to an increase in economic growth. Moreover, when income inequalities become more pronounced, they contribute to political instability, which reduce the action of local investors and create a non-attractive condition for foreign investors to settle, thereby damaging economic growth.

The second important result of this study is that, fertility rate is the transmission channel through which an increase in income inequality may harm economic growth. This result is in line with De la Croix & Doepke (2003) who suggested that when an increase in income inequality contributes to an increase in the fertility differential between rich and poor, an increase in income inequality would reduce average of education and be detrimental to economic growth. One possible explanation of our finding can be that, an increase in income inequality would reduce the income share of the poor in favour to the rich. In Africa where child labour is not formally prohibited, poor people generally prefer to have more children because children provide labour force that generate an additional source of income. In this context, an increase in fertility rate from a quantitative and not a qualitative point of view (the poor may not have money to send their children to school) as a result of income inequality, will affect human capital, which in turn will damage economic growth.

We have also found that, an increase in income inequality is likely to reduce investment. A similar result has been obtained by Delbianco et al (2014) in the case of Latin America. Gründler & Scheuermeyer (2018) also found the same result. The economic intuition that underpins this finding would result from the fact that an increase in income inequality is likely to cause social unrest and claims[6]. This would ultimately inhibit investors and lower economic growth. This channel is helpful to explain how income inequality affect negatively economic growth. However, it fails to explain the positive impact of income inequality on economic growth.

[6] Odedokun and Round (2001) found that high income inequality in Africa increase the risk of instability.

IV.3.2. Alternative explanation of inverted U-shape relationship between economic growth and income inequality

At the end of the 1970s, most African countries were shaken by an economic crises caused by the failure to implement expansionist development policies after the years of independence. This crises, which led to significant macroeconomic imbalances in both public finances and the balance of payments, prompted governments to solicit the World Bank and IMF's assistance to stabilize the economy. The result was the implementation in the early 1980s of the Structural Adjustment Programmes (SAPs), whose one of the measures was the ban on recruitment and the withdrawal of some jobs in the public administration that was the main source of employment in Africa. This had the direct effect of increasing income inequality in the early 1990s. Moreover, SAP also had a development goal through its five-year objectives which provide a conducive environment for investors to settle in. In addition, debt relief for some African countries in the early 2000s strengthened the economic structure of the countries through public investment. All these conditions contributed to stimulate economic activity during this period. This can explain why, despite an increase in income inequality, Africa has experienced a fairly remarkable increase in economic growth between 1995 and 2005. In addition, the resurgence of socio-political instability and economic turmoil in Africa in recent years is likely to be at the root of the negative relationship between economic growth and income inequality.

IV.3.3. Policy implications

We have seen in the previous section that income inequality can damage economic growth when it contributes to increase fertility rate and reduce investment. In order to continue to sustain economic growth in a context of high income inequality, the following suggestions are made:

- ✓ From the high level of income inequality in Africa compared to the rest of the world and rapid economic growth between 1990 and 2010, it cannot be excluded that the slowdown in economic activity since 2012 may be due to a misallocation of the benefits of growth. Thus, African states should make economic growth more inclusive, which would ultimately reduce inequalities while promoting economic activity.
- ✓ Measures may be taken to abolish and formally prohibit child labour. This could constrain parents of poor households to limit their number of children.
- ✓ The negative relationship between income inequality and investment simply suggests that the business environment is not conducive to the establishment of investors. As a result, African governments should create conditions in terms of regulations, norms and tax concessions to support investors in their processes of settlement. They should also provide good institutions for peace and social cohesion in the country in order to reduce the risk of instability.

IV.4. Sensitivity tests of regression model

This section assesses the validity and sensitivity of the different regression models used in this study. The first test to be verified is the overall significance of the model. The result of the test

is provided by the p value of Wald's chi-2 statistic. The result of this test suggests that all the models used in this study are globally significant at the 1% level.

The second test is the validity of the instruments. The accuracy of our results depends on the validity of the instruments chosen by the model. The Sargan test reported for each model shows that its value is more than 10% so the instruments used for each model are valid[7]. In addition, the Thumb rule is verified for all our models in the way that the number of instruments is lower than the number of countries.

The results of the autocorrelation tests show globally at the 5% level, a presence of first-order autocorrelation and an absence of second-order autocorrelation.

In addition, there is a wide variability in the coefficients obtained, mainly due to the fact that our panel data is unbalanced.

[7] However, in the model of the fertility channel, the Sargan test is less than 1%, which suggests that there is some doubt about the validity of the instruments for this specific model.

CONCLUSION

In a context of high levels of inequality in Africa compared to other regions of the world, this study aimed to determine the impact of an increase in income inequality on economic growth as well as to identify the main channels that would influence this relationship. To achieve this objective, we first reviewed previous literature on the subject. Three types of relationships between economic growth and income inequality emerge: positive, negative and non-linear. Moreover, previous studies have also provided us on five main transmission channels through which income inequality would influence economic growth. These are Fertility rate, Life Expectancy, Investment, Political Stability and Fiscal Policy. In addition, a GMM of dynamic panel model was proposed for analysis purposes.

On the basis of the theoretical information, we set up a panel with data from various sources. The estimations carried out show an inverted U-shaped relationship between income inequality and economic growth. This finding suggests that, in Africa, an increase in income inequality would lead to an increase in GDP per capita until some extent from which any increase in income inequality would lead to a decline in GDP per capita. As a result, income inequality is positively associated with GDP per capita when it is not likely to undermine political stability but reduce GDP per capita if it becomes unbearable for the population.

The investment and fertility rate channel does not explain the positive relationship between income inequality and economic growth. However, we have found that fertility rate and investment are the channel through which income inequality would influence significantly and negatively economic growth. In fact, an increase in income inequality would lead to an increase in fertility that would negatively affect human capital (education) and eventually reduce economic growth. In addition, an increase in income inequality would increase political instability which in turn reduce investment as well as economic growth.

Several difficulties were encountered during the completion of this study. The main important is the data constraint due to the fact that the Gini index has a lot of missing value. In fact, most studies on the subject generally cover all countries in the world. So, even if the panel of data is unbalanced, the large number of countries would reduce any possible bias.

For future research on the subject, we suggest a thorough investigation of the fertility channel to describe the mechanism through which in response to an increase in income inequality, fertility would influence schooling and ultimately economic activity. Future researchers may also examine the mechanism that supports the investment channel. The focus should be on the relationship between income inequality and political stability and its consequences for investment. We also suggest the construction of an income inequality index to address the problem caused by the high number of missing data from the Gini index and the income share.

REFERENCES

AfDB, 2012. *Briefing Notes for AfDB's Long-Term Strategy: INCOME INEQUALITY IN AFRICA,* s.l.: African Development Bank Group.

AfDB & OECD, 2010. *African Economic Outlook,* Addis Ababa: African Development Bank Group.

AfDB, OECD & UNDP, 2016. *African Economic Outlook 2016: Sustainable Cities and Structural Transformation,* s.l.: African Development Bank; OECD Development Centre; United Nations Development Programme.

Alesina , A. & Perotti , R., 1996. Income distribution, political instability, and investment. *European Economic Review ,* pp. 1203- 1228.

Alesina , A. & Rodrik , D., 1994. Distributive Politics and Economic Growth. *The Quarterly Journal of Economics,* pp. 465-490.

Andrei, A. & Craciun, L., 2015. Inequality and economic growth: theoretical and operational approach. *Theoretical and Applied Economics,* pp. 177-186.

Barro, R. J., 2000. Inequality and Growth in a Panel of Countries. *Journal of Economic Growth,* p. 5–32 .

Bloom, D. E. & Al., 2007. Fertility, Female Labor Force Participation, and the Demographic Dividend. *PGDA Working Paper No. 25.*

Bloom, D. E. & Williamson, J. G., 1998. Demographic Transitions and Economic Miracles in Emerging Asia. *The World Bank Economic Review,* pp. 419-455.

Blundell, R. & Bond, S., 1998. Initial conditions and moment restrictionsin dynamic panel data models. *Journal of Econometrics,* p. 115–143.

Bond, S., Hoeffler, A. & Temple, J., 2001. GMM Estimation ofEmpirical Growth Models. *Discussion Papers 3048, Centre for Economic Policy Research.*

Buccellato, T. & Alessandrini , M., 2009. *Natural Resources: a Blessing or a Curse? The Role of Inequality,* s.l.: s.n.

Castelló-Climent, A., 2010. Channels through Which Human Capital Inequality Influences Economic Growth. *The University of Chicago Press,* pp. 394-450.

Chambers, D., 2010. Does a rising tide raise all ships? The impact of growth on inequality. *Applied Economics Letters,* pp. 581-586.

Cruz, M. & Ahmed, S. A., 2018. On the impact of demographic change on economic growth and poverty. *World Development,* pp. 95-106.

De la Croix, D. & Doepke, M., 2003. Inequality and Growth: Why Differential Fertility Matters. *The American Economic Review,* pp. 1091-1113.

Deininger, K. & Squire, L., 1996. A New Data Set Measuring Income Inequality. *THE WORLD BANK ECONOMIC REVIEW,* pp. 565-591.

Delbianco , F., Dabús , C. & Caraballo, M. Á., 2014. income inequality and economic growth: new evidence from latin america. *Cuadernos de Economía,* pp. 381-398.

Docquier, F., 2004. Income Distribution, Non-Convexities and the Fertility: Income Relationship. *Economica,* pp. 261-273.

Dorfman, R., 1979. A Formula for the Gini Coefficient. *The Review of Economics and Statistics,* pp. 146-149.

Dynan, K. E., Skinner, J. & Zeldes, S. P., 2004. Do the Rich Save More?. *Journal of Political Economy,* pp. 397-444.

ECA & United Nations, 2017. *Rapport économique sur l'Afrique 2017: l'industrialisation et l'urbanisation au service de la transformation de l'Afrique,* Addis-Abeba, Éthiopie: Economic Commission for Africa.

EC, IMF & OECD, 2009. *Systeme of National Accounts 2008.* s.l.:International Monetary Fund.

Firebaugh, G. & Beck, F. D., 1994. Does Economic Growth Benefit the Masses? Growth, Dependence, and Welfare in the Third World. *American Sociological Review,* pp. 631-653.

Forbes, K. J., 2000. A Reassessment of the Relationship Between Inequality and Growth. *THE AMERICAN ECONOMIC REVIEW,* pp. 869-887.

Frazer, G., 2006. Inequality and Development Across andWithin Countries. *World Development,* p. 1459–1481.

Galor, O., 2012. *Inequality, Human Capital Formation and the Process of Development.* Bonn, Brown University and Institute for the Study of Labor (IZA) , pp. 1-62.

Galor, O. & Moav, O., 2004. From Physical to Human Capital Accumulation: Inequality and the Process of Development. *Review of Economic Studies,* pp. 1001-1026.

Galor, O. & Weil, D., 2000. Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and beyond.

Go, D., Nikitin, D., Wang, X. J. & Zou, H.-F., 2007. Poverty and Inequality in Sub-Saharan Africa: Literature Survey and Empirical Assessment. *ANNALS OF ECONOMICS AND FINANCE,* pp. 8-2, 251–304.

Gründler, K. & Scheuermeyer, P., 2018. Growth effects of inequality and redistribution: What are the transmission channels?. *Journal of Macroeconomics,* pp. 293-313.

Hakura, D. et al., 2016. *Inequality, Gender Gaps and Economic Growth: Comparative Evidence for Sub-Saharan Africa,* s.l.: International Monetary Fund.

Hirschman, C., 2004. *POPULATION AND DEVELOPMENT: WHAT DO WE REALLY KNOW?.* s.l., Center for Studies in Demography and Ecology and Department of Sociology, University of Washington, Seattle, WA 98195-3340, p. 5.

Jorge A., C. C., 2011. UNDERSTANDING INCOME INEQUALITY: CONCEPT, CAUSES AND MEASUREMENT. *International Journal of Economics and Management Sciences,* pp. 17-28.

Kennedy, T. & Al., 2017. Does income inequality hinder economic growth? New evidence using Australian taxation statistics. *Economic Modelling,* pp. 119-128.

Kuznets, S., 1955. EconomicGrowthandIncomeInequality. *TheAmericanEconomicReview,* pp. 1-28.

Lee, J.-E., 2006. Inequality and globalization in Europe. *Journal of Policy Modeling,* p. 791–796.

Malthus, T., 1798. *An Essay on the Principle of Population.* s.l.:s.n.

Miyazawa , K., 2006. Growth and Inequality: A Demographic Explanation. *Journal of Population Economics,* pp. 559-578.

Nithesh , S., 2019. *https://www.quora.com/What-is-the-Gini-coefficient.* [Online].

Odedokun, M. O. & Round, J. I., 2001. *Determinants of Income Inequality and its Effects on Economic Growth: Evidence from African Countries.* Helsinki, s.n., p. Discussion Paper No. 2001/103.

Odusola, A., Cornia, G. A., Bhorat, H. & Conceição , P., 2017. Income Inequality Trends in sub-Saharan Africa Divergence: Determinants and Consequences. In: s.l.:United Nations Development Programme Regional Bureau for Africa.

OECD, 2015. Concepts of Inequality Development Issues No. 1. 21 October.

Qin, D. & Al., 2009. Effects of income inequality on China's economic growth. *Journal of Policy Modeling* , pp. 69-86.

Roodman, D., 2009. How to do xtabond2: An introduction todifference and system GMM in Stata. *The Stata Journal* , p. 86–136.

Rougoor, W. & Van Marrewijk, C., 2015. Demography, Growth, and Global Income Inequality.

SEN, A., 1972. *ON ECONOMIC INEQUALITY.* s.l.:Oxford University Press.

Shin, I., 2012. Income inequality and economic growth. *Economic Modelling,* pp. 2049-2057.

Suwoto, T. & Zhai , Y., 2016. *Income Inequality as a Determinant of Economic Growth: A Cross-Country Analysis.* s.l.:Georgia Institute of Technology, ECON 3161 Econometrics.

Turchin, P., 2003. *Complex Population Dynamics: A Theoretical/Empirical Synthesis (MPB-35).* s.l.:Princeton University Press.

United Nations & ECA, 2016. *The Demographic Profile of African Countries,* Addis Ababa, Ethiopia : Economic Commission for Africa .

Wahiba , N. F. & Weriemmi, M. E., 2014. The Relationship Between Economic Growth and Income Inequality. *International Journal of Economics and Financial Issues,* pp. 135-143.

Yang, Y. & Greaney, T. M., 2017. Economic growth and income inequality in the Asia-Pacificregion: A comparative study of China, Japan, South Korea, andthe United States. *Journal of Asian Economics,* pp. 6-22.

A. Ando et Franco Modigliani, « The 'life-cycle' hypothesis of saving: aggregate implications and tests », *American Economic Review*, vol. 53, nº 1, 1963, p. 55-84

http://iresearch.worldbank.org/PovcalNet/povDuplicateWB.aspx
https://acaneretuedutr.weebly.com/uploads/9/0/1/5/9015786/ray_chapter6_2012.pdf
https://ourworldindata.org/economic-inequality-by-gender

APPENDIX

Table 6: Summary statistics

Variables	*Year*	*Number Obs*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
GINI	***1990***	18	0,45	0,10	0,29	0,61
	1995	26	0,45	0,09	0,30	0,63
	2000	33	0,46	0,08	0,30	0,66
	2005	36	0,44	0,08	0,30	0,65
	2010	33	0,43	0,08	0,31	0,63
	2015	17	0,44	0,09	0,32	0,63
Q1	***1990***	18	0,05	0,02	0,01	0,10
	1995	26	0,05	0,02	0,02	0,10
	2000	33	0,05	0,02	0,02	0,09
	2005	36	0,06	0,02	0,03	0,09
	2010	33	0,06	0,02	0,02	0,09
	2015	17	0,06	0,02	0,02	0,09
Q2	***1990***	18	0,09	0,03	0,04	0,13
	1995	26	0,09	0,02	0,04	0,13
	2000	33	0,09	0,02	0,05	0,13
	2005	36	0,10	0,02	0,05	0,13
	2010	33	0,10	0,02	0,05	0,13
	2015	17	0,10	0,02	0,05	0,13
Q5	***1990***	18	0,51	0,08	0,39	0,64
	1995	26	0,51	0,08	0,40	0,66
	2000	33	0,52	0,07	0,39	0,70
	2005	36	0,51	0,07	0,39	0,71
	2010	33	0,50	0,07	0,41	0,69
	2015	17	0,50	0,08	0,40	0,68
Kuznets_ratio	***1990***	18	6,43	3,26	2,97	14,26
	1995	26	6,33	3,38	3,07	15,53
	2000	33	6,09	2,55	2,98	15,07
	2005	36	5,69	2,62	3,01	15,08
	2010	33	5,56	2,45	3,20	14,64
	2015	17	5,88	3,12	3,24	14,27
Income (LnY)	***1990***	39	7,67	0,85	5,94	9,56
	1995	39	7,65	0,87	5,92	9,63
	2000	39	7,71	0,88	6,26	9,78
	2005	39	7,79	0,89	6,49	9,76
	2010	39	7,93	0,91	6,57	9,91
	2015	39	8,03	0,92	6,59	10,07
Ln_Population	***1990***	39	15,58	1,47	11,15	18,37
	1995	39	15,65	1,47	11,19	18,45
	2000	39	15,78	1,48	11,27	18,57
	2005	39	15,90	1,50	11,32	18,70
	2010	39	16,02	1,52	11,37	18,83
	2015	39	16,14	1,54	11,41	18,96
Fertility	***1990***	38	6,02	1,22	2,32	7,77
	1995	39	5,70	1,37	2,25	7,74
	2000	39	5,33	1,49	2,03	7,70
	2005	39	5,04	1,51	1,90	7,64
	2010	39	4,78	1,45	1,67	7,54
	2015	39	4,51	1,34	1,46	7,38
Mortality	***1990***	39	0,89	0,35	0,14	1,59
	1995	39	0,87	0,34	0,13	1,51
	2000	39	0,81	0,30	0,12	1,27
	2005	39	0,70	0,26	0,12	1,11
	2010	39	0,58	0,22	0,12	1,05
	2015	39	0,49	0,20	0,12	0,96
Life_exp	***1990***	39	53,58	8,39	34,22	69,40
	1995	39	53,60	8,87	29,43	70,92
	2000	39	53,79	8,17	42,87	72,56
	2005	39	55,07	8,03	43,97	73,82
	2010	39	58,18	7,31	46,23	74,58
	2015	39	61,36	6,60	49,84	75,19
Yr_schooling	***1990***	39	12,26	0,64	11	13
	1995	39	12,26	0,63	11	13
	2000	39	12,27	0,64	11	13

Variables	*Year*	*Number Obs*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
	2005	39	12,30	0,62	11	13
	2010	39	12,36	0,53	11	13
	2015	39	12,35	0,47	12	13
Primary	***1990***	37	76,8%	0,28	0,26	1,25
	1995	39	77,8%	0,27	0,27	1,26
	2000	38	84,5%	0,25	0,30	1,37
	2005	38	94,6%	0,21	0,43	1,31
	2010	39	102,0%	0,19	0,55	1,46
	2015	38	105,3%	0,17	0,69	1,45
Secondary	***1990***	31	24,2%	0,18	0,05	0,72
	1995	33	28,7%	0,25	0,05	1,13
	2000	35	33,1%	0,25	0,05	0,90
	2005	35	36,9%	0,25	0,08	0,87
	2010	35	43,5%	0,24	0,12	0,92
	2015	32	50,1%	0,23	0,17	0,98
Tertiary	***1990***	25	3,3%	0,04	0,01	0,14
	1995	31	3,5%	0,04	0,00	0,13
	2000	34	4,2%	0,06	0,00	0,30
	2005	34	5,4%	0,07	0,00	0,29
	2010	36	7,6%	0,08	0,01	0,34
	2015	38	11,0%	0,09	0,01	0,38
Investment	***1990***	34	20,2%	0,09	0,05	0,53
	1995	34	19,4%	0,08	0,08	0,43
	2000	35	18,8%	0,07	0,05	0,38
	2005	35	19,8%	0,07	0,09	0,38
	2010	38	22,7%	0,07	0,11	0,43
	2015	39	24,8%	0,09	0,08	0,51
Trade	***1990***	38	61,3%	0,36	0,14	1,86
	1995	39	66,0%	0,34	0,18	1,81
	2000	39	68,6%	0,35	0,24	1,76
	2005	39	71,7%	0,36	0,33	1,89
	2010	39	73,9%	0,35	0,33	2,02
	2015	39	76,0%	0,35	0,35	2,12
FDI	***1990***	38	1,1%	0,02	-0,03	0,06
	1995	39	1,5%	0,02	-0,01	0,07
	2000	39	2,9%	0,04	0,00	0,21
	2005	39	3,6%	0,04	0,00	0,22
	2010	39	4,3%	0,04	0,00	0,17
	2015	39	5,3%	0,06	-0,01	0,33
credit	***1990***	36	15,2%	0,14	0,02	0,71
	1995	39	16,6%	0,15	0,01	0,86
	2000	38	17,5%	0,21	0,02	1,14
	2005	39	19,6%	0,23	0,02	1,18
	2010	39	22,7%	0,26	0,03	1,40
	2015	38	27,5%	0,28	0,06	1,42
GFCE	***1990***	34	15,2%	0,06	0,01	0,28
	1995	34	15,3%	0,06	0,02	0,29
	2000	34	14,5%	0,06	0,01	0,32
	2005	35	15,3%	0,07	0,03	0,41
	2010	38	15,2%	0,06	0,06	0,37
	2015	39	15,9%	0,06	0,07	0,36
Inflation	***1990***	33	12,4%	0,20	-0,01	1,07
	1995	36	46,3%	1,77	0,02	10,76
	2000	36	35,5%	1,67	0,01	10,09
	2005	38	8,7%	0,14	0,01	0,85
	2010	38	7,5%	0,04	0,02	0,19
	2015	38	6,2%	0,05	0,01	0,20
Pol_Stab	***1990***					
	1995	39	-0,34	0,89	-2,11	1,09
	2000	39	-0,35	0,87	-2,04	1,28
	2005	39	-0,39	0,84	-2,15	1,03
	2010	39	-0,38	0,85	-2,04	1,01
	2015	39	-0,49	0,79	-2,08	1,06