

INCOME INEQUALITY AND ECONOMIC GROWTH: APPLICATION OF QUANTILE REGRESSION



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ABSTRACT

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The main objective of this article is to examine the relationship between the income inequality and the economic growth using quantile regressions. This methodology takes into account the heterogeneity of the parameters through the conditional distribution of the sample growth. In fact, the impact of the income inequality on the economic growth differs from one income group to another through different transmission channels such as the financial liberalization, the commercial liberalization, the corruption, the human capital and the political stability. According to the results, the income inequality exerts low impact on the growth through the trade openness.

1. INTRODUCTION

The major economic problem in the world is the fight against the poverty and the reduction of income inequality. To do this, it is essential to consider two fundamental aspects namely the economic growth and the income inequality. It is necessary to target policies to have an effective redistribution of wealth which encourages the states to invest more in different sectors such as education, health and infrastructure which can stimulate growth and reduce poverty. Our problematic consists to apply the quantile regression to analyze the impact of income inequality on economic growth. The economic researchers on the study of the relationship between income inequality and growth have always held an important place in search of the developing economy. Indeed, there are debates in economic thoughts. First, some economists suggest that unequal income distribution stimulates economic growth. However, other economists argue that income inequality slows growth and contributes to increased poverty. For example, Bourguignon and Christian (2002) and Cling *et al.* (2004) point out that the reduction of inequality leads to the reduction of poverty and consequently the increase of economic growth. According to Deininger and Squire (1996) reducing poverty and promoting growth requires that governments to strengthen their efforts to allocate income of an egalitarian manner. In this context, the famous economist (Piketty, 1997) suggests, in its works, that countries with large numbers of poor people and an unequal distribution of

income can benefit from strong economic growth. On the contrary, countries that are characterized by an equal distribution of income and a good proportion of the rich people benefit from an advanced economy. In addition, [Kuznets \(1955\)](#) known by the famous *inverted U curve*, connects the national per capita income and inequality. In this sense, he states that the increase in productivity in the modern sector without redistribution in favor of the rural sector leading to a more unequal distribution of income. The hypothesis of Kuznets postulates that an increase in inequality during a first period is followed by a decline since the late nineteenth or early twentieth century. This double movement is related to the fact that if there is a gap between the average incomes of households in both sectors (modern and rural), the transfer of the workforce from one sector to another (from agriculture to the industry) will be sufficient to reduce the inequality. However, [Deininger and Squire \(1996\)](#) criticized the Kuznets hypothesis by stating that achieving a high level of growth, must be considered by an equal income distribution. Moreover, [Piketty \(1997\)](#) criticized the Kuznets hypothesis. Based on his research which are based on French and US data, this author found that reducing inequality is not mechanically associated with the growth of GDP per capita. But it is historically linked to the unexpected events (disasters, inflation, war ...) or to the tax (including tax). Indeed, [Barro \(2000\)](#) concluded, through the study of the level of economic development for different countries, that the effect of income inequality on growth can be positive or negative; this effect depends on the level of the development. In other words, the income inequality in poor countries retards the economic growth, while the income inequality in rich countries stimulates the growth. Using panel data, [Barro \(2000\)](#) showed that the correlation between inequality and growth is negative in the initial phase of the economic development so that it can be positive during the stable phase of the development. Among the economists who have shown the existence of a positive relationship between income inequality and growth we can mention [Bourguignon \(2003\)](#); [Forbes \(2000\)](#). However, other economists such as [Helpman \(2008\)](#); [Alesina and Perotti \(1996\)](#) reported the existence of a negative relationship between these two concepts. Our analysis has two sections; first, we will introduce the fundamentals of the literature. In other words, we will present some economic studies that have analyzed the relationship between the income inequality and each transmission channel (or each determinants of the growth). Second, we will present an analytical framework to explain the methodology of the quantile regression, and then we will apply this type of regression to examine the relationship between the income inequality and the economic growth.

2. THEORETICAL EVALUATION OF THE TRANSMISSION CHANNELS

2.1. Financial Liberalization

The use of financial liberalization as a transmission channel by which income inequality has an effect on economic growth is based on certain theoretical and empirical studies. In fact, these studies show that financial development has a direct impact on income inequality through easier access of the poor to financial services (financial organization, bank services...). In addition, it has indirect effects on inequality through its positive and significant impact on economic growth. Indeed, there are a number of models based on the hypothesis of [Kuznets \(1955\)](#) we cite as an example [Greenwood and Jovanovic \(1990\)](#). These economists have models where the effect of financial development on inequality is nonlinear; the basic idea is inspired by the imperfections of credit markets. In fact, the financial system has no direct effect on the incomes of the poor since they have no access to bank loans and financial services. The economy proposed by [Greenwood and Jovanovic \(1990\)](#) is composed by two types of agents (high income agents and low income agents) that produce the most cost-effective technologies by investing only in financial assets. Indeed, this relationship is explained by two different points of view (depending on the slope of the curve of Kuznets). The first slope (in the development process) assumes that only high-income workers access to the financial market, therefore, inequality increases. The second slope postulates that inequalities have reduced through increased access to financial services for poor agents. However, these conclusions have been criticized by Clarke Meanwhile; Some economists conducted an analysis of panel data from 40 developed and developing countries during the period 1960-1995. The authors conclude that income inequality becomes weak when the

financial sector development is increasing; all depends on the structure of the economy considered. In other words, an economy of a developed financial system is linked to a low Gini index. The majority of empirical studies confirm that financial openness has a significant effect on income distribution. In other words, the liberalization contributes to reduce income inequality. Galor and Zeira (1993); Banerjee and Newman (1993) assume that the relationship between financial development and income inequality is linear. The main theory is based on the imperfections of the financial markets (financial asymmetries, transaction costs ...). Indeed, when the poor get projects that promote their large profits, it reduces social mobility of the poor to urban areas and reduces the efficiency of capital allocation. Moreover, the researches of Liang (2006) based on panel data on rural and urban cities of China show that there is a negative linear correlation between financial liberalization and income inequality in the two study areas. Bittencourt (2006) examined this relationship in Brazil during the period 1980-1990. The results show that financial development that favors the poor access to credits, mitigates inequalities against which contributes in part to promote the well-being of the individual and the economy of the country. This finding was confirmed by the research cross sectional of Bulir (1998). Moreover, Salins (2007) analyzed the impact of financial openness on internal income disparities. His study focuses on the evolution of income distribution in 42 emerging countries that implemented financial liberalization reforms between 1980 and 2000. The results show that financial liberalization has an effect on the rich population at the expense of the middle class. This effect is due through direct investment abroad and investment banking. Accordingly, financial openness tends to reduce income inequality between households. This is explained by the fact that multinational companies pay relatively high wages for the workforce of relatively skilled. In addition, Some economists examined the effects using panel of 22 African countries data for a period from 1990-2004. They showed that income inequality decrease as economies develop their financial sectors. The same results were found by Hoeckman and Zarrouk (2009) after analyzing the role of financial development in explaining income differences for a panel of 98 countries over the period 1980-2006.

2.2. Trade Liberalization

The principle is that trade liberalization has an effect on economic growth is not new and dates back to Adam Smith. Indeed, several studies like Dollar and David (1992); Dollar and Kraay (2002) showed that there is a positive relationship between trade openness and growth. However, there are several channels through which trade promotes growth; we refer mainly to resources allocation with more efficient ways. To do this, it is necessary to encourage economies to specialize and to produce in areas where the relative cost is more advantageous than in other economies. Indeed, the removal of barriers to entry, such as customs duties on exports, improves competitiveness and allows producers to reduce costs. In addition, it gives consumers access to cheaper products which helps to increase their standard of living and purchasing power. Trade openness also allows expanding markets that local producers can access and allows them to produce with a more efficient level to limit costs. It also allows the transfer of agents, ideas and technologies; it allows developing countries that do not have sufficient capacity to develop new technologies and to use technologies of advanced countries. Trade policies are generally considered as a means to fight against poverty because of their impact on employment, transfers and prices. Indeed, trade liberalization has direct and indirect effects on income inequality. Direct effects occur through changes in producer prices. In fact, due to globalization, domestic prices are no longer determined solely by the participants of the local markets because rising prices in the world would be directly transmitted to domestic prices. Thus, the relative prices of goods exert a powerful influence on migration, wages and therefore the welfare of households by weakening their income. Fighting against poverty is a fundamental goal of public policy, it is for this reason that trade liberalization is considered an important part of the program of action to stimulate growth. Indeed, Some authors studied the supply and demand of skilled labor and the variations in wages the in Costa Rica before and after trade liberalization. They found that the skill premium increased after liberalization following the changes in the structure of labor demand. Harrison and Hanson (1999) examined employment and wage changes of skilled and

unskilled workers. After the commercial opening, they found a slight variation in employment levels and a significant increase in workers' wages. They also showed that foreign companies heavily involved in export markets pay higher wages to skilled workers. (Dollar and Kraay, 2002) used data on open trade as a share of GDP at constant prices for a sample of 101 countries of which 73 are developing countries. These economists have shown that trade liberalization leads to a rapid growth in average income, this growth in turn allows to increase the incomes of the poor. In fact, the poor countries that lowered trade barriers and participated more in international trade over the last twenty years have seen their growth rates accelerate. In particular, in the 90s, these poor countries have grown faster than the advanced countries. However, developing countries that have not participated in globalization are becoming more delay. The general conclusion released by the authors, is that globalization has helped to mitigate inequality and absolute poverty as in India, Vietnam, China and Thailand. Bussolo and Lay (2003) studied the relationship between trade openness and income inequality in Latin America and Africa, they found that the trade opening may cause a change in the distribution of income at the expense of unskilled workers (which are likely to be among the poor) and increasing exports of certain intensive sectors of human resources and natural resources. Moreover, Milanovic and Squire (2005) found that lower tariffs contribute to increase income inequality in 118 developing countries during the period 1983-1999. Thus, data on trade liberalization that have been implemented (mainly in Latin America) suggested a positive relationship between commercial liberalization and income inequality. Recently Trefler and Zhu (2007) analyzed empirically this impact in 20 developing countries during the period 1985 to 1998. In conclusion, they found that trade liberalization has no effect on inequality; this is due to the catch-up process that explains the income inequality through changes in the composition of exports.

2.3. Political Instability

According to the empirical literature there is a positive relationship between income inequality and political instability Alesina and Perotti (1996); Mo (2009). Indeed, political instability creates uncertainty in the protection of property rights which reduces, accordingly, productivity and investment. In fact, Alesina and Perotti (1996) studied the income distribution of the effect on GDP growth across the political instability and the transmission mechanism for a sample of 71 countries over a period 1960-1985. The retained conclusion is that if the facts of political instability increase, while the economic growth will decline; we cite as example the increase in revolutions, political uncertainty, violence etc. Furthermore, Mo (2009) examined the impact of income inequality on growth via political stability channel. The results show that the inequality has a negative effect on growth. If the GDP growth rate depends on political stability which in turn depends on income inequality, the effect of the Gini index on the growth rate can be broken down as follows:

$$\frac{dGR}{dGINI} = \frac{\partial GR}{\partial GINI} + \left(\frac{\partial GR}{\partial INSTAB} \frac{\partial INSTAB}{\partial GINI} \right)$$

The estimates of Mo (2009) focused on the effect of income inequality on productivity growth and its effect by way of political instability. The results show that the elasticity of the growth of the productivity is -2.29; it's about 8.1 per cent of the reduction that requires the instability channel. For the GDP growth rate, the elasticity is -2.98; it's about 7.3 per cent of the reduction that goes through this channel. Nel (2003) in his study used ordinary least squares (OLS) to estimate the effects of income inequality on growth. His estimates are based on cross-sectional data for the period 1986-1997 for a sample of countries in Sub-Saharan Africa. The main purpose of his research is to ascertain whether the consequence of the negative relationship between inequality and growth is attributed to the effect of inequality on political instability. The results indicate that the increase in inequality does not affect the political instability in the sample. While this increase affects negatively the perceptions of the risks of potential investors so it dampens growth. In addition, Diaz (2006) examined the impact of income inequality on economic growth through the channel of political instability. According to his estimates, the impact is positive but became

negative due to the impact of political instability on the determinants of income inequality and because of the introduction of physical capital as direct investments abroad.

2.4. Human Capital

Most of the literature has studied the effect of income inequality on economic growth through its effects on human capital accumulation channel. These studies are based on the constraints of credit (credit market imperfections). Indeed, the main idea assumes that the poor, whom do not have enough means to educate themselves, are forced to access credit. In this context, Galor and Zeira (1993) showed that in the presence of credit market imperfections, the distribution of income has a significant effect on investment in human capital and on economic development. In fact, Alesina and Rodrik (1994); Persson and Tabellini (1994) and Perotti (1996) have shown that there is a negative correlation between income inequalities and GDP per capita. On the basis of modern theoretical perspectives Alesina and Perotti (1994); Persson and Tabellini (1994) examined the different channels through which inequality can affect economic growth. Their studies affirm the validity of the human capital channel. The results showed that inequality is indeed associated with decreased human capital formation level. In addition, lower level of human capital is associated with lower levels of rates of economic growth. Contrary to previous findings, the study of Perotti (1996) based on the political economy channel claims that income inequality is in fact associated with lower tax rates. While, lower levels of taxation is associated with low levels of economic growth. Furthermore, according to the researches of Deininger and Squire (1998) initial inequality has a negative and significant impact on education and economic growth. In conclusion, human capital is the engine of growth, then it constitutes an important transmission channel through which income inequality exerts an effect on growth.

2.5. Corruption

Many empirical studies have focused on the subject of the relationship between corruption and economic growth (eg Kakwani (2000); Hall and Jones (1999); Mo (2001)). All these studies have led to the fact that corruption helps to lower revenue growth. However, corruption does not only affect the revenue growth, it also affects the distribution of income. "The benefits from corruption are Likely to increased Individuals connected to the better ... who mostly belong to high income groups" (Gupta, 2002). Indeed, income inequality leads to corruption through different mechanisms. Some economists consider corruption as a source of motivation and opportunity mainly for the rich people. In fact, in the case where inequalities are greater, corrupt activities amounted for the rich people by using the economic resources as a political tool to maintain and increase their opportunities and interests. On the other hand, in countries where the level of income inequality is high, and given the limited capacity of the poor to control the corrupt activities of rich people poor people are probably deprived of their basic rights... In addition, they have a lot of problems for public services such as education and medical care compared with those who live in countries characterized by low income inequality. In fact, Li (2000) found in their research that corruption increases the Gini coefficient. The latter is higher in countries with an intermediate level of corruption while it is low in countries characterized by a high or low level of corruption. The main result reached by the authors is that in a country characterized by a distribution of income more or less equal, corruption is associated with a small increase in income inequality and a larger decline in the growth rate. Gupta (1998) studied for 56 countries the mechanisms by which corruption has a negative effect on income distribution and poverty. He analyzed the relationship between economic growth, the gap in the tax system and income inequality. He concluded that the inequalities that arise from corruption diminish growth moreover tax evasion increases inequality. He also noted that low social programs contribute to increasing income inequalities because they promote more rich people. This discourages policies against poverty. Using the Gini index as income inequality indicator, Gupta (1998) found that the benefits of corruption lead to poverty and inequality. Mo (2001) found that corruption affects negatively the growth; the results show that an increase of one unit of corruption weakened the income per capita growth rate of around 0.6%

points. In addition, he noted that corruption affects growth mainly through increased political instability. [Dincer and Günalp \(2008\)](#) studied the impact of corruption on income inequality and economic growth for the countries of the United States. They found that corruption contributes to increased inequality and to reduce growth. In addition, [Brempong and De Camacho \(2006\)](#) used panel data from 61 countries of different economic levels for a period of 20 years to study the regional distribution of corruption on economic growth and income distribution. The results affirm that the biggest impact of corruption on growth and income inequality is found primarily in African countries. While in the OECD (*The Organization for Economic Co-operation and Development*) countries and Asian countries the impact is less important. Indeed, the authors concluded that the reduction of 10% of corruption increases the revenue growth rate of approximately 2.8% in African countries, 2.6% in the countries of Latin America and 1.7% in the OECD countries and Asian countries.

3. APPLICATION OF THE QUANTILE REGRESSIONS OF THE RELATIONSHIP BETWEEN INCOME INEQUALITY AND ECONOMIC GROWTH

3.1. The Relevance of Quantile Regressions

The main idea of the application of quantile regressions is inspired by the article of [Buchinsky \(1994\)](#) in which the economist has studied the evolution of the wage structure in the United States during 1963-1987 by applying the method of quantile regressions. Since the topic of this article is about our subject, we will use this method in our sample during the period 1960-2011. Indeed, the first economists who used the quantile regressions technique are [Koenker and Bassett \(1978\)](#). Before presenting the basic model we will define this technique. The quantile regressions extend the usual regression models with conditional quantiles of the dependent variable. Indeed the main advantage of the quantile regressions is the flexibility in data modeling with the heterogeneity of the conditional distributions. In addition, the quantile regressions aim to analyze the relationship between the dependent variable (also called the response variable) and the explanatory variables (the predictors). In reality, the variable response cannot be predicted exactly only from the estimate of the fixed value of each explanatory variable. In fact, this estimate requires some central measures such as the mean, the median, the mode...

As we know, the analysis of traditional regression (simple linear regression, multiple regressions, nonlinear regression ...) focuses on the average. In other words, the relationship between the dependent variable and the explanatory variables is described by the mean of the dependent variable for each fixed value of the predictor variables. In this case, the model used is called the conditional mean of the dependent variable. These models are characterized by valuable statistical properties. Moreover, they are easy to be interpreted. However, the conditional mean models have some disadvantages especially in studies of "economic inequality between the rich and the poor." These models are ineffective for inequality studies (economic inequality in wages, health inequality, education inequality, etc.). In fact, when the income is continuous (salary, grade ...), the average contains only limited information to characterize the distribution of the dependent variable, because it requires special properties of the distribution (central location, asymmetry ...). Then, the average income is not likely to inform us about his more or less uneven distribution in the population. To reduce the gap between the rich and the poor, some economists have focused on other relevant and appropriate techniques "the conditional mean models". However, the conditional median models are used to study the relationship between the dependent variable and all the other covariates. In addition, when the variable of interest is a very spread distribution (with extreme values), by the model of the conditional median the results will be stronger. In this case, the quantile regression is the most reliable technique to study the impact of the covariates on the distribution of the variable of interest. In fact, the median is a particular quantile, it allows to write the central location of a distribution. The conditional median regression is a special case of the regression quantile in this case the conditional 0,5th quantile is modeled as a function of the covariates. Generally, there are other quantiles that can describe non-central positions of the distribution.

In conclusion, the majority of empirical and economic researchers focused on how are the effects of the independent variables on the dependent variable. However, there are other relevant analyzes of the income distribution, we mean the quantile regressions. One example cited by Buchinsky (1994) who provided a concrete example in the United States for its study of the wage distribution. He found that the average income has remained stable since the 70s, but it has progressed during the last decile. In addition, it was verified that the returns to the education and the experience differed according the quantile wage. Galiani and Titunik (2005) also studied the evolution of the wage structure in Panama using the technique of the quantile regressions. Lemiux (2006) used the quantile regressions to study the levels of the education and the wage inequality. In this case, Machado and Mata (2005) used this technique to analyze changes in the income distribution. By using the quantile regressions method, it will be possible to model any position of the distribution as the study of poverty in a low-income population. Therefore, this method is very important in the social sciences, especially in the study of the inequalities.

3.2. Analytical Framework

In the previous paragraph we showed that for the research on the distribution, mainly on the income distribution, the conditional median models "quantile regressions" are more effective than the conditional mean models.

The distribution functions of a random variable are $Y: F_Y (F_Y(y) = P(Y < y))$

The τ^{th} quantile of Y is by definition $q_{\tau}(y) = \inf \{y : F_Y(y) \geq \tau\}$, the most median quantiles frequently used is ($\tau = 0.5$), the first and the last deciles are ($\tau = 0.1$ and 0.9) and the first and the last quartiles are ($\tau = 0.25$ and 0.75). As the distribution function, the quantile function provides a complete characterization of the random variable Y . The different quantiles may solve a simple optimization problem.

In general, the standard quantile regressions of the conditional distribution assume that they have the following linear form: $q_{\tau}(Y / X) = X' \beta_{\tau}$ with $\tau \in [0,1]$

To define the estimation of the quantile regressions (that is considered as an extreme quantile estimator), it is necessary to solve the following minimization program:

$$q_{\tau}(Y) = \min E [\rho_{\tau}(y - a)] \text{ with } q_{\tau}(u) = u (\tau - I \{u < 0\})$$

In the conditional part:

$$q_{\tau}(Y / X = x) = \min E [\rho_{\tau}(y - a) / X = x]$$

a

We consider the following linear regression model $Y_i = X_i' \beta_{\tau} + u_i, i = 1 \dots n$

β_{τ} : $(K + 1)$ is a vector of the coefficients

X_i' : represents the transposed column vector of i^{th} row of the matrix of the explanatory variables X ($n * k$)

Y_i : is the " i^{th} " observation of the dependent variable

u_i : is the error term iid (independent and identically distributed)

The residues may have any distribution such that $q_{\tau}(\tau / X = x) = 0$

The resolution gives the program the following vector: $\beta = \min \sum_{i=1}^n \rho_{\tau}(Y_i - X_i' \beta)$

β

From a linear function of the conditional mean $E(Y / X = x) = X'\beta$, we can estimate the β vector by the ordinary least squares by minimizing the sum of squared residuals:

$$\hat{\beta} = \min \sum_{i=1}^n E(Y_i - X_i' \beta)^2$$

β

However, from a linear function of the conditional quantile $q_{\tau}(Y) (\tau / X = x) = X_i'\beta (\tau)$, the estimator of the quantile regression minimizes the following asymmetric linear function:

$$\widehat{\beta}_{\tau} = \min \left[\sum_{i \in \{i: Y_i \geq X_i \beta\}} \tau | Y_i - X_i \beta | + \sum_{i \in \{i: Y_i < X_i \beta\}} (1 - \tau) | Y_i - X_i \beta | \right]$$

β

$$= \min \rho_{\tau}(u_i)$$

β

From this expression we can identify a simple definition of a quantile namely: An observation of τ^{th} quantile exceeds $\tau\%$ of other observations. It is also smaller than $(1-\tau) \%$ of observations. If we look at the median ($\tau = 0.5$),

$\widehat{\beta}_{\tau}$ minimizes the sum of absolute differences. In that case, the interpretation will be easier and the solution will be

called a conditional median estimator or Least Diverter LADE (Least Absolute Deviation Estimator).

The minimization problem is reduced to:

$$\text{Min } \sum_{i=1}^n | Y_i - X_i' \beta |$$

β

Since we have β for each quantile (τ), the technique of the quantile regressions allows us to identify the effects of the covariates on the dependent variable at different points of the distribution. Indeed, the coefficient $\beta_k (\tau)$ can be interpreted as the marginal variation in the dependent variable due to the changes in the explanatory variable K^{th} in the τ^{th} quantile. For example, we assume that the dependent variable is the average growth rate of GDP per capita and the explanatory variable is the initial level of income per capita. The initial income coefficient at $\tau = 0.75$ gives the marginal variation in the average GDP growth rate associated with the marginal variation of the initial income for countries that are in the range of less than 75% of the conditional distribution of the average growth rate (GDP). Before applying the quantile regression in our sample, we can conclude that when the explanatory variables affect only the location of the conditional distribution of growth so the estimation of the conditional mean will be reliable. However, when the variables affect the distribution of the error term, the most appropriate method is the estimation of the conditional median. To test the effect of the income inequality on the growth we will apply the quantile regressions in our sample. Despite the advantages of the regression quantile mentioned above, this technique suffers from some disadvantages such as the problem of the endogeneity. In the following paragraph, we will outline this problem and propose some solutions to solve it.

3.3. Endogeneity Problem

Giving biased and difficult results to interpret the quantile regression analysis is not sufficient because of the ignorance of the problem of the endogeneity between variables, Regarding the endogeneity, Chernozhukov and Hansen (2004a) are two famous economists; they have focused on this subject. Indeed, they have proposed a method of quantile regression instrumented.

On the $Y = \alpha (U) + X'\beta (U) \quad U | X, Z \text{ Uniform } (0,1)$

$D = \delta (X, Z, V)$ where V is statistically dependent to U

$\tau \rightarrow \alpha (\tau) + X'\beta (\tau)$ is strictly increasing in τ

“Y” is the dependent variable, “U” is a random variable, “D” is a matrix of endogenous variables, “V” is a matrix of unobserved disturbances determined by “D” and correlated with “U”, “Z” is a vector of instruments. Finally, “X” is the matrix of control variables (exogenous variables).

To simplify the previous model, we can show the endogeneity in the following function of quantile regressions:

$$Y = \alpha D + \beta X + U$$

$$D = \sigma + \delta + V Z$$

“D” and “X” mean respectively the matrix of endogenous and exogenous variables, “Z” is a matrix of instrumental variables having a size at least equal to “X” and which satisfies the following condition $E(V / Z) = 0$; “V” and “U” are error terms (residues) and α , β , δ and σ are the parameters to be estimated.

4. FIXED ENDOGENEITY, METHODOLOGY AND RESULTS

There are several methods for correcting the endogeneity in quantile regressions analysis. According Chernozhukov and Hansen (2004a) it is possible to correct the endogeneity by the method of the instrumental variables. In addition, there is another simple method for correcting this problem; it is the technique of the predicted value.

4.1. Correction of Endogeneity, Methodology of Estimation

In this section we will interpret the estimation of the quantile regressions for our sample over the period 1960-2011. We will follow the same methodology of Koenker and Machado (1999). They have applied this method to estimate a cross-sectional estimation. Above all, it should be noted that the median quantile regression can be used to assess changes in location. While other specific quantiles (0.1 to 0.9 and 0.25 to 0.75) are used to evaluate how a co-variable predicts a conditional non-central location. Thus, they can study the evolution of the dependent variable. We will estimate the following equations:

$$Y_i = \Omega + \alpha + \beta \text{gini}_i X_i + \mu_i$$

$$\text{Gini}_i = \sigma + \delta + \gamma \text{instrument}_i X_i + \varepsilon_i$$

With “Y_i” is the growth rate of observed real GDP per capita over the period 1960-2011, “gini_i” is the observed Gini coefficient in 2011, “X_i” is the vector of the explanatory variables, “Z_i” is the vector of instrumental variables, β , α , δ and γ are coefficients to be estimated. In our case, we are going to focus on the estimation of the parameter β because it expresses the effect of income inequality on growth for different quantile (0.10 to 0.25; 0.5 to 0, 75 and 0.90). The estimation of the quantile regression is very important insofar as it takes into account the heterogeneity of β coefficient expressing, in our case, the relationship between the income inequality and the economic growth. According to our database, the variables are available for 117 countries that belong to different income group (the high income countries, middle-income and low-income). We note that the world is changing more and more economically and politically, this has an effect on the growth of the countries irrespective of their level of development through several transmission channels, it is for this reason that we have chosen to analyze our problems over a long period. In fact, the period we are going to study is $t_0 = 1960$ and $t_T = 2011$. The Sources of data are various, we cite as example: the World Bank Database (2014), the World Income Inequality Database for all countries of the world (WIID), the Luxembourg Income Study (LIS), Peen World Table 7, World Government Indicators (WGI), (available in the website: www.barrolee.com) and Deininger and Squire Database. The choice of the sample studied depends on the availability of the data; it contains developed and developing countries. Using the STATA software we analyzed the quantile regressions.

The following table reflects the direct effect of income inequality on economic growth.

Table-1. Two-stage quantile regressions

	DLS*	$\tau = 0,10$	$\tau = 0,25$	$\tau = 0,5$	$\tau = 0,75$	$\tau = 0,90$
Constant	-0,895 (-0,26)	1,160 (0,07)	-6,750* (-1,□5)	3,123* (1,86)	3,825 (1,20)	6,268 (0,76)
Ly ₆₀	-0,163 (-1,17)	0,218 (0,24)	-0,030 (-0,15)	-0,165* (-1,91)	-0,182 (-1,36)	-0,474 (-0,52)
Cp	0,018 (0,99)	0,018 (0,54)	0,0005 (0,05)	0,003 (0,60)	0,018 (1,45)	0,041 (0,59)
Trade	-0,0002 (-0,03)	0,006 (0,24)	0,010 (0,99)	0,008* (1,80)	-0,0006 (-0,07)	-0,010 (-0,31)
IPC	-0,005 (-0,02)	-0,145 (-0,18)	0,474** (2,04)	0,298** (2,37)	-0,189 (-0,79)	-0,599 (-0,54)
Human	0,057 (0,68)	-0,005 (-0,01)	0,072 (0,71)	0,080 (1,22)	0,117 (0,14)	0,143 (0,29)
Stab	0,025 (0,08)	-0,262 (-0,24)	-0,435 (-1,20)	-0,429 (-2,28)	0,043 (0,12)	0,490 (0,46)
Gini	-0,008 (-0,18)	-0,167 (-0,62)	0,0416 (0,37)	0,030 (0,94)	-0,047 (-1,29)	-0,022 (-0,52)
Observations	58	60	60	60	60	60
Pseudo R ²	(.)	0,182	0,160	0,156	0,123	0,171
1- Dependant variable GR : growth rate of GDP per capita						
2- Gini : Gini index						
3- Y ₆₀ : initial GDP per capita						
4- Stab : measure of political instability						
5- Human : the average years of schooling for the population over 15 years						
6- IPC : Index of perception of corruption						
7- Trade : Sum of exports and imports of goods and services as a % of GDP						
8- CP : Private domestic credit as a % of GDP						

Note: *DLS: Double Least Squares

4.2. Results and Interpretations

In table (1) we start with the initial income per capita GDP. This variable is significant only for the middle quintile, it has an expected sign (negative), and this result is consistent with the theory of the conditional convergence. As for the human capital, we note that the coefficients are not significant. Note the same finding in the least squares regression (not significant). In fact, especially if the quantile increases the coefficients increase also. So we conclude that the human capital is higher in developed countries with high growth rates. Concerning the trade liberalization "Trade", the coefficient in rich countries ($\tau = 0.75$ and $\tau = 0.9$) seems to have the same sign as the regression by the DLS method. This variable is only significant in countries with moderate growth. Indeed, the financial liberalization has a positive and not significant impact on the growth of different countries. According to the results, the corruption has a positive and not significant effect on the growth of underdeveloped countries ($\tau = 0.1$). However, it has a positive and a significant impact in low-income countries ($\tau = 0.25$) and in countries that are close to the sample median ($\tau = 0.5$). Moreover, the corruption has a negative impact on growth in high-income countries. Regarding the variable "Stab", it has a negative effect on some countries mainly those that belong to the lowest quantile and to developing countries. However, it has a positive effect in rich countries. So the assurance of the political stability helps to promote growth especially in high-growth countries. In terms of the income inequality, we note that it has a negative impact in underdeveloped countries. In addition, it has a positive impact in countries with low growth rates and in countries with moderate growth. Nevertheless, it has a negative effect in high-growth countries ($\tau = 0.75$ and $\tau = 0.9$). This result is consistent with that obtained in the theoretical literature. After estimating the direct effect (which is the effect on productivity) of income inequality on growth by quantile regressions, we will pass to the next step to study the indirect effects of income inequality on economic growth through the transmission channels but still by the method of the quantile regressions. As regards the

transmission channels, where the Gini coefficient is proved endogenous, we will keep the same results obtained by double least-squares DLS. Finally, we will use the quantile regression in two stages in order to study the indirect effects of the income inequality on these different channels.

Financial liberalization « Cp »: Two-stage quantile regression

Variables	DLS	0,1	0,25	0,5	0,75	0,9
Constant	181,631*** (5,79)	71,990*** (3,93)	134,566*** (6,09)	140,023*** (7,23)	256,791*** (12,82)	336,369 (3,32)
Gini	-3,403*** (-4,42)	-1,897*** (-3,29)	-3,523*** (-5,23)	-2,710*** (-5,59)	-4,410*** (-9,75)	-4,990*** (-2,54)
Observations	114	121	121	121	121	121
Pseudo R ²	(.)	0,060	0,097	0,120	0,248	0,196

Let's start with the channel of financial liberalization; the effect of income inequality on growth through this channel is negative and significant at the level of 99%, for all countries. This finding is the same for the regression by the DLS. Therefore the financial liberalization is an important channel to express the relationship between the income inequality and the economic growth.

Corruption « IPC » : Two-stage quantile regression

Variables	DLS	0,1	0,25	0,5	0,75	0,9
Constant	12,169*** (7,45)	6,179*** (5,18)	6,800*** (8,02)	8,969*** (8,76)	16,028*** (14,45)	18,912*** (7,58)
Gini	-0,202*** (-5,02)	-0,122*** (-3,27)	-0,116*** (-4,84)	-0,141*** (-5,47)	-0,246*** (-9,84)	-0,253*** (-5,18)
Observations	117	125	125	125	125	125
Pseudo R ²	(.)	0,041	0,075	0,119	0,313	0,355

Regarding the corruption, the income inequality has a negative and a very significant effect (at a level of 99%) on the Corruption Perceptions Index "IPC". From the results, we note that this effect is similar to that of the regression by the DLS.

Human capital « Human » : Two-stage quantile regression

Variables	DLS	0,1	0,25	0,5	0,75	0,9
Constant	18,921*** (8,60)	30,657*** (6,11)	23,999*** (13,80)	19,677*** (2,79)	17,532*** (10,04)	15,835*** (2,81)
Gini	-0,288*** (-5,35)	-0,818*** (-5,14)	-0,522*** (-10,55)	-0,316*** (-10,57)	-0,210*** (-5,34)	-0,119 (-1,08)
Observations	102	109	107	110	102	101
Pseudo R ²	(.)	0,259	0,306	0,299	0,229	0,103

The table above shows that by applying the DLS method, the Gini coefficient has a negative and a very significant impact on the growth via the channel of the human capital. However, by applying the quantile regressions we note that through this channel the income inequality affects negatively and significantly the growth of all the countries exception the countries with a very high growth.

Political stability « Stab » : Two-stage quantile regression

Variables	DLS	0,1	0,25	0,5	0,75	0,9
Constant	2,856*** (3,80)	4,747 (1,36)	5,117*** (3,97)	3,985*** (6,04)	2,735*** (5,72)	2,533*** (3,40)
Gini	-0,072*** (-3,91)	-0,189* (-1,73)	-0,161*** (-4,41)	-0,098*** (-5,92)	-0,049*** (-4,57)	-0,030** (-2,03)
Observations	116	124	124	124	124	124
Pseudo R ²	(.)	0,095	0,113	0,145	0,129	0,081

The results of the above table argue that the political stability channel is effective for all the countries to the extent that the Gini coefficient is negative and significant. He seems to have the same sign and the same order of significance that the regression by the DLS.

Trade liberalization « Trade » : Quantile regression

Variables	DLS	0,1	0,25	0,5	0,75	0,9
Constant	85,943*** (6,30)	38,516*** (2,32)	65,216*** (4,84)	88,200*** (4,58)	113,307*** (4,17)	94,740 (1,10)
Gini	-0,0089 (-0,03)	-0,018 (-0,05)	-0,232 (-0,73)	-0,327 (-0,72)	-0,019 (-0,30)	1,125 (0,55)
Observations	145	145	145	145	145	145
Pseudo R ²	(.)	0,0001	0,0042	0,0016	0,0013	0,0082

Regarding the trade liberalization, the Gini coefficient has a non-significant impact on the growth of different countries. This is the same result obtained by the DLS regression. This is consistent with our results on the relative contribution of this channel to explain the indirect effects of income inequality on the growth. The contribution was 1.7% which is the lowest share of contributions from other transmission channels.

5. CONCLUSION

Our approach is interesting since it is the first time it tries to go beyond the usual studies (Ordinary Least Squares: OLS and Double Least Squares: DLS) to explore the relationship of income between the inequality and the growth, taking into accounts the possibilities of existence of differences in the coefficients between countries with strong and weak economic growth. The results of the quantile regression are strong interesting since they allow us to know clearly how the income inequality affects different levels of growth. The results are expected and conform to the literature. Specifically, the income inequality has a negative and a significant effect in countries with low-income, middle-income and also in high-income which underlines the importance of taking into account the heterogeneity of the countries. Moreover, we performed the same job for the indirect effects of income inequality on economic growth. The corruption, the financial liberalization, the human capital and the political stability prove valid for low growth countries, for moderate growth countries and also for strong growth countries, in other words for all the quintiles.

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