

INCOME INEQUALITY AND ECONOMIC GROWTH: EMPIRICAL INVESTIGATIONS ON THE TRANSMISSION CHANNELS

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Abstract

The aim of this paper is to quantify the transmission channels of income inequality on economic growth. We try to determine what is the most important channel through which income inequality affects growth. To do this, we will estimate our basic model with variable rates. Then, we will use a simultaneous equations model to decompose the direct and indirect effects of income inequality on economic growth. According to the results, corruption is the most important channel, while trade openness channel is the least important.

Key words: income inequality; economic growth; transmission channels

JEL Classification : I3; O4; Q33

Introduction

The major economic problem in the world is the fight against poverty. In fact, it is necessary to take into account two aspects: economic growth and income inequality. There must be policy targets for effective redistribution of wealth in order to promote growth. This encourages the state to invest more in different sectors such as education, health, infrastructure, etc.. This allows subsequently to stimulate growth and then to slow down poverty. Economic research on the study of the relationship between income inequality and growth have always held an important place in research developing economy. However, they are contradictions in economic thinking. Some economists suggest that unequal distribution of income stimulates economic growth. While others say that income inequality decreases growth and contributes to increase poverty. In addition, Kuznets (1955), known by the famous *inverted-U*, connects the national per capita income and inequality. He says that the increase in productivity in the modern sector without redistribution in favor of the rural sector, led to a more unequal distribution of income. The Kuznets hypothesis postulates that an increase in inequality during the first period is followed by a decline since the late nineteenth or early twentieth century.

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The different channels of income inequality

We will empirically analyze the direct and indirect effects of income inequality on growth through five channels: human capital (Human), financial liberalization (Cp), political stability (Stab), corruption (Icp) and trade liberalization (Trade).

Analytical Framework

In a first step, we combine the technique developed by Papyrakis and Gerlagh (2006) and the methodology of Mo Pak Hung (2009). In fact, cross-sectional regression requires data averaged for a specified period. The study period is $t_0 = 1960$ and $t_T = 2011$. The growth rate of GDP per capita is $G^i = (1/T) \ln(Y_T^i / Y_0^i)$ which

depends on the initial income per capita « Y_0^i », income inequality "giniⁱ" and the vector of explanatory variables representing the transmission channels "Zⁱ". Then we will estimate the growth equation as follows:

$$G^i = \alpha_0 + \alpha_1 \ln(Y_0^i) + \alpha_2 \text{gini}^i + \alpha_3 Z^i + \varepsilon^i \quad (a)$$

Which "i" is every year, "gini" reflects the impact of income inequality on growth and α_1 is intended to capture the effect of conditional convergence.

To determine the long-term effect of income inequality on the transmission variables, we use the technique developed by Papyrakis and Gerlagh (2006). To do this, we will first compare two different states (k and j). The basic assumptions made by the authors assume that:

H1: The two states of the initial vector "Z", the variable "gini" and the initial level of per capita income « $\ln(Y_0^i)$ » are identical.

H2: Permanent changes of characteristics related to the growth of the variable "gini" and the vector "Z" can assume that $\text{gini}^j \neq \text{gini}^k$ and $Z^j \neq Z^k$

$$\mathbf{H3:} \Delta \ln Y_0 = \ln(Y_0^j) - \ln(Y_0^k), \quad \Delta \text{gini} = \text{gini}^j - \text{gini}^k \quad \text{and} \quad \Delta Z = Z^j - Z^k$$

According to *Appendix 2*, a permanent difference of "gini" and "Z" shows the long-term effect on the income, that is to say:

$$E(\Delta \ln Y_\infty) = -(\alpha^2 / \alpha_1) \Delta \text{gini} - (\alpha^3 / \alpha_1) \Delta Z \quad (b)$$

So, $\Delta \ln Y_\infty = \ln(Y_\infty^j) - \ln(Y_\infty^k)$ represent the long-term effect of the Logarithm of income .

The ratio $-(\alpha^2 / \alpha_1)$ captures the long-term (LT) effect of the income inequality indicator on growth. Similarly, the ratio $-(\alpha^3 / \alpha_1)$ detects the LT effect of variables of transmission channels on growth.

We can rewrite equation (b) introducing an exponential function to clear the long-run relative effect on income: $\Delta Y_\infty / Y_\infty = \exp [-(\alpha^2 / \alpha_1) \Delta \text{gini} - (\alpha^3 / \alpha_1) \Delta Z] - 1$ (c)

For small values of $[(\alpha^2 / \alpha_1) \Delta \text{gini}]$ and of $[(\alpha^3 / \alpha_1) \Delta Z]$, we can conclude the following approximation: $\Delta Y_\infty / Y_\infty \approx [-(\alpha^2 / \alpha_1) \Delta \text{gini} - (\alpha^3 / \alpha_1) \Delta Z] - 1$ (d)

In our estimates, we will gradually add the determinants of growth that compose the vector Z^i to examine the impact of the Gini coefficient (α_2). The variables used are:

1-	Dependant variable GR : growth rate of GDP per capita
2-	Gini : Gini index
3-	Y60 : initial GDP per capita
4-	IY : the investment share of real GDP per capita
5-	PopG : the growth rate of the population
6-	Pright : index of political rights
7-	Stab : measure of political instability
8-	Human : the average years of schooling for the population over 15 years
9-	Gov : the government as a % of GDP
10-	IPC : Index of perception of corruption
11-	Trade : Sum of exports and imports of goods and services as a % of GDP
12-	CP : Private domestic credit as a % of GDP
13-	Inf : Inflation relative to GDP

The sources of data are presented in *Appendix 1*.

Table 1: Growth regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0,9261 (0,83)	-0,3920 (-0,31)	0,9339 (0,53)	0,1429 (0,08)	0,0341 (0,02)	1,7462 (0,77)
Ly ₆₀	-0,0181 (-0,18)	-0,0523 (-0,43)	-0,0855 (-0,70)	-0,1148 (-0,96)	-0,1138 (-0,95)	-0,2281 (-1,92)
Gini	-0,0329 (-1,51)	-0,0171 (0,73)	-0,0028 (-0,11)	0,0007 (0,03)	0,0034 (0,13)	-0,0042 (0,15)
Human		-0,1220 (1,36)	0,0483 (0,41)	-0,0508 (-0,45)	-0,0739 (-0,66)	-0,0871 (-0,79)
PopG		-0,6004	-0,3523	-0,4434	-0,5465	

	(-1,31)	(-0,72)	(-0,90)	(-1,10)
IPC		0,2631** (2,02)	0,2227 * (1,67)	-0,0706 (-0,30)
IY			0,0216 (1,03)	0,0257 (1,32)
CP			0,0196**	(1,97)

Obs	78	66	66	65	64	64
R ²	0,036	0,054	0,116	0,165	0,215	0,275

Note : symbols ***, **, * represent significance levels of the coefficients to 1%, 5% and 10% respectively. Figures in brackets are standard deviations corrected for heteroscedasticity when the Breusch-Pagan test is significant.

	(7)	(8)	(9)	(10)	(11)
Constant	2,8585 (1,25)	3,0309 (1,19)	2,8616 (1,90)	5,6982** (2,25)	5,9512** (2,33)
Ly ₆₀	-0,2705** (-2,11)	-0,2732** (-2,02)	-0,2717** (-2,00)	0,3537 ** (-2,55)	0,3660** (-2,57)
Gini	-0,0081 (-0,31)	-0,0089 (-0,33)	-0,0098 (-0,36)	-0,0187 (-0,68)	-0,0252 (-0,60)
Human	-0,0766 (-0,88)	-0,0787 (-0,89)	-0,0934 (-1,06)	-0,1062 (-1,24)	-0,0996 (-1,16)
PopG	0,3421 (-0,83)	-0,3275 (-0,78)	-0,3534 (-0,85)	-0,2378 (-0,55)	-0,2611 (-0,59)
IPC	-0,0855 (-0,35)	-0,1143 (-0,42)	-0,0830 (-0,28)	-0,2144 (-0,66)	-0,2510 (-0,75)
IY	0,0251 (1,30)	0,0249 (1,30)	0,0259 (1,41)	0,0252 (1,33)	0,0251 (1,32)
CP	0,0215** (2,05)	0,0217** (2,06)	0,0200* (1,68)	0,0207 (1,18)	0,0211 (1,21)
Gov	-0,1077** (-2,21)	-0,1079** (-2,20)	-0,1119** (-2,24)	-0,1172 ** (-2,38)	-0,1141** (-2,18)
Stab		0,0991 (0,28)	0,0126 (0,03)	-0,1915 (-0,53)	-0,1340 (-0,34)
Trade			0,0042	0,0037	0,0030

	(0,87)	(0,73)	(0,55)
PRight		-0,3858**	-0,3905**
		(-2,09)	(-2,12)
Inf			-0,0012
			(-0,72)

Obs	64	64	64	61	61
R ²	0,348	0,349	0,355	0,401	0,405

symbols ***, **, * represent significance levels of the coefficients to 1%, 5% and 10% respectively. Figures in brackets are standard deviations corrected for heteroscedasticity when the Breusch-Pagan test is significant

Different tests :

Tests	(1)	(2)	(3)	(4)	(5)	(6)
Breusch-Pagan $\chi^2(1)$	9,70***	0,00	2,39	2,63	0,95	1,80
Ramsey (stat F)	0,71	4,63***	4,89***	6,86***	6,81***	4,08**

Tests	(7)	(8)	(9)	(10)	(11)
Breusch-Pagan $\chi^2(1)$	1,74	1,71	1,91	1,07	1,03
Ramsey (stat F)	4,18**	4,28**	4,05**	2,95	2,94

Interpretations :

- Autocorrelation (Ramsey test) :

In equations (1), (10) and (11), $F_{\text{calculated}} < F_{\text{theoretical}}$, the probability of Fisher is more than 0.05. So, the tests are not significant and then we accept H_0 . The assumption of no autocorrelation of errors is verified, the model is well specified. In contrast, in the equations (2) to (9) we see that the tests are significant at 1% and 5%. Hence, we must reject H_0 in favor of H_1 that implies the existence of autocorrelation.

- Heteroscedasticity (Breusch-Pagan test) :

With the exception of the first equation, the tests are not significant. This means that we accept the null hypothesis that assumes the presence of homoscedasticity. In Table (1) we estimated the growth equation (a) using the method of ordinary least squares. And in each regression, we introduced a transmission variable "Z". The coefficients in this table represent the coefficient α_2 . In a first step, the dependent variable (the growth rate of real GDP per capita) depends only on the initial income per capita and the Gini coefficient, that is to say, we will study the overall effect of income inequality on growth. The results show that no variable is statistically significant. In contrast, we find that the Gini coefficient has negative effect on economic growth.

More specifically, an increase of one percentage point reduces the Gini coefficient growth of 0.0092% per year.

When the effect of income inequality on the growth continues, and according to equation (b) which reflects the ratio - (α^2/α_1), this indicates that a 1% increase of income ($\Delta\text{Gini} = 0.01$) also raises the income level of long-term ($\Delta Y^\infty / Y^\infty = 0.01$) of 1%. The output of the first regression shows that an increase of 1% of income inequality led to a long-term effect of $(-0.9261 / -0.0181) * 0.01 = 0.51\%$.

Regarding the regressions (2) and (3), we introduced respectively the variables Human and PopG. We concluded that the initial income and the Gini coefficient remain negatives but not significant. In addition, when we added the variable Human, the Gini coefficient has increased. So, we can deduce that through the transmission channel "human capital" income inequality has an impact on economic growth. Indeed, the coefficients related to human capital often appear smalls and insignificant. This result is not surprising since there are many studies that have found a non-significant coefficient, and sometimes negative, concerning the impact of human capital on economic growth (Pritchett (1996), Benhabib and Spiegel (1994)). In addition, the results show that population growth has a negative and insignificant impact on growth. In this regard, some studies have shown that if the number of inhabitants is growing faster than production, the rate of population growth led to the impoverishment of countries mainly countries of the arrival of the South. In column (4), we see that the (Ipc) variable "index of perception of corruption", which is the channel of corruption, has a positive effect on growth. This effect remained positive and significant in regression (5) where we have added another determinant of growth; it is the share of investment in real GDP per capita (IY). The inclusion of the (Cp) variable "private domestic credit to GDP ratio" in regression (6) shows that financial liberalization has a positive and significant impact on growth. This result is confirmed by the empirical literature. In this case, initial income has a negative and significant effect on economic growth. This result also supports the hypothesis of conditional convergence of Mankiw, Romer and Weil (1992). These authors argue that developing countries tend to grow (and approach to the technological frontier) faster than developed countries. In regressions (7) and (8) we introduced respectively the following variables: Gov and Stab. The results are expected so that the coefficient associated with the variable Gov is negative and significant. In contrast, the variable Stab has a positive sign but it is not significant, which leads to the conclusion that political stability has a positive effect on economic growth. This is logical, because the political stability gives people the best conditions to produce more in order to promote the growth of their economy.

In addition, the coefficient associated with the variable (Trade) is positive but insignificant, it means that trade openness has a positive but insignificant impact on economic growth. The variable (Pright) represents the index Gastil of political rights. This is important insofar as it serves to control the effect of the level of development. According to our regression the coefficient of the variable (Pright) is negative and significant. In addition, the introduction of this variable affected the sign of the

coefficient associated with the variable *Stab* (it was negative). Finally, we include the variable (*Inf*), the estimates show that inflation has a negative and insignificant effect on growth. Indeed, the weakness of the Gini coefficient in the regression (11) can be explained by the introduction of new transmission variables in the previous regressions. The results of recent regressions show that conditional convergence is checked and that the Gini coefficient is weaker. This means that income inequality reduces the growth of real GDP per capita through the transmission variables. Therefore, the relationship between income inequality and growth can affect the political process and commercial economy. In conclusion, the results in Table (1) shows that the addition of variable transmission reduces the importance of the Gini index. In this case, we can say that income inequality is not harmful to economic growth, but they help to slow this growth primarily through the following mechanisms (education, corruption, trade liberalization, financial liberalization and political stability). That is to say that income inequality has not only a direct effect on economic growth, but it also has another effect on the determinants of growth. In fact, these transmission channels used to capture indirect effects since the estimation of Gini index shows that there is a negative impact of income inequality on growth. The regression results are not quite satisfactory, since some coefficients of the variables have unexpected signs. For this, we must correct the endogeneity bias of gini coefficient and test the robustness of the results by using the method of two stages least squares (2sls). To do this, we correct this endogeneity by approximating the variable (*Gini*) by the distance from the equator (*latitude*) and the indicator of political freedoms (*Ipff*). According to econometric research of Atkinson ([2002], p10) and Clement and Meunié ([2008], p5), these instruments are correlated with the Gini coefficient and not correlated with real GDP per capita.

Table 2: *Growth Regressions: 2SLS estimation*

	(1)	(2)	(3)	(4)	(5)	(6)	
Constant		3,0979 (1,68)*	2,5350 (0,83)	1,3350 (0,61)	-1,5715 (-0,55)	-1,0069 (-0,34)	1,3375 (0,40)
Ly ₆₀	0,0722 (-0,59)	-0,0889 (-0,63)	-0,0895 (-0,70)	-0,0965 (-0,79)	-0,1027 (-0,84)	-0,2218* (-1,73)	
Gini	-0,0752 (-2,47)**	-0,0700 (-1,35)	-0,0124 (-0,28)	0,0396 (0,74)	0,0270 (0,53)	-0,0043 (0,08)	
Human		0,0645 (0,52)	0,0433 (0,41)	-0,0372 (-0,34)	-0,0767 (-0,61)	-0,0848 (-0,77)	
PopG			-0,5637	-0,4794	-0,5261	-0,5742	

		(-1,31)	(-0,97)	(-1,07)	(-1,13)
IPC			0,2835** (2,14)	0,2322 * (1,72)	-0,0617 (-0,25)
IY				0,0230 (1,07)	0,0261 (1,32)
CP					0,0193* (1,91)
Obs	78	66	66	65	65
R ²	(.)	(.)	0,113	0,124	0,175
					64
					0,273

Note: The symbols ***, **, * represent significance levels of the coefficients at 1%, 5% and 10% respectively. Figures in brackets are standard deviations corrected for heteroscedasticity when the Pagan-Hall test is significant.

	(7)	(8)	(9)	(10)	(11)
Constant	2,7630 (0,79)	2,6557 (0,79)	2,8616* (1,90)	5,1267 (1,52)	5,3855 (1,61)
Ly ₆₀	-0,2690* (-1,90)	-0,2671* (-1,91)	-0,2717** (-2,00)	-0,3435 ** (-2,37)	-0,3568** (-2,43)
Gini	-0,0061 (-0,13)	-0,0016 (-0,04)	-0,0098 (-0,36)	-0,0092 (-0,22)	-0,0072 (-0,17)
Human	-0,0761 (-0,86)	-0,0766 (-0,85)	-0,0934 (-1,06)	-0,1024 (-1,15)	-0,0949 (-1,05)
PopG	-0,3486 (-0,86)	-0,3532 (-0,87)	-0,3534 (-0,85)	-0,2727 (-0,65)	-0,2998 (-0,69)
IPC	-0,0834 (-0,32)	-0,1028 (-0,35)	-0,0830 (-0,28)	-0,1925 (-0,55)	-0,2322 (-0,66)
IY	0,0252 (1,31)	0,0253 (1,31)	0,0259 (1,41)	0,0257 (1,34)	0,0256 (1,33)
CP	0,0214** (1,96)	0,0214** (1,96)	0,0200* (1,68)	0,0201 (1,11)	0,0205 (1,15)
Gov	-0,1074** (-2,24)	-0,1068** (-2,24)	-0,1119** (-2,24)	-0,1153** (-2,40)	-0,1118** (-2,20)
Stab		0,0855	0,0126	-0,2056	-0,1425

		(0,24)	(0,03)	(-0,55)	(-0,36)
Trade			0,0042	0,0036	0,0028
			(0,87)	(0,72)	(0,52)
PRight				-0,3738**	-0,3787**
				(-2,14)	(-2,17)
Inf					-0,0014
					(-0,82)
Obs	64	64	64	61	62
R ²	0,348	0,348	0,354	0,399	0,402

Note: The symbols ***, **, * represent significance levels of the coefficients at 1%, 5% and 10% respectively. Figures in brackets are standard deviations corrected for heteroscedasticity when the Pagan-Hall test is significant.

Different tests :

Tests	(1)	(2)	(3)	(4)	(5)	(6)
F stat	3,16**	3,24**	2,83	3,23**	2,89	3,64**
DWH ($\chi^2(1)$)	0,15	0,012	0,014	0,18	0,06	0,24
Pagan-Hall ($\chi^2(q)$)	2,40	4,83	3,78	2,86	3,33	3,91
Sargan ($\chi^2(1)$)	2,37	0,32	0,50	0,30	0,27	0,08

Tests	(7)	(8)	(9)	(10)	(11)
F stat	3,61**	3,19**	4,10**	3,30**	3,27**
DWH ($\chi^2(1)$)	0,45	0,37	0,31	0,05	0,06
Pagan-Hall ($\chi^2(q)$)	4,96	5,14	5,17	3,83	4,63
Sagan ($\chi^2(1)$)	0,26	0,32	0,29	0,01	0,001

Interpretations :

- Fisher statistic

Fisher test allows to know if a multiple regression model is globally significant or not. Except the equations (3) and (5), tests of other equations are significant. In addition, the values associated with the probability of Fisher are less than 0.05. So, we accept the alternative hypothesis H_1 which confirms the global significance of the model.

- Durbin-Wu-Hausman

This test was conducted in two stages least squares regressions to ensure that the Gini coefficient is actually disencumber of the part of endogenous after the introduction of the instruments. According to the results, the DWH test is not significant, $F_{\text{calculated}} < F_{\text{theoretical}}$ so we accept H_0 which means the absence of endogeneity of the Gini coefficient. So, in order to have consistent and unbiased estimators, we must use the method of 2sls. In another words, we must introduce valid instrumental variables.

- Pagan-Hall

This test is performed to check the constancy (homoscedasticity) of the residues in regressions with two stages least squares. According to the results, all chi-square statistics are not significant. Thus we accept the null hypothesis of homoskedasticity. So, to verify the validity of the instruments we should applied the Sargan statistics.

- Sargan

According to the results, all the coefficients are not significant. So, we accept H_0 which confirms the validity of the instruments.

▲ In table 2, the regression of equation (1) the Gini coefficient is negative and significant. The results are more robust than in Table 1. They confirmed the negative effect of income inequality on growth respecting the assumptions of the transmission channels. In the next section, we will test the empirical effects of income inequality on each determinant of growth (transmission channel).

The effect of income inequality on the transmission channels

To detect the importance of transmission mechanisms, we estimate the effect of income inequality on human capital, political stability, corruption, financial liberalization and trade liberalization. This step captures the indirect effect of income inequality on economic growth. First, we will estimate the dependence of the transmission variables on the measurement of income inequality (Gini):

$$Z^i = \beta_0 + \beta_1 \text{gini}^i + \mu^i \quad (e)$$

With β_0 is the coefficient associated to the constant, β_1 is the coefficient associated to the variable «gini» and Z^i represents the vector associated to the different transmission channels. To test the robustness of our results, we use an alternative specification for the transmission channels. To do this we incorporate the variable “initial level of real GDP per capita” in equation (e).

The equation that describes the transmission variables becomes:

$$Z^i = \lambda_0 + \lambda_1 \text{Ln}(Y_0^i) + \lambda_2 \text{gini}^i + \sigma^i \quad (f)$$

Z^i represents the vector of transmission channels; λ_0 , λ_1 and λ_2 are coefficients that reflect the influence of the constant, the effect of initial income per capita and that of income inequality on the transmission channel concerned. Since the Gini coefficient explains some of the variation in transmission variables. Then it will be possible to calculate the direct and indirect effect of income inequality on economic growth. Substituting equation (e) in equation (a), we obtain:

$$G^i = (\alpha_0 + \alpha_3 \beta_0) + \alpha_1 \text{Ln}(Y_0^i) + (\alpha_2 + \alpha_3 \beta_1) \text{gini}^i + \alpha_3 \mu^i + \varepsilon^i \quad (g)$$

Table 3 : Indirect Transmission Channels of Income Inequality

	Stab	Human	Trade	Cp	Ipc
Constant	0,0337 (-0,04)	8,3849*** (3,42)	65,6605** (2,29)	10,7854 (0,34)	5,0049** (2,52)
Ly ₆₀	0,1033 (1,34)	0,3207 (1,18)	2,1902 (0,63)	8,9209** (2,42)	0,2890 (1,45)
Gini	-0,0192* (-1,79)	-0,0746*** (-2,78)	-0,1260 (-0,32)	-0,7148* (-1,74)	-0,0686** (2,52)
Obs	78	66	78	77	77
R ²	0,075	0,121	0,008	0,150	0,153
Breusch-Pagan	0,02	0,81	5,94	2,15	4,57

*Estimated with OLS considering that Stab, Human, Trade, Cp and Ipc are respectively dependent variables. Note *, **, *** correspond to significance at the 10, 5 and 1%.*

The results of the different regressions show that there is a significant negative correlation between the Gini index, and political stability, human capital, financial liberalization and corruption. So, income inequality has a negative and significant effect on these transmission channels. In contrast, the relationship between the Gini index and trade openness is negative but not significant. This result may be due to the presence of the initial level of per capita income as an explanatory variable. For this reason, we estimate again equation (f) with elimination of the initial level of GDP per capita. The results are presented in Table (4).

Tableau 4: Gini index and transmission channels : Estimation with OLS

	Stab	Human	Trade	Cp	Ipc
Constant	0,7766** (-2,28)	11,8049*** (12,99)	85,9431*** (6,30)	95,0600*** (6,27)	6,8298*** (8,11)
Gini	-0,0184** (-2,38)	-0,1065*** (-4,99)	-0,0089 (-0,03)	-1,2035*** (-3,58)	-0,0655*** (3,52)
Obs	144	121	145	142	143
R ²	0,031	0,141	0,000	0,075	0,083
Breusch-Pagan	1,33	0,09	1,09	5,71	10,21***

Note that Stab, Human, Trade, Cp and Ipc are respectively dependent variables.

, **, * Correspond to the significance at 10, 5, and 1%.*

After eliminating the initial level of real GDP per capita, we note that the results are almost the same interpretations as those in the previous table. So it is confirmed that the Gini coefficient has a negative and insignificant effect on trade liberalization. To test the robustness of our results, we will estimate equation (f) using the 2sls method.

Table 5: Gini index and transmission channels : Estimation with 2SLS

Stab	Human	Trade	Cp	Ipc	Constant
	13,789*** (2,17)	90,021** (3,87)	101,503*** (2,18)	10,726*** (1,98)	2,929** (3,67)
Ly ₆₀	0,033 (0,33)	0,231 (0,83)	-0,076 (-0,02)	4,647 (1,24)	0,120 (0,55)
Gini	-0,079*** (-3,43)	-0,191*** (-3,09)	-0,456 (-0,65)	-2,169** (-2,51)	-0177*** (-3,55)
Obs	67	59	67	68	67
F	6,95***	28,60***	4,36**	5,30***	7,40***
DWH	14,67***	6,16 **	3,68	6,41**	10,02***
Pagan-Hall	2,69	3,42	3,45	5,96	3,05
Sargan	2,74	1,84	4,65**	2,28	3,17

Note that Stab, Human, Trade, Cp and Ipc are respectively dependent variables.

, **, * Correspond to the significance at 10, 5, and 1%.*

R² is not on the table since the command `lvrreg` on stata removes R² in the regressions by two least-squares method when it is negative. In addition, the R² does not really statistical significance in the context of regression by 2sls, see (<http://www.stata.com/support/faqs/stat/2sls.html>)

Table 5 shows that income inequality has a negative and significant impact on the transmission channels except channel of trade openness. And that may be the cause of the existence of the variable "LY₆₀". For this reason, we will estimate again the regression regardless this variable to check the robustness of the results.

In fact, the Fisher statistics indicate that the models are statistically significant. In addition, exception of the equation of trade openness, the DWH test shows the endogeneity of Gini coefficient, so we had to settle for a regression with 2sls method. In addition, the Pagan-Hall test indicates that the residuals are homoskedastics, so we will apply the Sargan test. And this shows that the selection of instruments are valid for our regressions except for the variable "Trade" where the Gini coefficient is exogenous.

Table 6: Gini index and transmission channels: Estimation WITH 2sls

Stab	Human	Trade	Cp	Ip	
Constant	2,856** (3,80)	18,921*** (8,60)	90,021** (2,18)	181,631*** (5,79)	12,169*** (7,45)
Gini	-0,072*** (-3,91)	-0,288*** (-5,35)	-1,147** (-2,09)	-3,403*** (-4,42)	-0,202*** (-5,02)
Obs	116	102	116	114	117
F	15,32***	28,60***	4,36**	19,56***	25,22***
DWH	13,51***	23,93 ***	1,13	16,26**	21,70***
Pagan-Hall	3,42	5,97	2,97	3,15	2,75
Sargan	1,74	1,95	4,65**	2,28	0,17

Note that Stab, Human, Trade, Cp and Ip are respectively dependent variables.

*, **, *** Correspond to the significance at 10, 5, and 1%.

R^2 is not on the table since the command *lvmreg* on stata removes R^2 in the regressions by two least-squares method when it is negative. In addition, the R^2 does not really statistical significance in the context of regression by 2sls, see (<http://www.stata.com/support/faqs/stat/2sls.html>)

We conclude that the indirect effects of income inequality on economic growth are confirmed. The Gini coefficient has a negative and significant effect on all variables. Thus, human capital, political stability, financial liberalization, trade openness and corruption are the transmission channels through which income inequality affects growth. In the next section, we will quantify the relative contribution of each transmission channel.

The total effect of income inequality

To distinguish between direct and indirect effects of income inequality on economic growth, we will use a simultaneous equations model, the proof can be found in *Appendix 3*. It should be noted that we use this model only to decompose direct and indirect effects and not to estimate these effects. In fact, to get the long-term effect of income inequality on the transmission channels, we rewrite the equation Z^i :

$$Z^i = \beta_0 + \beta_1 \text{Ln}(Y_0^i) + \beta_2 \text{gini} + \epsilon^i$$

$$E(\Delta Z^i) = \beta_0 + \beta_1 (\Delta \text{Ln}(Y_0^i)) + \beta_2 (\Delta \text{gini}) + \epsilon^i$$

$$\text{Où } \Delta \text{Ln } Y_0 = \text{Ln}(Y_0^j) - \text{Ln}(Y_0^k), \Delta \text{gini} = \text{gini}^j - \text{gini}^k, \Delta Z = Z^j - Z^k$$

Then, we divide the last equation by (Δgini) to release the long-term effect of income inequality on the transmission channels.

$$E\Delta Z / \text{gini} = \beta_1 (\Delta \text{Ln}(Y_0) / \text{gini}) + \beta_2$$

From this equation: $G^i = (\alpha_0 + \alpha_3 \beta_0) + (\alpha_1 + \alpha_3 \beta_1) \text{Ln}(Y_0^i) + (\alpha_2 + \alpha_3 \beta_2) \text{gini} + (\alpha_3 \mu^i + \epsilon^i)$

We can conclude the value of $(\Delta \text{Ln}(Y_0) / \text{gini})$, and we obtain:

$$E\Delta G^i / \text{gini} = (\alpha_1 + \alpha_3 \beta_1) \Delta \text{Ln}(Y_0^i) / \text{gini} + (\alpha_2 + \alpha_3 \beta_2)$$

$$\Delta \text{Ln}(Y_0^i) / \text{gini} = -(\alpha_2 + \alpha_3 \beta_2) / (\alpha_1 + \alpha_3 \beta_1)$$

We replace this equation in $E\Delta Z / \text{gini} = \beta_1 (\Delta \text{Ln}(Y_0) / \text{gini}) + \beta_2$ we obtain;

$$E\Delta Z / \text{gini} = \beta_1 [-(\alpha_2 + \alpha_3 \beta_2) / (\alpha_1 + \alpha_3 \beta_1)] + \beta_2$$

→ This expression represents the long-run effect of income inequality on the transmission channels.

Table 7: Simultaneous equation model

	OLS	2SLS
Constant	6,0437* (1,66)	6,0437* (1,66)
L_{Y60}	-0,1816 (-0,90)	-0,1816 (-0,90)
μ_1 (Human)	-0,2459 (-0,28)	-0,2159 (-0,25)
μ_2 (Cp)	-0,0588 (-0,49)	-0,0622 (-0,52)
μ_3 (Icp)	-2,2800 (-1,48)	-2,2007 (-1,43)
μ_4 (Trade)	0,0271 (0,58)	0,0261 (0,56)
μ_5 (Stab)	0,2477 (0,09)	0,1873 (0,07)
Gini	-0,1252* (-1,94)	-0,1252* (-1,94)
Obs	64	64
R^2	0,103	0,166

Simultaneous estimation with GDP per capita growth rate as dependent variable

*, **, *** correspond to 10. 5. and 1% of significance respectively

Returning to the analytical framework of Mo (2000-2009), the decomposition of the contribution of income inequality on economic growth through the channels of transmission are as follows:

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

Where $\frac{dGR}{dGINI}$ represents the total effect of income inequality on growth, $\frac{\partial GR}{\partial GINI}$ represents the direct effect of inequality on economic growth detected by the coefficient α_2 in the equation (a).

In addition, $\frac{\partial GR}{\partial CT}$ is the effect of transmission channels on growth captured by the coefficient α_3 . Finally, $\frac{\partial CT}{\partial GINI}$ is the effect of income inequality transmission channels captured by the coefficient β_2 . The total effect represented by this equation corresponds to the coefficient $(\alpha_2 + \alpha_3 \beta_2)$. We will estimate this coefficient in the following table. We have found that the coefficient is equal to 0,1914.

Table 8 : The importance of transmission channels

Variables		Direct Effect	Indirect Effect	Contribution	Relative
α_2	α_3	β_2	$\alpha_2 + \alpha_3 \beta_2$		
Gini		-0,0172		-0,0172	9%
Stab		0,2477	-0,0172	-0,0047	2,4%
Human		-0,2459	-0,0746	0,0183	9,5%
Trade		0,0271	-0,1260	-0,0034	1,7%
Cp		-0,0588	-0,7148	0,0420	22%
Icp		-2,2800	-0,0686	0,1564	81,7%
Total				0,1914	100%

This table presents the calculation of the relative contributions of income inequality and transmission channels on economic growth. The main result that emerges from these estimates is that income inequality affects growth primarily through corruption with a relative share of 81.7% of the total effect. Trade openness is the least important channel through which income inequality affects growth with a contribution of almost 1.7% of the total effect. This result confirms the insignificant effect of the Gini coefficient on the variable “Trade” in table (3) and (5).

Conclusion

The effects of income inequality occupy a major concern of economists. In fact, based on the work of Papyrakis and Gerlagh (2006) and the analytical framework developed by Mo Pak Hung (2000-2009), we analyzed the direct and indirect effects of income inequality on economic growth. Our study consist to examine the transmission channels through which inequality has an impact on growth.

To address the problem of endogénéisation of the Gini index, we adopted the regression with the method of two stages least squares. The results show that corruption is the most important channel, while trade liberalization is the lowest channel.

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Appendices

Appendix 1 : The data base sources

- 1- GR : World Bank and World development indicators 2011
- 2- Gini : World Bank, WDI, WIID World Income Inequality Database, LIS Luxembourg Income Study et Database de Deininger et Squire
- 3- Y_{60} : World Bank et World development indicators 2011
- 4- IY : Peen World Table 7
- 5- PopG : World Bank et World development indicators 2011
- 6- Pright: The Gastil index of political rights freedom house
- 7- Stab: WGI World Government Indicators
- 8- Human: Database de Barro et Lee 2010
- 9- Gov : Peen World Table 7
- 10- IPC : Web site of transparency international
- 11- Ouv: World Bank and World development indicators 2011
- 12- CP : World Bank and World development indicators 2011
- 13- Inf : World Bank and World development indicators 2011

Appendix 2 : The long term effect of income inequality on transmission channels and economic growth

To determine the long-term income effects of the transmission channels on economic growth, we re-write equation (a) as follows:

$$(\ln(Y_T^i) - \ln(Y_0^i)) / T = \alpha_0 + \alpha_1 \ln(Y_0^i) + \alpha_2 \text{gini}^i + \alpha_3 Z^i + \epsilon^i$$

$$\ln(Y_T^i) = \alpha_0 T + (\alpha_1 T + 1) \ln(Y_0^i) + \alpha_2 T \text{gini}^i + \alpha_3 T Z^i + T \epsilon^i$$

In order to derive the expected difference in income followed by a change in Gini and the different transmission channels:

$$E(\Delta \ln(Y_T)) = \alpha_2 T \Delta \text{gini} + \alpha_3 T \Delta Z$$

$$\text{Where } \Delta \ln Y_0 = \ln(Y_0^j) - \ln(Y_0^k), \Delta \text{gini} = \text{gini}^j - \text{gini}^k \text{ et } \Delta Z = Z^j - Z^k \quad (\text{H3})$$

To assess the long-term effects of *Gini* and *Transmission Channels* on income, we assume that ΔGini_t and ΔZ constant over time, and we study the propagation of

income differences over time. After two periods of T years, income differences are equal to:

$$E(\Delta \text{Ln}(Y_{2T})) = (\alpha_1 T + 2) (\alpha_2 T \Delta \text{gini} + \alpha_3 T \Delta Z)$$

After three periods, we have:

$$E(\Delta \text{Ln}(Y_{3T})) = [1 + (\alpha_1 T + 1) + (\alpha_1 T + 1)^2] (\alpha_2 T \Delta \text{gini} + \alpha_3 T \Delta Z)$$

For $T \rightarrow \infty$, the first term at the right hand side vanishes and the other terms are reduced to:

$$[1 + (\alpha_1 T + 1) + (\alpha_1 T + 1)^2 + (\alpha_1 T + 1)^3 \dots] = 1 / [1 - (\alpha_1 T + 1)] = -1 / \alpha_1 T$$

$$\text{So, we find the equation (b) : } E(\Delta \text{Ln} Y_\infty) = - (\alpha^2 / \alpha_1) \Delta \text{gini} - (\alpha^3 / \alpha_1) \Delta Z$$

Appendix 3 : Simultaneous equation

The growth equation is :

$$G = \alpha_0 + \alpha_1 \text{Ln}(Y_0) + \alpha_2 \text{gini} + \alpha_3 \text{ouv} + \alpha_4 \text{cp} + \alpha_5 \text{human} + \alpha_6 \text{ipc} + \alpha_7 \text{stab} + \varepsilon_1 (1)$$

Transmission channels equations :

$$Z^i = \beta_0 + \beta_1 \text{Ln}(Y_0) + \beta_2 \text{gini} + \varepsilon^i$$

$$\text{ouv} = \beta_0^1 + \beta_1^1 \text{Ln}(Y_0) + \beta_2^1 \text{gini} + \varepsilon_1^1 \quad (2.1)$$

$$\text{cp} = \beta_0^2 + \beta_1^2 \text{Ln}(Y_0) + \beta_2^2 \text{gini} + \varepsilon_1^2 \quad (2.2)$$

$$\text{human} = \beta_0^3 + \beta_1^3 \text{Ln}(Y_0) + \beta_2^3 \text{gini} + \varepsilon_1^3 \quad (2.3)$$

$$\text{ipc} = \beta_0^4 + \beta_1^4 \text{Ln}(Y_0) + \beta_2^4 \text{gini} + \varepsilon_1^4 \quad (2.4)$$

$$\text{stab} = \beta_0^5 + \beta_1^5 \text{Ln}(Y_0) + \beta_2^5 \text{gini} + \varepsilon_1^5 \quad (2.5)$$

The substitution of equations (2), (3), (4) and (5) into (1) gives :

$$G = (\alpha_0 + \alpha_3 \beta_0^1 + \alpha_4 \beta_0^2 + \alpha_5 \beta_0^3 + \alpha_6 \beta_0^4 + \alpha_7 \beta_0^5) + (\alpha_1 + \alpha_3 \beta_1^1 + \alpha_4 \beta_1^2 + \alpha_5 \beta_1^3 + \alpha_6 \beta_1^4 + \alpha_7 \beta_1^5) \text{Ln}(Y_0) + (\alpha_2 + \alpha_3 \beta_2^1 + \alpha_4 \beta_2^2 + \alpha_5 \beta_2^3 + \alpha_6 \beta_2^4 + \alpha_7 \beta_2^5) \text{gini} + (\varepsilon_1^1 + \varepsilon_1^2 + \varepsilon_1^3 + \varepsilon_1^4 + \varepsilon_1^5) \quad (3)$$