Universitat Jaume I

FINAL DEGREE PROJECT

INEQUALITY AND GROWTH

Degree in Economics
4th Year 2014/2015
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Abstract

Inequality is a phenomenon which is analysed from many points of view. Several studies find that inequality is positive for economic growth whereas some other reports believe it is unfavourable for the economy's improvement. This project aims to provide a small contribution to the relationship between income inequality and economic growth rate.

For this purpose, I have used a theoretical model of endogenous growth that proves the connection between the GDP growth rate and income inequality. This model is tested empirically for the period 1970-2010 by using a series of Organisation for Economic Co-operation and Development (OECD) countries and some other countries such as Mauritius, Malaysia, China, etc. The results that I have obtained on how inequality affects on economic growth indicated that the greater income inequality, the greater economic growth becomes in a country.

Keywords: inequality, economic growth, Gini's coefficient, OECD, 1970-2010.

1. INTRODUCTION

Since many years ago, with the early projects of Lewis (1954)[1] and Kuznets (1955)[2], the problem emerging from the effect of income inequality on economic growth has been analysed. Most of the reports related to this topic have used both theoretical and empirical information. Many of the articles on this issue accept a number of variables necessary to achieve positive economic growth. In this context, certain aspects can be pointed out, such as human capital, free markets, macroeconomic and political stability.

In this report, I would like to help explain the effect that income inequality makes on economic growth. I have made an empirical analysis by using a series of data for the period 1980-2010 of OECD countries and other countries like Mauritius, Malaysia or Indonesia. Before analyzing the empirical part of the model that I have used, I start analyzing both the theoretical consequences of income inequality on the economy as well as the empirical consequences that several authors have obtained. From this point on, I apply an endogenous growth model and I explain the results that I have obtained after using multiple regressions.

2. THEORETICAL AND EMPIRICAL CONSEQUENCES OF INEQUALITY ON GROWTH

Many theories consider that inequality can be an obstacle for the economic growth, throughout the absence of incentives to effort and institutional deterioration. These theories can be divided into four groups: poor institutional quality, imperfections within the capital market, social unrest and savings rates. Regarding the empirical reports that have been done, there are some authors who have acquired results indicating that inequality is positive for growth, whereas some others have achieved completely different results.

2.1 Poor institutional quality

The first explanatory reason is based on the quality of institutions. It is considered that inequality causes deterioration in the institutions, bringing corrupt political institutions.

[1] LEWIS, W.A. (May 1954), “Economic Development with Unlimited Supplies of Labour”, The Manchester School, Vol.22, Issue 2, pp. 139-191.

[2] KUZNETS, S.(1955), “Economic Growth and Income Inequality”, American Economic Review 45, pp.1-28.

In these societies, a small percentage of politicians have so much political power that allows them to create a lobby[3] in order to adopt policies that benefit from them. These policies are usually detrimental to the economy and the rest of society. This lobbies' power allows them to block policies that benefit the majority of society; the rejection of these proposals could reduce poverty significantly.

This political corruption marginalizes a group of population generating income, that is, it excludes those disagreeing with the politicians ruling the country, damaging growth. In these societies policies aiming to divert income (rent-seeking[4]) are applied, favouring the groups supporting politicians. There is also less protection on property rights and, therefore, a lower economic growth.

2.2 Imperfections in the capital market

This second category consists of the imperfections in the capital market[5]. Here it is considered that individuals who are in poverty do not have the same opportunities as people who have a good purchasing power since poor people cannot afford good levels of education. Another reason is that they cannot reach a loan to finance their business projects, and they cannot afford insurance which covers them in any problems that may arise in their businesses either.

This imperfection in the capital market may lead to a higher cost of access to the credit market, which means that financing is more expensive and there are more requirements when borrowing money. For these reasons, unequal information in financial markets which normally occurs in less developed countries implies that countries with greater inequality and more poverty do not use its productive potential and growth properly, compared to other countries with fewer poor citizens or with a more equal distribution of income. Therefore, people who have applied for these loans remain poorer than they would be if the financial markets had granted those loans.

For this reason, if financial markets and institutions improve at the same time as economy does, the effects caused by imperfections in the capital markets are more relevant in poorer countries than in advanced economies.

[3] Lobbying (also lobby) is the act of attempting to influence decisions made by officials in the government, most often legislators or members of regulatory agencies.

[4] Rent-seeking is spending wealth on political lobbying to increase one's share of existing wealth without creating wealth.

[5] Capital markets are financial markets for the buying and selling of long-term debt or equity-backed securities.

2.3 Social Unrest

Thirdly, the consequences derived from fairly high inequality are the alteration on social cohesion, because increasing the gap between the rich and the poor motivates the poorest to participate in public crime, riots and other harmful activities affecting the whole society. Moreover, all these riots and protests cause a reduction in the firms' productivity in the economy.

Considerable inequality can lead to bigger political instability, leading to a drastic reduction in investment. In addition, higher levels of crime occur in more unequal societies (South America, sub-Saharan Africa) and in high growth regions (Asia, Russia). This situation is a social and economic burden that can slow down growth due to several reasons, but especially due to the uncertainty generated over property rights. Even in a dictatorship, dictators' interests would be to promote equality in income if the effects of such equality reduced social unrest and political instability. Therefore, a good redistribution reduces riots and crime, this reduction in violence affects positively on economic growth.

2.4 Saving rates

Some economists believe that higher inequality in income encourages higher savings rates. If this was true, greater equality and a better redistribution would lead to a reduction in savings rates. This vision can be caused by Keynes in his book *General Theory*. Other economists believe that inequality is positive to encourage saving rates in the really poor countries, while a good redistribution would be positive for the savings rate in middle-income countries.

With this explanation, I am determined to show that inequality can have a positive effect on economic growth by improving savings rates, although this improvement in the savings rate is a bit ambiguous.

2.5 Median voter theory

This theory explains certain phenomena occurring in majority vote systems. Politicians tend to adopt programs and policies aiming to convince the majority vote, so politicians must adapt their appearances according to the thought of the median voter. In relation to economic inequality, several authors such as Alesina and Rodrik (1994) feel that the economic policies proposed by politicians are directed to the median voter. At his point they have hypothesized that the more equitable the distribution of income in an

economy is, a better allocation of capital the median voter will have. Therefore, the equilibrium level of capital tax will be lower and the economy's economic growth rate will be favoured.

2.6 Empirical results

From today onwards, many studies about the effects of inequality on economic growth have been done. But all the results from the studies are not consistent because the net effects of inequality on economic growth are ambiguous. For this reason, we cannot consider this theory as a model to follow. For instance, Perotti (1993) assures that inequality causes a decrease in economic growth after performing a regression of a set of countries.

Benabou (1996) also obtained the same conclusions as Perotti (1993). Li and Zou (1998) and Forbes (2000) consider the opposite, so that inequality promotes economic growth. Other authors such as Barro and Salaimartín (2000) achieved results showing that there is a negative effect in inequality on the economic growth in poor countries. Nevertheless, these effects are totally different in developed countries because there is a positive correlation.

The results that I acquired regarding the effect of inequality on economic growth in the group of countries that I have used prove that inequality promotes economic growth.

After analysing both the theoretical and empirical effects that inequality has on economic growth, I reach the conclusion demonstrating that there is ambiguity in both cases and as I said earlier there is no consensus on an empirical or a theoretical model to follow.

3 EMPIRICAL ANALYSIS OF GROWTH FRAMEWORK

Now I am going to design a neoclassical model, which is inspired on the one designed by Barro (2000), and I will use for the empirical study that I am undergoing about how inequality affects on economic growth.

The empirical framework derives from a neoclassical growth model, which can be summarized in a simple equation:

$$Dy = F(y, y^*) \qquad (1)$$

Dy represents the economic growth rate, *y* is the current GDP level and *y** stands for the target level of GDP in the following period. In neoclassical models such as those used by Lewis (1954) and Stiglitz (1969), it is defended that inequality can help improve

an economy's growth. This model's background defends that increasing aggregate savings and reducing the cost of capital leads to increased investment and, therefore, an increase in GDP[6] (Gross Domestic Product).

The results that I am determined to explain in the next section about economic growth have been obtained after using a number of variables about countries, which I will explain later in more detail. The sample data that I have taken are OECD countries and other countries that I mentioned earlier from 1970 to 2010. In the model I have used countries from the five continents, although most of the countries I have chosen are rich countries because most countries belong to the OECD. The starting point of the analysis is in 1970, as most of the data that I have used are available only from this date on.

For there are many incomplete series, I have built ten-year periods and I have used a similar way to that used by Barro (2000) since he built five-year periods. I have obtained five observations for each variable and each country. The sample is limited to 24 countries to avoid potential sources of heterogeneity across countries and because there is no data for many of them.

The model that I have used for regression and to know the effect of inequality on economic growth is as follows:

$$G_{it} = \alpha_i + \beta.y_{it} + \gamma.z_{it} + \delta.h_{it} + u_{it} \qquad (2)$$

The first member of equation *(2)* is the growth rate of real GDP of the country *i* in period *t*, *α* represents the constant term (in this case it represents the particularities of each country); *y* stands for the GDP per capita at constant prices from 1970; *β* is the vector for estimated parameters of *y*; *z* is a series of both economic and institutional variables that I have used in the regression, because they affect the steady state components of the sample. *γ* is the parameter associated with *z*; *h* represents the inequality index that I have used as a regressor, *δ* is the parameter which measures the influence of *h* on *G*, and finally *u* are the estimates or mistakes of random disturbance.

The panel that I have used includes the following variables:

[6] Gross domestic product (GDP) is defined by OECD as "an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production".

- **lypc**

The first is lypc, which represents the GDP per capita. I have used this variable to check if the individual's income is relevant to explain economic growth in a state's economy.

- **lypc2**

The second variable is lypc2, which comes from squaring the first variable. I have done this to reduce the dispersion that may exist between each country's GDP, that is, to check if a relationship between economic growth and GDP per capita has a positive or negative linear correlation.

- **opnid**

The third regressor is opnid, which represents the openness index. I have used this regressor to check whether international trade is relevant in a country's economic growth.

- **csh_i**

The fourth variable in question is csh_i, which consists of the percentage of investment on GDP. I have used this variable to find out if the investment taking place in a country helps or drags out economic growth.

- **csh_g**

The next variable that I have used is csh_g, which lies on the percentage of public expenditure on the GDP produced in a country. I have used this variable to find out whether the level of intervention by the state benefits or rather harms the economy within a country.

- **lhc**

lhc represents the Index of human capital based on the years of schooling. With this variable, I mean to see if better prepared human capital helps or damages a state's economic growth. In order to obtain this variable, I have used the variable hc logarithm to reduce the variable's variability.

- **gin**

Gin, which corresponds to the Gini's index, represents the inequality index that I have used in this study. I have used it to check how inequality affects on economic growth. In

annex I, I indicate what types of inequality indicators exist, specifying how each of them are built and used.

- **gin2**

This variable has been obtained from squaring the previous variable (gin) in order to check what kind of correlation between economic growth and inequality exists. More specifically, the goal is to see if inequality's effect on growth is different at different levels of inequality.

- **ginlypc**

This variable is the interaction between the Gini's index and the GDP per capita. I have done this interaction to check whether the interaction between these two variables is significant for economic growth.

- **dt_2**

This regressor is a temporary dummy of the inequality index (**gin**) in 1980-1990. I have used this dummy to find out the inequality's effect on economic growth in the period 1980-1990.

- **dt_3**

Like the previous regressor, it is a dummy Gini's Index, but in this case for the period 1990-2000. As with the previous variable, I have used it to see the inequality's effect on economic growth in the mentioned period of time.

- **dt_4**

As in the last two variables, this variable is a temporary dummy of inequality index that I have used in the regression (**gin**), but in this case for the period 2000-2010. This regressor shows the inequality's effect on economic growth in the mentioned decade.

- **gin_t2**

This regressor comes from the interaction between the Gini's index and the dummy[7] period 1980-1990 (dt_2). I have introduced this variable to check the inequality's effect on economic growth during this period.

[7] Dummy variable is one that takes the value 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome.

- **gin_t3**

This variable is similar to the above. It is an interaction between the inequality index that I have used (**gin**) and dummy period 1990-2000 (dt_3). Like the previous variable, it aims to find out the inequality's effect on economic growth in the decade (1990-2000).

- **gin_t4**

Finally, this variable is similar to the two previous ones. It is the interaction between the Gini's index and the dummy corresponding to the period 2000-2010 (dt_4). It analyses the inequality's effect on economic growth in this period.

All the variables mentioned above are explained in detail in Annex II, where I show the sources that I have used to compile all the variables' data, the years that I have used and all the variables' peculiarities.

The regression that I have used is based on panel data, since cross-sectional regressions are not useful due to the fact that there are too few observations for each year and I do not obtain robust results. In order to counteract the unobservable individual heterogeneity in panel data, I have used the random effects estimator, because in this case it is more preferable than the fixed effects estimator, given that it is more efficient because the typical errors are smaller than using fixed effects. Then I explain in detail what fixed effects estimators are, variable effects estimators and also when it is appropriate to use each one of them.

There are two widespread methods for estimating panel data models with unobserved individual heterogeneity. The first one is the fixed effects estimator, which is efficient when the idiosyncratic mistakes are homocedastic and have no autocorrelation. In this case, no assumption about the correlation between individual heterogeneity and explanatory variables is made.

If I use the method of random effects in this case, I usually acquire inconsistent parameter estimates. The fixed effects estimator is often applied to incomplete data panels. That is why you cannot have some periods of observation if there is not any relationship with the terms of idiosyncratic error. The fixed effects estimator is more robust but a less efficient estimator than the random effects method.

The random effects estimator is convenient to use when unobserved effects are uncorrelated with the explanatory variables. In this situation, you can let the ai coefficients along with the error term. This estimator is preferable in this situation because it is more efficient, as we get typical smaller errors regarding the fixed effects estimator.

The comparison of results from both methods can be an informal way to test whether there is a correlation between the unobserved heterogeneity, ai, and the explanatory variables, xit, assuming that the terms of idiosyncratic errors and the explanatory variables are uncorrelated. Hausman (1978) was the first author to apply these methods.

The regression's objective I am going to do is to know whether the variables that I have used to explain economic growth are significant, if the signs are positive or negative, but I will focus especially on the inequality index that I have used (**gin**). For this purpose, I have made several regressions over time. I have also used a series of time dummies to know the inequality's effect on several periods of time. To perform this regression, I have used ten-year periods to see how they have different inequality's effects on economic growth. The decades that I have chosen are comprised from 1970 up to 1980, from 1980 to 1990, from 1990 to 2000 and from 2000 to 2010. The starting point is 1970 because it is only available from that year on and I have not found any information prior to that period.

4. EMPIRICAL RESULTS

The empirical part of this project focuses on a panel data analysis to investigate the correlation between income inequality and economic growth in a sample of countries.
For this study's empirical results I have used the Gretl[8] econometric program. The following table shows the variables' descriptive statistics that I have found significant when analyzing the inequality's effect on an economy's growth. On these statistics, we can observe each variable's average, minimum and maximum in each period.

	1970			1980			1990			2000		
	avg	min	max	avg	min	max	avg	min	max	avg	min	max
crec				4,28	1,06	10,68	3,20	0,57	7,20	4,33	1,99	9,17
gin	33,88	23,84	51,30	31,96	20,90	57,42	34,50	20,80	67,00	36,38	24,56	67,00
infl	7,50	-0,39	22,66	19,69	2,71	90,84	206,24	1,56	2735,50	4,23	-1,25	20,45
lypc	8,99	6,72	10,07	9,30	6,98	10,19	9,52	7,10	10,39	9,85	7,51	10,61
lhc	0,78	0,21	1,20	0,87	0,31	1,37	0,95	0,46	1,53	1,04	0,56	1,62
opnid	0,45	0,03	1,98	0,58	0,06	3,51	0,61	0,06	3,36	0,69	0,09	3,18
csh_g	0,14	0,06	0,29	0,16	0,07	0,28	0,15	0,07	0,23	0,15	0,07	0,23
csh_i	0,27	0,05	0,56	0,28	0,08	0,60	0,25	0,12	0,47	0,23	0,17	0,40

Table 1. Descriptive statistics of the variables.

Table 1 shows the analyzed variable's evolution over time. Through the inequality index that I have used (Gin) I deduce that the average level of inequality from the analyzed sample of countries has increased over time. It also highlights that the highest level of inequality has increased considerably (South Africa in 2010 has an index of 70 while the country with the highest level of inequality in 1970 had a value of 51,3).
Other remarkable variables are the GDP per capita (lypc), human capital (lhc) and the openness index (opnid), as all these variables' average value has increased in all the analyzed periods. In contrast, investment (csh_i) has decreased.
Table 2 shows a basic regression used to calculate the inequality's effect on economic growth. I have introduced a number of variables, such as GDP per capita (lypc), human capital (lhc) and other variables that let me a temporary change in parameter the inequality index that I have used, the Gini's index (gin).

[8] Gretl is an open-source statistical package, mainly for econometrics. This program is avalaible for download at: http://gretl.sourceforge.net/

	Coefficient	Standard deviation	T Statistics t	P value	
const	39,0456	10,1889	3,8320	0,0003	***
lypc	-4,9775	1,03678	-4,801	8,49E-06	***
opnid	2,20614	1,35571	1,627	0,1081	
csh_i	-4,39564	3,4994	-1,256	0,2132	
csh_g	-4,22158	4,81354	-0,877	0,3834	
lhc	6,09048	2,30611	2,641	0,0102	**
gin	0,174883	0,0461697	3,788	0,0003	***
dt_2	0,0532685	1,16516	0,04572	0,9637	
dt_3	-0,134574	0,777584	-0,1731	0,8631	
dt_4	1,16591	0,514416	2,266	0,0265	**

Table 2. Determinants of growth.
Part I. Basic regression.

Table 2 shows several variables that are significant in relation to economic growth. The first is the GDP per capita (lypc), which is very insignificant (1%). This variable has a negative effect on economic growth because a 1% increased in GDP per capita causes a reduction of 0,0049775 (4,9775 / 100) percentage points in the economy's growth.

Another variable to consider is the Gini's index (gin) in the period 1970-1980. This inequality indicator has also been rather insignificant (1%). This inequality index is positively correlated with the economy's growth, because the one-unit increase in the Gini's index gives way to an improvement in the economic growth of 0,174883 percentage points.
Human capital (lhc) is a rather significant regressor (5%) though. This regressor is positively correlated with economic growth which can be seen in an increase of 1% in human capital that causes an improvement in the economy of 0,00609048 (6,09048 / 100) percentage points.

Finally, Gini (dt_4) stands for another variable that has been significant in the regression is the inequality index (dt_4) in the period 2000-2010, as it is significant at 5%. The inequality indicator in this period also has a positive correlation with economic

growth- when it increases by one inequality unit, economic growth increases 1.16591 percentage points.

Table 3 shows the same regression performed in Table 2 but excluding South Africa, as its inequality index is much higher than the average in all the analyzed periods. South Africa's inequality index is higher than 50 in all periods, while the average inequality in all periods is less than 25. For this reason, I have decided to exclude this country to check if it has caused any disturbance in the regression results previously explained.

	Coefficient	Average deviation	T Statistics	P Value	
const	33,6885	9,72322	3,465	0,0009	***
lypc	-4,4118	1,00223	-4,402	3,82E-05	***
opnid	2,28948	1,25336	1,827	0,0721	*
csh_i	-5,25559	3,45859	-1,52	0,1332	
csh_g	-4,43586	4,7447	-0,9349	0,3531	
lhc	6,02808	2,25642	2,672	0,0094	***
gin	0,18527	0,0456762	4,056	0,0001	***
dt_2	0,652224	1,10767	0,5888	0,5579	
dt_3	0,281971	0,747521	0,3772	0,7072	
dt_4	1,49907	0,507272	2,955	0,0043	***

Table 3. Determinants of growth.
Part II. Basic regression excluding South Africa.

In Table 3, we can observe that there have been some changes in the results in comparison to Table 2. These changes have taken place after excluding South Africa from the regression. The most remarkable changes are the inclusion of a new significant variable, changing the variables' parameters and the change of certain variables' significance, which had a different degree of significance in Table 2. In this regression, the openness index (opnid) is a significant variable when explaining economic growth. This variable has a degree of significance of 10%. This regressor has a positive effect on economic growth, since the increase of one percentage point in the aperture ratio causes an increase in 2,28948 percentage points in economic growth.

On the other hand, human capital (LHC) has changed the degree of significance with respect to the one in Table 2, which has a degree of significance of 1% in Table 2, while in Table 3 it was significant at 5%. It happened the same with the inequality index in the period 2000-2010 (dt_4) as in Table 3 it has a significance of 1% while in Table 2 it comes up to 5%.

In Table 4, I have added two variables in the basic regression, the squared GDP per capita (lypc2) and the squared Gini's index (gin2). I have used this regression, together with the inclusion of these squared variables, in order to verify whether the connection between these two variables and economic growth has a linear, positive or negative relationship. So, at different income levels the effect on economic growth is different or at different levels of inequality the effect on the economy's growth is different.

	Coefficient	Standard deviation	T statistics	P value	
const	21,548	18,9158	1,139	0,2586	
lypc	2,4222	4,23013	0,5726	0,5688	
lypc2	-0,491466	0,243546	-2,018	0,0475	**
opnid	2,59641	1,45217	1,788	0,0782	*
csh_i	-7,19643	3,81894	-1,884	0,0637	*
csh_g	-11,3458	5,20591	-2,179	0,0327	**
lhc	5,29539	2,2413	2,363	0,021	**
gin	-0,234417	0,220998	-1,061	0,2925	
gin2	0,00569045	0,00294098	1,935	0,0571	*
dt_2	0,351447	0,605418	0,5805	0,5635	
dt_3	1,98467	0,84328	2,354	0,0215	**
dt_4	1,59501	1,28535	1,241	0,2188	

Table 4. Determinants of growth.
Part III. Basic regression with squared GDP per capita and squared inequality index.

In Table 4, we can be aware of the fact that the two squared variables which have been introduced are significant in relation to economic growth. The first one, squared GDP per capita (lypc2), has a degree of significance of 5% and this variable has a negative relationship with the economy's growth, so the relationship between GDP per capita and economic growth follows an ∩ shape.

The other variable that has been introduced is the squared Gini's index (gin2), which has a significance of 10% and has a positive relationship with economic growth, so the relationship between inequality and economic growth represents a U shape.

Next, Table 5 is shown, where the basic regression plus a variable representing the two variables interactions is explained. This variable (ginlypc) represents the interaction

between the GDP per capita and the Gini's index. I have made this regression to check whether the interaction between these two variables is significant on economic growth as well as to verify if having different income levels has any negative effect on the economic growth.

	Coefficient	Standard deviation	T statistics	P value	
const	19,750	19,0145	1,039	0,0303	
lypc	-3,01144	1,97245	-1,527	1,31E-01	
opnid	2,25170	1,34217	1,678	0,0979	*
csh_i	-2,21947	4,03414	-0,550	0,5840	
csh_g	-4,46411	4,81777	-0,927	0,3573	
lhc	6,54864	2,34115	2,797	0,007	***
gin	0,648177	0,4249060	1,525	0,1317	
ginlypc	-0,0507577	0,0451693	-1,124	0,2650	
dt_2	-0,371970	0,5894370	-0,6311	0,5301	
dt_3	0,8806860	0,7969460	1,1050	0,2729	
dt_4	-0,289684	1,16426	-0,2488	0,8042	

Table 5. Determinants of growth.
Part IV. Basic regression with the interaction between the index of inequality and the GDP.

Table 5 shows that the interaction between the inequality index (gini) and the GDP per capita (lypc) is not significant when it comes to explain the economic growth. Therefore, there may be a non-linear connection between income inequality and economic growth for certain levels of income.

The last regression is included on Table 6. I have examined this regression to check what the inequality's effect over the time is. In order to do it, I have introduced in the basic regression the interaction between the Gini's index and temporary dummies.

	Coefficient	Standard deviation	T Statistics	P value	
const	37,840	10,4677	3,615	0,0006	***
lypc	-4,74434	1,06954	-4,436	3,44E-05	***
opnid	2,20054	1,38848	1,585	0,1176	
csh_i	-6,96136	4,37375	-1,592	0,1161	
csh_g	-7,87965	5,26446	-1,497	0,1391	
lhc	5,02513	2,54098	1,978	0,052	*
gin	0,182301	0,0696477	2,617	0,0109	**
gin_t2	-0,0362837	0,0553825	-6,551	0,5146	
gin_t3	-0,015857	0,0579734	-0,2735	0,7853	
gin_t4	0,0242466	0,0650442	0,3728	0,7105	
dt_2	0,895855	2,39691	0,3738	0,7098	
dt_3	2,01881	1,63547	1,234	0,2213	
dt_4	2,64203	1,22764	2,152	0,0349	**

Table 6. Determinants of growth.
Basic regression with effect of long-term inequality.

In the Table 6 above table, we note that the interaction between the Gini's index (gin) and time dummies is not significant. We can then consider that the income inequality's parameter is constant over time. In short, the inequality's effect on economic growth does not change over the periods that have been analyzed.

5 CONCLUSIONS

Unlike some other authors such as Perotti (1993) or Benabou (1996), I have obtained results indicating that income inequality encourages economic growth.

In order to demonstrate my results, I have used a series of regressions. The first one is a basic regression (Table 2), in which I have used a number of regressors to test the inequality's effect on the economy's growth. Afterwards, I have done the same basic regression excluding South Africa in the sample (Table 3), as its inequality index is much higher than the average and I needed to see if it disturbed the results.

Another regression that I analysed was to include a pair of squared variables (Table 4). My purpose with this operation was to check if the relationship between these two variables and economic growth was a positive or negative linear. I have also made another regression by using the interaction between GDP per capita and inequality (Table 5) in order to verify if having different income leads to any effect on economic growth. And finally, I have done a regression by introducing the interaction between the Gini's index and temporary dummies (Table 6) to determine the inequality's effect over time.

After undergoing all these empirical evidence, I have come to the conclusion that income inequality is positive to improve economic growth.

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ANNEX I

INEQUALITY MEASURES

With respect to the tools available to analyze the distribution of income, Cowell (1995) believes that the existing methods designed to study the distribution of income can be grouped into graphic tools, indices and rankings.

Graphic tools

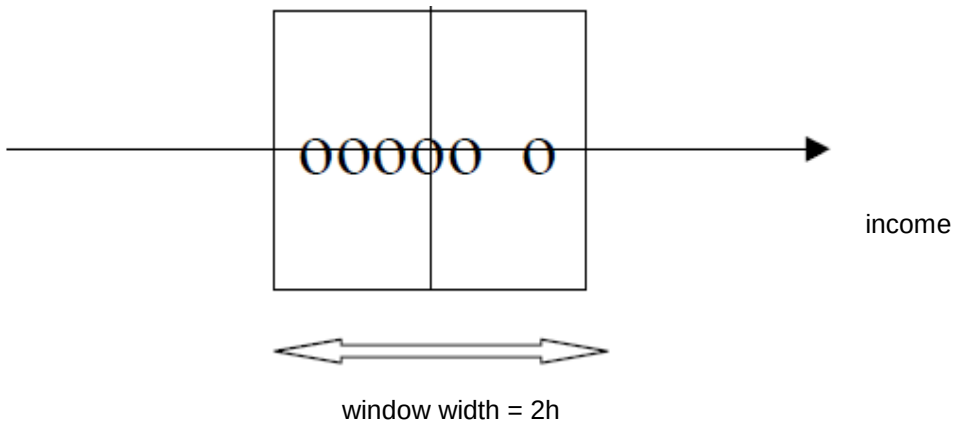
Graphic tools are the simplest and well-known way for estimating income distribution. The most commonly used models for this type of tool are histograms. They are the result from ordering the population form lowest to highest according to their income. Income range is divided into a fixed number of equal width intervals. These intervals are represented on the y-axis, while the ordinates' axis is represented by their relative frequencies. Therefore, the histogram represents the distribution of revenue as a series of rectangles with a base being equal to the income range and a height equal to their relative frequency.

This type of instrument involves some downsides. On the one hand, it shows discontinuities at the intervals ends. Furthermore, the histogram is very sensitive to the chosen interval, which is arbitrary. The larger the interval is, the lower precision we have when calculating the distribution. However, in case the intervals are too small, we are likely to obtain inconclusive information, with many bars with irregularities on the histogram.

On the other hand, this tool's interval width is independent from the number of cases included. A good way to represent this tool is to choose smaller intervals in the densest areas of distribution and larger intervals in areas where the number of cases is lower, as in the distribution tails. The final representation of the histogram also depends on the chosen initial point to draw the bars.

The problems just mentioned have led to other methods to measure income distribution. The Kernel method is currently being used in many studies on inequality. It consists of calculating the observations' density for a certain level of income. These observations are sorted from the largest to the smallest income. To estimate the observations' density for a certain level of income, we used a window picture to represent the data. Later on this window slides to estimate the density at a new point. This method is represented in the following graph.

GRAPH 1. KERNEL METHOD



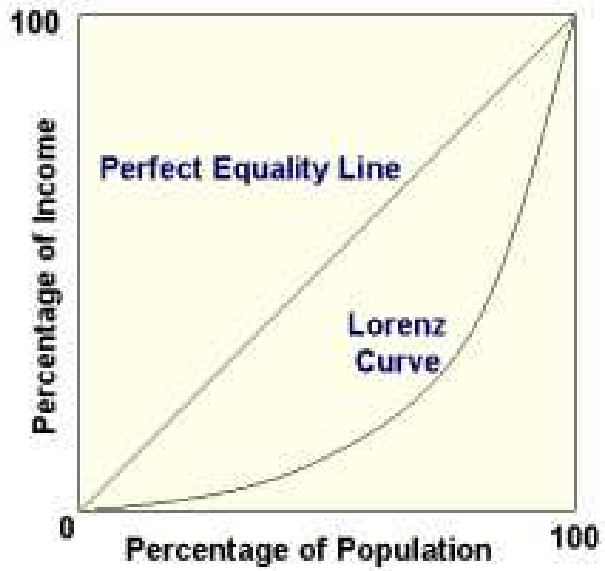
Source: Cowell et al (1996)

The most commonly way used to represent information within this window is to simply count the number of observations that fall inside the window (six in this case). This method is similar to the histogram then. A more useful way to represent information is to give different weights to each observation within the window, establishing decreasing relationships as observations move away from the window's central point.

Another graphical method usually used is the Lorenz's curves, which are represented from the ordering of the population according to their income, from lower income up to higher income. A square is used, where the ordinates axis stands for the percentage of the population and the y-axis represents the percentage of income. If a society has an equal income for everyone, 1% of the poorest population receives 1% of revenue or 10% of the company receives 10% of total revenues, and so on.

In this case Lorenz's curve would be represented by a diagonal in the square above. This 45 degree line corresponds to a society with an equal distribution of income. Therefore, the bigger income inequality is, the more distant the Lorenz's curve would be. In the case of maximum inequality, where only one person would have any income, the Lorenz's curve coincides with the coordinate axis and the right side of the square shown below.

GRAPH 2. LORENZ CURVE



Source: Compiled from sportsandillumination.com

This graphical method allows ordering both distributions because in case two non-intersected Lorenz's curves are represented, the curve located below is the one having less low levels of inequality, while the dominant curve along the curve Lorenz is located above, the one representing less inequality. It is often not possible to use the dominance criteria in Lorenz's direction as the curves intersect or cross each other.

Inequality indexes

The estimation of inequality through indexes has reached great methodological advances. Normally, the indices that are commonly used for the analysis of inequality accomplish with a series of conditions. The conditions or basic principles are:

- Pigou-Dalton transfers principle. This condition expects inequality to increase if a transfer from a poorer individual to a richer individual occurs. At the same time, a transfer from one rich person to another poorer person should reduce the inequality index. Cowell (1995) considers this principle as the weak transfers' principle, since it only requires the inequality's increase if there is a transfer from a poorer individual to a richer individual, but it does not set the percentage of the increase.
- Scale independence. The inequality indicator has to be invariant to uniform proportional transformations in the distribution of income. If all individuals'

income changes at the same extend, the percentage of inequality would remain the same.

- Population principle. It defends that measures in income inequality must be independent from the population's size taken into account.
- Decomposition. This principle considers that global inequality has to be consistently related to the different groups of the distribution.

There are different statistical methods to measure the degree of income inequality, being *Yit* the value in country *i* at time *t* of that variable respect to the one we wish to analyse the inequality in a country respect to a set of countries *N*.

- **Range of variation**

This index is an absolute measure of dispersion which only considers the variable's extreme values.

$$\text{Range} = \max(y_i)_{i=1}^{N} - \min(y_i)_{i=1}^{N}$$

The higher the variation range is, the bigger the degree of inequality in a country will be. The unit that has been used to calculate the range is the same as the one used in the variable *y*.

- **Relative variation range:**

This method is very similar to the previous one. It is a relative measure of dispersion which only takes into account the variable's extreme values.

$$\text{Relative range} = \frac{\max(y)_{i=1}^{N}}{\min(y)_{i=1}^{N}}$$

Like the previous index, the higher the range's value, the higher the degree of inequality in a state.

- **Standard deviation:**

This method is also an absolute measure of dispersion which uses all observations of the analyzed variable and gives them equal weight to each of them, regardless of the country or state's size.

$$\sigma_i = \sqrt{\frac{\sum_{i=1}^{N}(y -)^2}{N}}$$

$\bar{y} = \sum_{i=1}^{N} \frac{y}{N}$

With the standard deviation's indicator we acquire greater inequality when this deviation's value is higher. We must bear in mind that if the standard deviation is calculated on original values, this method of inequality is subject to arbitrary measurement units. So, the standard deviation per capita income measured in euros will be a thousand times greater than the one we get in thousands of euros. Therefore, the simple fact that there is inflation causes increasing deviations, as each country has different levels of inflation.

Furthermore, if we obtain the standard deviation of the logarithm values of the natural variable, we will not face the problem explained above and we will be able to appreciate a relative measure from the degree of inequality.

- **Coefficient of variation:**

It is a relative dispersion measurement, so it does not become affected by the unit measurement problems.

Coefficient of variation = $\frac{\sigma_y}{\bar{y}}$

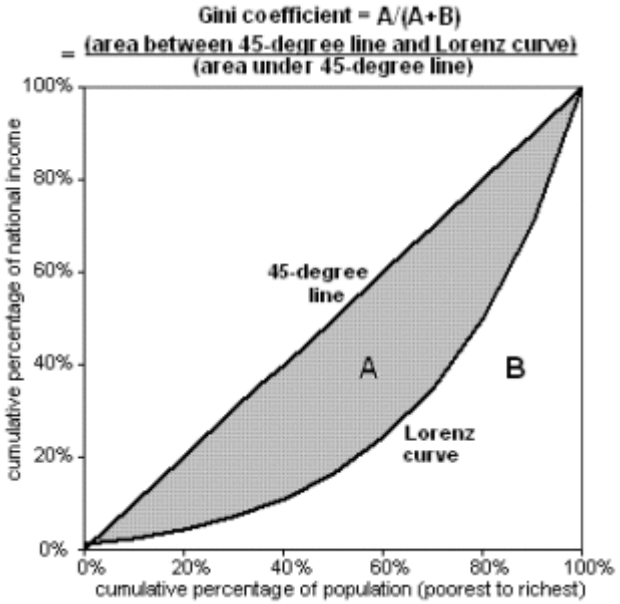
Despite the fact that the variance is a measure of dispersion, the more dispersed the analyzed sample is, the greater the deviations become in respect to the average, and therefore the variance's value becomes bigger.
The variation's coefficient is usually takes as a measure of inequality, as an appropriate measure of inequality has to be a relative measure capable of allowing comparisons between different states and moments. This is possible thanks to the average ratio. The main problem with this measure is that the standard deviation and the average only demonstrate two aspects of the income distribution. Another disadvantage is that this measure is more sensitive to changes in the distribution's upper tail with respect to the distribution's middle and lower ends.

- **Gini's coefficient:**

This measure is based on Lorenz's curve, shown above. In the situation of maximum equity or equitable distribution, the Gini's coefficient is zero. As inequality increases, the Gini's coefficient approaches one. This coefficient can be regarded as the proportion

between the area where the equity line and the Lorenz's curve remain (represented by A in the graph). That is G = A / (A + B).

GRAPH 2. GINI COEFFICIENT



Source: Compiled from The Settlers of GovHack

The Gini's coefficient is obtained as the quotient between the area comprising the perfect equality diagonal and the Lorenz's curve. As inequality improves, the area decreases and the Lorenz's curve comes closer to the diagonal. On the other hand, if inequality increases, the Lorenz's Curve moves away from the diagonal. If inequality was total, the B area would disappear and only the A area would remain. This situation means that one family receives all the income.

- **Theil's index**

This indicator is an inequality's measure based on Shannon entropy (1948). It is used to calculate and compare the distribution of income. Pablo Cotler believes that this index can be disaggregated into an inequality component within the groups intended to be studied and another component corresponding to inequality between groups.

Theil = 1 – exp (-R)

The resulting value from this indicator lies between 0 and 1. The closer to 1 this value is, a greater income inequality in the analysed country there will be.

Rankings

- Deciles and quintiles

Deciles are defined as 10% of the population, while quintiles represent 20% of the population. These two types of rankings are the most used. To apply them the sample must be ordered from lower to higher income. A traditional inequality indicator is to compare the bottom quintile (the higher income) to the first quintile (the lowest entry) and a person's average income is estimated in the bottom quintile (the richest country against poorest). Furthermore, we can also obtain the average income among other deciles (quintiles), for example, Q2 / Q1, Q3 / Q2, Q4 / Q3 and Q5 / Q4. Therefore, we can see if inequality is homogeneous throughout the population or it focuses on a particular group.

ANNEX II

Information of variables regression

- Lypc. This variable represents the GDP per capita. I have extracted the data on GDP per capita at constant prices from the Penn World Table. I have got all the data on the GDP from the countries in the years 1970, 1980, 1990, 2000 and 2010.
- Lypc2. It represents the squared GDP per capita. In order to obtain it, I have used the same data as the previous regressor.
- Openid. It stands for the countries' openness index. For this variable I have used the percentages of exports and imports. I have achieved these percentages from the Penn World Table. I did not have any problem at the time of collecting such data in periods that I have used.
- Csh_i. It is the percentage of investment existing in a country. This variable, like the three previous ones, has been compiled from the Penn World Table. I did not have any problems in collecting the data for this variable.
- Csh_g. It represents the percentage of public expenditure existing in a state. This percentage is calculated by dividing the public investment in a country into the GDP. These ratios have been taken from the Penn World Table, there is no anomaly in the data for each period.
- Lhc. It is Index of human capital per person, based on the schooling years. This index is used to make the quality of each state's human capital known. For this variable I have used the hc variable's logarithm. I have done this to reduce the variable's variability. The data for this index have been obtained from the Penn World Table, like the other regressors that I obtained through this database. I did not have any problems when collecting the data for the years that I have worked on.
- Gin. It represents the inequality index (Gini's index) that I have used in the regression. I have used this regressor to calculate the level of inequality existing in a state. I have compiled this data index from the database http://www.chartbookofeconomicinequality.com/. I have found some difficulties

in collecting the data for some countries in the years that I have used for the study. Table 7 specifies the years that I have used for each period.

COUNTRY	1970	1980	1990	2000	2010
Germany	1969	1978	1990	2000	2010
France	1970	1979	1990	2000	2010
Italy	1970	1980	1989	2000	2010
Japan		1981	1990	2000	2008
Malaysia	1970	1979	1990	1999	2009
Norway		1986	1990	2000	2010
Portugal			1993	2000	2010
Southafrica			1993	2000	2008
Spain		1980	1990	2000	2010
Sweden	1975	1980	1990	2000	2010
Switerland		1982	1992	2000	2004
United Kingdom	1970	1980	1990	2000	2010
USA	1970	1980	1990	2000	2010
Singapure			1990	2000	2005
NewZealand		1982	1990	2001	2009
Netherlands		1981	1990	2000	2008
Mauritius	1975	1980	1991	2001	2012
Indonesia	1969	1980	1990	1999	2010
India		1978	1988	2005	2010
Finland	1971	1981	1990	2000	2010
Canada	1976	1980	1990	2000	2010
Brazil		1981	1990	1999	2009
Argentina	1974	1980	1990	2000	2010
Australia		1981	1989	2000	2010

Table 7

- Dt_2, dt_3 and dt_4. I have obtained these dummies thanks to econometric program that I have used to carry out the regression (Gretl). For these regressors I have used the same data as for the Gini's index (gin).
- Gin2. I have obtained this variable from squaring the Gini's index. So I have obtained the data from the same source that I have obtained the data on inequality measure that I have used.
- Ginlypc. It is the interaction between inequality index (gin) and GDP per capita (lypc). For this variable I just multiplied both variables. The sources for this variable are the same as those used for the Gini's index and GDP per capita.
- Gin_t2. It is the interaction between the Gini's index and the dummy in this period (1980-1990). For this regressor I have multiplied this indicator of inequality by the dummy of this period (dt_2). The source that I have used to create this variable is the same as that I used to form the Gin's variable.

- Gin_t3. This variable consists of the interaction between the inequality index (gin) and temporal dummy for the period 1990-2000. In order to obtain this variable, I have multiplied the Gini's index by the corresponding dummy to this decade (dt_3). The source for this variable is the same as the preceding variable.
- Gin_t4. It consists of the interaction between the Gini's index and the dummy for the period 2000-2010. In order to create this variable I have increased the inequality index that I have used (gin) through the corresponding dummy (dt_4). The source used to create this variable is the same as in the last two variables.