The optimal rate of inequality: A framework for the relationship between income inequality and economic growth

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Abstract

This paper contributes to the debate over the relationship between inequality and growth by proposing that the disparities in empirical studies derive from the fact that they have not accounted for the level of inequality as a factor that can affect the sign of the relationship. An inverted "U" shaped relationship is demonstrated, showing that low levels of inequality exert a positive correlation with economic growth while high levels have a negative one. Additionally, and more importantly, it is demonstrated the existence of an optimal rate of inequality (ORI) that maximizes growth rates and releases the economy from any distortion generated by elevated inequality or taxation. Empirical evidence from a broad panel of countries as well as a bibliometric analysis is presented to validate these propositions.

JEL Classification O15, D31, D33, E25
Keywords: Inequality, Growth, Redistribution, Optimal Rate of Inequality.

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Over the last two decades there has been a continuous debate over which is the true relationship between income inequality and economic growth. Empirical studies have found a series of contradictory results, from the ones who affirm a negative relationship (Alesina and Rodrik, 1994; Clarke, 1995; Perotti, 1993; Alesina and Perotti, 1996; Persson and Tabellini, 1994; Perotti, 1996; Kremer and Chen, 2002; Castelló and Doménech, 2002; De la Croix & Doepke (2003), Josten, 2003; Ahituv and Moav (2003); Viaene and Zilcha, 2003; Josten, 2004; Castello-Climent, 2004; Knowles, 2005; Davis, 2007 and Pede et al., 2009), the ones who find a positive one (Partridge, 1997; Forbes, 2000; Li and Zou, 1998; Nahum, 2005), a non linear correlation (Barro, 2000; Banerjee and Duflo, 2003; Pagano, 2004; Voitchovsky, 2005; Bengoa and Sanchez-Robles (2005); Barro, 2008; Castello-Climent, 2010) to the studies who assert an inexistent one or a non conclusive (Lee and Roemer, 1998; Panizza, 2002; Castelló and Doménech, 2002).

Although the sources of information in the empirical studies are, in many cases, the same[1], authors have incorporated diverse variations in the characteristics of their works in order to find the "real" relationship between inequality and growth and conciliate the differences in the literature. Either by upgrading the quality of the data, employing different methodologies in the estimation of the models[2], reducing or incrementing the time horizon of the expected effects from inequality to growth, testing different transmission mechanisms to explain the relationship or by including dummies in the estimation, none of them have taken into account the level of inequality as a potential cause for the discrepancy in the results.

Before asking ourselves if income inequality is positively or negatively related to economic growth we should question if the phenomenon is "natural" or at least expected in the context of a market economy, where it is generally accepted that the income level of its members is at least partially determined by its marginal productivity

[1] Among the most influential are the databases from Deininger and Squire (1996), more recently the one compiled by the World Income Inequality Database (WIID) and, for the socio-economical variables, the database from Barro and Lee (1993).
[2] Such as ordinary least squares (OLS), generalized method of moments (GMM), Three stage least squares (3SLS), seemingly unrelated regression (SUR), fixed or random effects estimation, Arellano and Bond (1991) type estimations, among others.

and by the comparative advantages that he/she displays as a result of its economic performance.

Rousseau (1755) declared more than two centuries ago, on his discourse on the origins of inequality, that in the moment when ancient man departed from the natural state and came to create the first societies, the foundations for the generation of inequalities among individuals were set. Meaning that individuals, as they became part of groups in which private property existed and where each of them, performing a specific role, interact with the other, the conditions were set for the differentiation of individuals and for inequality to exist.

Later in that century, Adam Smith made a statement that endorses the existence of differences between individuals which generate inequalities as an intrinsic part of the economic system. Smith declared that it is the division of labor and not the inherent characteristics of individuals what causes "the very different genius which appears to distinguish men of different professions" (Smith, 1776, p.p. 15-16). Further on his wealth of nations he even implies a positive relation between the accumulation of wealth by rich individuals (in the form of gold and silver) and the enrichment of a country (Smith, 1776, p. 326).

Schumpeter refers in this way to the incentives that motivate the performance of individuals in a bourgeois society:

> *It unleashes, with inexorable speed, the promises of wealth and the threat of ruin with which penalizes economic behavior ... These rewards are not distributed randomly ... require skill, energy and work capacity above normal, but if it were necessary to measure this skill or the personal input that goes into a particular success, the rewards that are actually paid would probably be considered disproportionate ... thus giving an impetus far more powerful than would a more fair distribution.* (Schumpeter, 1942, p.109)

The reasons for the existence of income inequality in any society can be numerous; from the result of land distribution and rural-urban conditions, to more endogenously determined ones like the characteristics or circumstances intrinsic to individuals and which can potentially determine their future income as the result of influencing their comparative advantages. Innate abilities, intelligence, personality, charisma, or even physical attributes such as strength or skills are some of the most fundamental causes why individuals may differentiate themselves from others. These differences can be determinants in the current and future income of any individual.

Additionally, the variety of preferences among individuals can potentiate or undermine any physical or intellectual attribute. These preferences are in fact influenced by social and cultural values due to the fact that they are in general constructed as the result of collective inertia derived of costumes, traditions, idiosyncrasy and other variables such as history and geography which can determine the individual's attitude towards certain preferences or choices such as work, education, and risk aversion.

If we agree that a certain amount of inequality is natural and even necessary in a market economy, then the question should rather be *how much inequality is harmful for growth?* To inquire only if inequality is harmful or beneficial to economic growth, as most studies implicitly do, requires to expect a linear answer and to assume the levels of inequality do not play any role in defining the relationship; in other words, it implies the effects of inequality over growth to be the same regardless of its magnitude. Moreover, to imply the possibility of agreeing on a general positive or negative relationship would mean either to reach recommendations to economies (regardless of their specific context, i.e. their current inequality level or their democratic status) for actively promoting permanent increases in their inequality levels or the opposite if it where the case.

Only a few studies (Barro, 2000; Banerjee and Duflo, 2003; Pagano, 2004; Voitchovsky, 2005; Bengoa, 2005; Barro, 2008; Castello-Climent, 2010) have found a non linear relationship between inequality and growth. Nevertheless, these studies attribute the change in the tendency to causes which are exogenous to the level of inequality[3] and, in most cases, directly related to the determinants of economic growth or to the income level of the country.

[3] Banerjee and Duflo attribute the negative relationship to changes in inequality but the effect comes from the economic distortions generated by distributive decisions at any level of inequality.

Barro (2000) and (2008) finds, after estimating for different income levels[4], a positive and significant relationship between income inequality and growth for rich countries[5] and a negative one for poor countries. These results imply, among other things, that in a country with low income levels, the more redistribution and lower inequality, the higher will the growth rate be. On the other hand, in countries with high per capita income (above the break point level), as the levels of inequality rise, the economy will experience more growth, derived from the proposed positive relationship. Pagano (2004) finds the same relationship on his study after dividing the sample into OECD and non-OECD countries. Additionally, he finds an inverse negative relationship between growth and inequality.

One could ask if the non linearity is sustainable at any level at both sides of the relationship, this is, if poor countries will need to virtually eliminate inequality (with all the implications of this extreme and improbable case) in order to reach the higher growth rates, or if rich countries trying to maximize growth or maintain the income level should promote increasingly high levels of inequality.

Moreover, these findings entail that there is a level of per capita income (the break point income level) associated with low economic growth, meaning that countries with income levels situated at the break point are in the worst case scenario, facing an income trap with the lowest possible growth rates at a point in which inequality (or the lack of it) does not affect growth in any way and where the decisions of how to promote potential growth would imply stimulating it through determinants that are not affected by the inequality - growth relationship, while promoting income inequality in order to spur the positive relationship predicted for the countries above the break point income level.

This interpretation also implies that a country in the path from low to high income per capita levels would have to go through the following phases in order to maximize growth performance:

[4] Barro (2008: p.p.6-7) finds when running the model with the full sample a negative and significant relationship between inequality and growth due to, "the fact that for most of the sample, the estimated effect of inequality on growth is in the negative range"

[5] In Barro (2000) the breakpoint occurs at an income level of approximately $2,000 (1985 US dollars), and in Barro (2008) around $11,900 (in 2000 US dollars).

Phase 1	Implementing redistributive policies with the purpose of lowering inequality and incrementing the growth rate.
Phase 2	Achieving growths through mechanisms not affected by inequality nor related to it, in order to surpass the income break point.
Phase 3	Promoting an increase in inequality levels in order to promote higher growth rates (derived from the positive relationship).

Note that in the context of this non-linear relationship, the income level is the determinant factor for the effects of income inequality over economic growth. The income level determines its rate of growth or reduction for a given inequality level in a country, thus making this economy contradictory with the established Kuznets (1955) inverted "U" hypothesis in which, countries, in their path to development, will experience first an increase in their levels of inequality, followed by a decrease as they further develop. This predicted initial rise in income inequality at low income levels would hold back the economy from further growing due to the negative relationship between inequality and growth predicted in this relationship. Furthermore, if a country could reach higher income levels and inequality starts to descend, as predicted by Kuznets, more growth would be difficult due to the positive relationship existing now between inequality and growth at high income levels.

The only study found to suggest a relationship between inequality and growth that could be determined by the level of inequality, this is, that account for the fact that different levels of inequality can exert different types of effects it the study developed by Cornia et al. (2004), nevertheless, this hypothesis is presented only at a theoretical level and not proven empirically.

Another study which finds a non linear relationship is the one carried out by Banerjee and Duflo (2003) who measure the effects of changes in inequality on economic growth in the short run and find that movements (in any direction) are associated with reduced growth in the next period. Under this view, if an economy could reach a circumstance in which no distributional conflicts were in place, economic growth would be higher. At this point, any change in redistribution (either positive or negative) would lower the growth rate.

These results are consistent with an inverted "U" shaped relationship between inequality and growth which was justified using political economy and wealth effect arguments. Note that the authors do not acknowledge the level of inequality as a cause for the non-linearity and assume that the absolute changes in inequality are the ones responsible for distorting growth. Their results imply, among other things, that the way to promote growth is to maintain inequality stationary, no matter how high or low it is, even with the assumption that growth does not have any distributional effects. It is also implied by the inverted "U" shape of the relationship that the optimal growth rate can be achieved at any level of inequality as long as this is fixed and no distributive distortions arise.

The purpose of this section is twofold; first, to demonstrate the fact that the main variable determining the effects of inequality over growth is inequality itself, specifically, the level of inequality is the one determining the sign of the relationship; second, to prove the existence of an Optimal Rate of Inequality (ORI) in which growth is optimized and the economy is liberated from the negative effects of high inequality and/or high taxation. Additionally, this research proposes the existence of an inequality trap in which countries with low marginal efficiency of redistribution and underdeveloped tax systems are unable to reach the ORI and achieve optimal growth. This inequality trap can, in theory, account for the inability of some countries to lower the levels of inequality and/or generate significant growth.

This chapter is structured as follows: on the following section a simple political economy model is presented to depict the relationship between redistribution, inequality and growth; the next section develops an empirical study composed by a broad panel of countries over four decades in order to test the non linear relationship; this study is follow by an alternative validation of the model trough the Kuznets curve; It follows a third empirical study, this one consisting in a highly disaggregated, country specific, study that will empirically test for the validity of the model in the context of the Mexican economy; finally, a bibliometric study is presented with the purpose of providing empirical evidence to demonstrate that the proposed relationship between inequality and growth holds for most empirical studies when analyzing the composition of the sample.

The model

Consider an economy in which the level of inequality is determined by the amount of redistribution. Higher levels of redistribution will lead to lower levels of inequality conditioned to the marginal efficiency of redistribution (MER) which is defined by the level of development of the tax system both on the revenue as in the redistributive expenditure side. An efficient redistributive system in which institutions and social programs are able to transfer resources effectively to the lower brackets of income, as well as a progressive tax system with low levels of evasion and informality, will result in a higher MER, in other words, higher changes in the levels of inequality as a response to changes in redistribution. Additionally, this situation will result in a lower value relation between inequality and redistribution, where lower levels of redistribution will be enough to achieve a lower level of inequality in comparison to an economy with a less developed tax system.

In this economy there is a tradeoff between the negative effects of high inequality (and low redistribution) and the negative effects of too much redistribution (and high taxation) on economic performance. High levels of inequality affect directly and indirectly the determinants of growth through its effects on investment, human capital, fertility and other variables that distort the potential of the economy. On the opposite side, high levels of redistribution and the associated high levels of taxation, also affect economic growth[6] by discouraging economic agents to pursue productive activities, by limiting the accumulation of productive capital, by restraining investment due to elevated taxation and by preventing individuals from the appropriation of the returns of their productive activities Persson and Tabellini (1994).

The economy tends to the concentration of income and higher levels of inequality (Sen 1992). In this sense, constant redistribution is needed in order to maintain or reduce the levels of inequality in the economy.

The previous arguments derive into three possible scenarios:

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[6] Castelló-Climent (2001) shows that the relationship between taxes on capital and growth rates behave as an inverted U, initially, capital taxation incentivizes growth, but after a certain level it starts generating negative effects over growth.

1. An economy with high levels of inequality and low redistribution that affect negatively the growth rate (y^2 in upper part of Figure 1).

2. An economy with low levels of inequality and high redistribution and taxation that affect negatively the growth rate (y^1 in upper part of Figure 1).

3. An economy with a level of inequality and redistribution in which both effects (the negative of high inequality and the negative of high redistribution) are minimized and the economic performance is released from any distortion to its growth potential. We will call this the optimal rate of inequality (ORI). At this level, the growth rate of the economy will be maximized in comparison to any other level of inequality (y^* in upper part of Figure 1). .

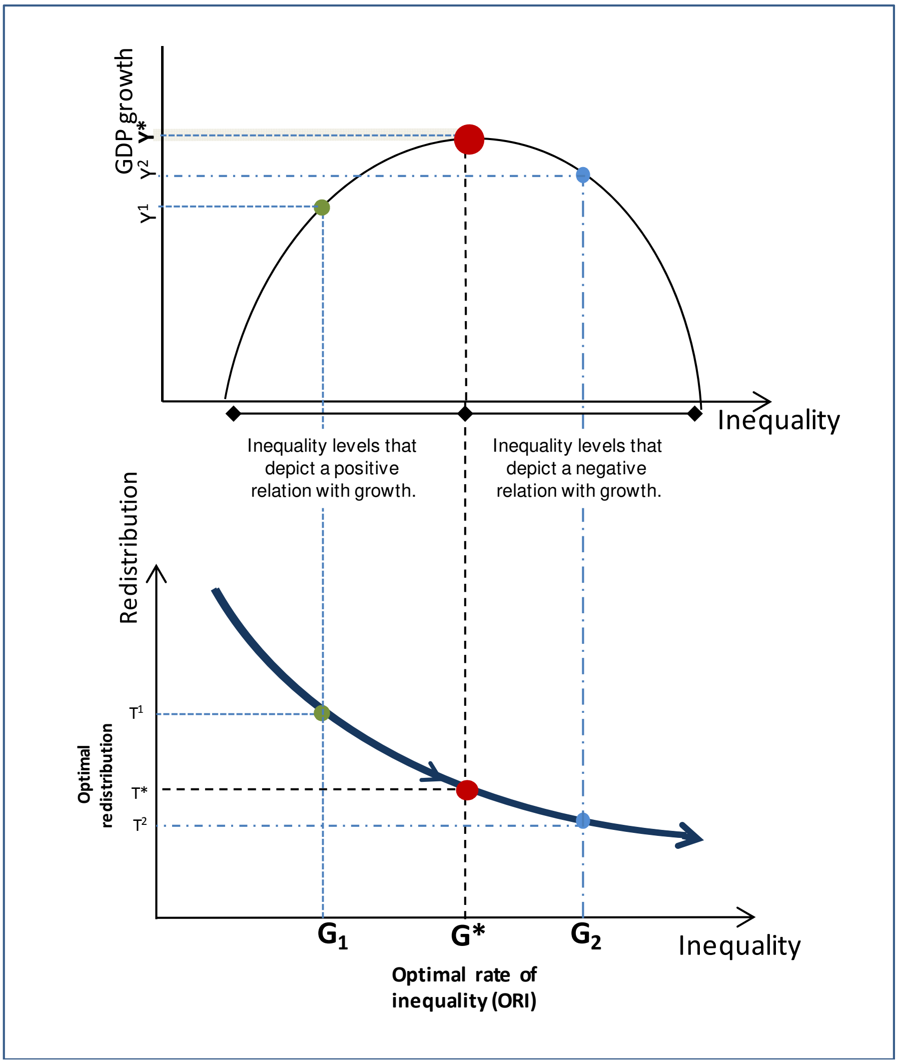
At the optimal rate of inequality, any change in the level of redistribution and inequality, positive or negative, will lead to a lower rate of economic growth. Nevertheless, lowering inequality will result in a positive relationship between inequality and growth as it will mean that in order to increase the growth rate to its maximum (and return it to the ORI) more inequality, and less redistribution/taxation which is the one affecting growth, will be needed (See Figure 1).

Accordingly, if a country is at the ORI and its levels of inequality rise, the empirical relationship between inequality and growth will turn negative, meaning that in order to maximize the growth rate, a reduction in the level of inequality (a rise in redistribution) will be needed. This means that when a country reaches the ORI (the maximum in the kinked relationship) the correlation between inequality and growth will become insignificant (with a slope cero and negative second derivative).

The intensity of the relationship between inequality and growth, in any direction, will be indicative of the distance of the current level of inequality from the ORI, the farther away from it, the stronger the relationship.

It is important to point out that this model does not explain how much will the economy grow at different levels of inequality. That is the job of conventional growth models. What it shows is that, *ceteris paribus*, there are certain levels of inequality that affect negatively the growth determinants in the economy and that there is a level of inequality that releases the potential of the economy, liberating it from any distortion from inequality or redistribution and maximizing the growth rate.

Figure 1: The optimal rate of inequality and the relationship between redistribution, inequality and growth.



The objective for a country should be to identify and reach the level of inequality that is empirically unrelated to growth. Once the ORI is reached there is no reason for moving away from it. The exception case would be a country in which the redistributive system (in the revenue and expenditure side) is highly underdeveloped and the level of taxation and redistribution necessary for maintaining the ORI needs to be very high. In this case, there could be a situation in which the negative effects of such level of taxation are higher than the positive effects of being at the ORI. Nevertheless, this situation is highly improbable due to the impossibility for a country to reach the ORI under those conditions.

In this model, growth does not have an automatic redistributive effect. Only through redistributive decisions can inequality be lowered. It is logical to assume that higher growth could translate into higher tax revenues that can increase the levels of redistribution, but only as the result of active redistributive policy implementation.

Marginal Efficiency of Redistribution

In this model, redistribution is defined ambiguously as the process of gathering resources (taxation) and allocating them at the lowest brackets of income (redistributive expenditure). This means that the decisions of lowering or increasing income inequality are affected both by the efficiency of the tax revenue system and of the redistributive expenditure programs.

A more efficient redistributive system, in which resources are effectively allocated to the lowest brackets of income in the way of monetary and in kind transfers, access to education, health and other determinants of income homogeneity will result in a higher MER, this is, a higher elasticity in the effects on inequality levels as a response to a change on redistribution, graphically represented as a steeper curve.

As an economy increases the MER, it will be easier to reach the optimal rate of inequality because less redistributive effort will be necessary to achieve significant changes in the level of income inequality.

The other determinant of the slope of the relationship between inequality and redistribution is the level of development of the distributive system on the revenue side. A country with a developed and progressive tax system in which the principles of vertical and horizontal justice are fulfilled[7], where evasion is minimized and informal

[7] Broadly speaking, vertical justice in the context of taxation means that different incomes pay progressively different taxes. Horizontal justice means that individuals in a same income level should pay the same amount of taxes.

economy is very small, will tend to have more developed and efficient redistributive programs. Additionally, for each level of redistribution there will be a lower level of inequality associated to it, in comparison to a country with a less developed tax system.

A country with high levels of evasion, informality and an inefficient tax collection system will require higher tax rates in order to obtain the same revenues as a country with a more developed tax system. This means that, for a country with a less developed tax system, more redistributive effort (on the revenue side) will be needed in order to achieve the same levels of inequality as an economy with a more developed system.

Empirically, the arguments presented before explain the following situations faced by countries in their redistributive efforts:

- The reason why different countries have different levels of inequality at similar levels of redistribution.
- The reason why some countries with similar levels of inequality have different levels of redistribution and taxation.
- The reason why some countries have to apply more intense redistributive policies than others in order to reduce inequality in depth.

A note on the causality between income inequality and redistribution

It is important to point out that in this model the causality of the relationship between inequality and redistribution is one sided. Changes in the level of inequality do not generate any significant effect on the levels of redistribution as some political economy models predict. For this to happen it would be necessary for a country to fulfill a series of assumptions such as perfect distribution of political power on the society (one person one vote), perfectly progressive tax systems, among other conditions in order for the median voter theorem to work.

Additionally, this mechanism stresses the negative effects of redistribution over growth such as the distortions generated by high taxation or time loss in the bargaining process of political decisions, without accounting for the potentially positive results from public investment and expenditure in activities such as education, R&D, health, infrastructure, among others. At best, it assumes the negative effects to overcome the positive ones.

Assuming an automatic effect from inequality to redistribution would imply imposing an unrealistic ambiguity between the variables in both causal directions: one with a positive relationship from the effects of inequality over redistribution; and two, with a negative correlation from the effects of redistribution to inequality.

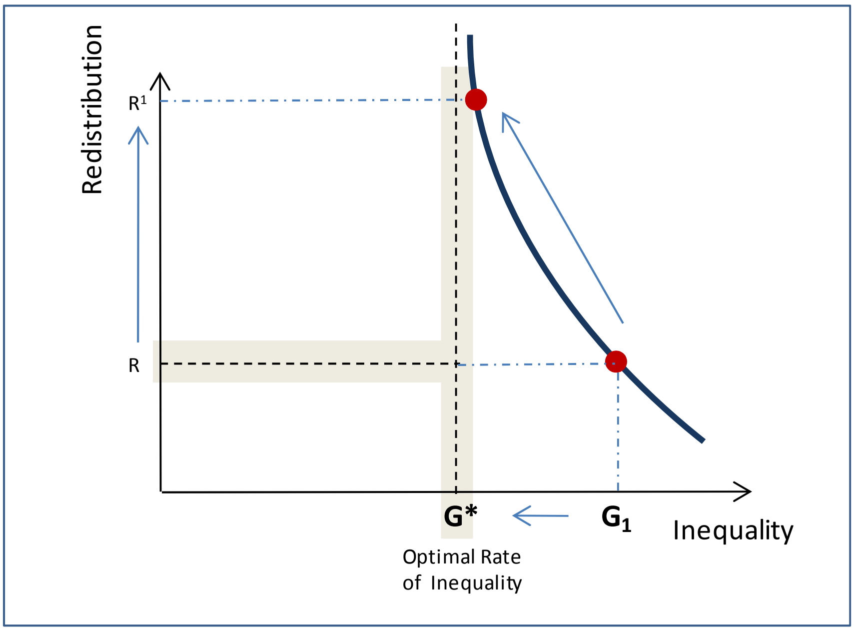
If it were the case of a country in which this assumptions were confirmed, the predicted positive effect from inequality to redistribution would entail that a "curative" mechanism is permanently at work to prevent movements in redistribution and inequality, implying the existence of an equilibrium which irremediably leads to question how can, in this perspective, any country get out from to their initial inequality level? and how can it be affirmed that a country with high inequality will grow less if the mechanism itself prevents inequality from growing? Under this view, the cases of countries with high inequality, used to explain the political economy models, are in fact exceptions to the precepts of the model.

Finally, several studies support these affirmations in that there is no convincing evidence to support the statement that inequality affects positively redistribution (Rodriguez, 2000; Benabou, 1996; Bertola, 2000; García-Peñalosa, and Turnovsky, 2006; Josten, 2003). Benabou (1996) affirms that "the effect of income distribution on transfers and taxes is rarely significant, and its sign varies from one study or even one specification to the other".

The inequality trap

Consider a worst case scenario in which there is a country with a very low marginal efficiency of redistribution and a highly underdeveloped tax system. This country is characterized by having low tax revenue due to high evasion and a large informal sector in the economy. Additionally, the redistributive system is highly inefficient; the resources are poorly allocated and any redistributive effort yields very low effects on the levels of income inequality. In consequence, this country sustains high levels of income inequality that distort the determinants of economic growth and limit the potential of the economy (See Figure 2).

Figure 2: Underdeveloped redistributive systems and the inequality trap.



Given these circumstances, this country would find itself facing an inequality trap in which any effort to reach the ORI would be insufficient. The level of redistribution needed in order to reach the optimum will be too high to achieve and it would mean additional distortion to the economy[8].

Any country that finds itself in this situation will not be able to reach the ORI with a distributive strategy. In order to achieve the desired level of income inequality, first, it would be necessary to develop the conditions for a higher marginal efficiency of redistribution and a more developed tax revenue system. Achieving this will result in lower levels of inequality with the same or even inferior levels of taxation and redistribution.

[8] In this example it would mean extremely high tax rates to the few contributors who pay. This elevated taxation could be interpreted as incentives to evade or to disengage from productive activities, resulting in even less revenue for the government.

A practical implication of this example is that a country determined to reach the ORI should be aware that increasing redistribution is not the only way to reach the desired level of inequality and economic growth. The first strategy for lowering income inequality should be to make sure that the redistributive system (both on the revenue as in the redistributive expenditure side) is fully developed, this will automatically generate two results:

1. A reduction in the level of income inequality as the value relation between redistribution and growth will decrease automatically.
2. More efficient redistributive policies that will yield better results in further lowering the levels of income inequality and approaching them to the ORI.

A country characterized by having poorly developed redistributive systems, both on the revenue as in the expenditure side, should be aware of the tradeoff they face in their decisions of moving inequality levels towards the ORI. Not only they are in a situation in which they could face an inequality trap that will prevent them from reaching the ORI but they will probably generate additional distortions to the economy derived from the higher taxes needed for the required redistribution levels.

A note on the relationship between this model and other non-linear propositions

Before proceeding to the empirical test of the model, it is necessary to clear out the fact that the above described model differs substantially from the, also non-linear, relationship supported by some authors (Barro, 2000; Pagano, 2004; Voitchovsky, 2005; Bengoa and Sanchez-Robles, 2005; Barro, 2008; Castello-Climent, 2010), even though readers might incorrectly assume some similarities.

First it is necessary to recall the fact that the core proposition of the kinked non-linear type of models is that inequality depicts a negative relationship with growth in low income countries and a positive one in high income countries[9]. This way, the income

[9] Refer to the introduction for a broader explanation of this relationship.

level is the determinant factor for the inequality-growth relationship, as the income level determined its rate of growth or reduction for a given inequality level.

In this sense, the overall relationship presented in this research could be compatible only under the following circumstances:

- That as countries increase their income levels, they also increase their redistribution levels (several country cases such as the United States demonstrate this is not an empirical regularity), or that they do so, after a certain income level[10].
- Given the prior; that the increasing redistribution will effectively lower the inequality levels as the economy grows. Implying a redistributive/taxation system that become more efficient (developed) as the economies grow.

These conditions imply the existence of an automatic growth → redistribution → lower inequality, mechanism which is the equivalent to affirming that economic growth leads automatically to economic development.

Accounting the income level as the main determinant of the inequality-growth relationship may imply assuming too many things that may not occur. Additionally, the income level will never cease to be relative to the ones existing at a specific time. The determination of a rich country in terms of its income will always be subject to the income of one's regarding others and, thus, to what happens individually in those economies but in comparison to the others. Maybe this is why the income break point in Barro (2000) differs so much from the one found in Barro (2008), around $2,000 (in 1980 US dollars) to $11,900 (in 2000 US dollars), when the first would have a value of approximately $3,245 if expressed in 2000 US dollars, a difference of almost four times the income between each other. Perhaps what happened was that in the 2008 sample the countries situated around the optimal rate of inequality had a higher income than those in the 2000 sample. Also, the reason for the negative and statistically significant overall

[10] This includes an additional side assumption in the sense that redistribution will be progressive; while there is evidence in the sense that less developed countries might be prone to have progressive taxation. (i.e. Bertola, 2000 and Scott, 2009).

relationship found in Barro (2008) between inequality and growth derives from the fact that in 2008 there were more countries with inequality levels above the ORI.

The core idea on the model developed in this research is that different levels of inequality will exert specific effects on the growth rates, at any income level. Any country that can reach the optimal rate of inequality[11], regardless of its income level or its "richness" in comparison to other countries, will release its growth determinants from the distortions of either high inequality or high taxation. In this sense, inequality is a far more useful measure, as its value can be reliably estimated and delimited (in a scale of 0 to 1 in the case of the Gini coefficient), additionally, it does not suffer from the relativity issues that the per capita GDP has to face.

Finally, and in a more philosophical perspective, the question which try to answer most of the previous studies on the effects from income inequality to economic growth, specifically: *Is inequality bad or good for growth?,* might be incorrectly stated. Furthermore, the answer provided in the case of the income dependent non-linear relationship, namely, *inequality is bad for the poor and good for the rich*, defies some of the basic foundations of any society, which rely on the existence of inequalities in the form of economic and social differentiation of individuals and in the incentives for achieving such differentiation.

Competence of this model in forecasting growth

As mentioned before, it is beyond the service of this model to provide a forecast on the growth rates of the economies, nor to forecast which will be the richest ones based solely on their inequality levels. The economic performance and the amount of growth of the countries are fundamentally determined by the variables known to be responsible of the economic cycle and production possibilities within a country and between them. Capital (K), labor (L), human capital (H), technology (T) and perhaps other variables, are the ones responsible for the production levels and productivity of a country.

[11] Later it will be proven that the ORI is at reasonably intermediate levels of inequality, at a Gino value of about .39.

The arguments of the model presented above imply that there is an optimal rate (or range) of income inequality which effectively liberates the growth determinants from the distortions of either high levels of inequality or of excessively low inequality levels, through the different mechanisms previously discussed in the theoretical framework.

From this, it is plausible to affirm that the model has much relationship not only with the nominal growth rates of countries but also with their potential growth. A country with higher (or lower) than optimal income inequality levels will see its growth determinants restrained from performing at their potential level, thus it will be impossible to reach its potential growth rate, regardless of the nominal growth rate it achieves. Contrastingly, a country with optimal income inequality levels will be able to grow at its potential rates of growth, or at least closer to them in comparison to other less egalitarian economies, regardless of its nominal growth rate or the fact that it could be lower to that of the previously exemplified country.

Consider the example of three countries (*A, B* and *C*) with nominal growth rates of $\Delta Y_A > \Delta Y_B > \Delta Y_C$ at a specific moment in time and inequality levels of $G_A > G_{B*} > G_C$. Income inequality in country B* is situated at optimal levels; at a higher than optimal level in country A and lower than optimal in country *C*. Finally, potential growth rates are $P\Delta Y_B > P\Delta Y_C > P\Delta Y_A$. Potential growth is defined as the growth rate at which the economy would growth if there were no distortions to the growth determinants.

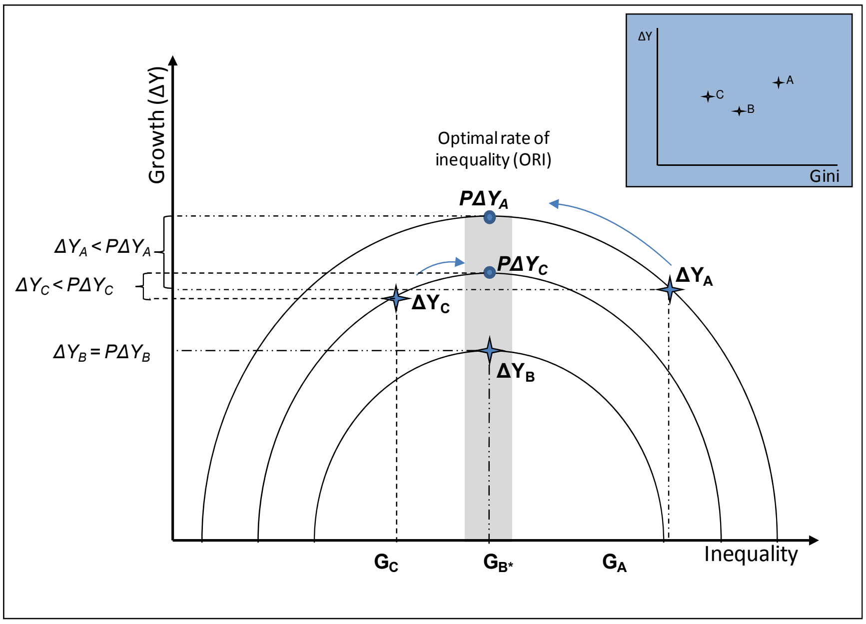
At any point in time, country *A* would have a nominal growth rate higher than those of countries *B* and *C*, derived from the specific circumstances of that country, such as capital accumulation, stock of human capital, technology, etc. Nevertheless, derived from the fact that the growth determinants in country *A* are distorted to some degree by the higher than optimal levels of inequality, the nominal growth rate will be lower than the potential growth rate ($\Delta Y_A < P\Delta Y_A$). Accordingly, the nominal growth rate of country *C* will be also lower than its potential growth rate ($\Delta Y_B < P\Delta Y_B$) and at a lower nominal rate than *A,* however, if country *C* could reach optimal levels of inequality its growth rate would be higher than *A*[12]. (See figure 3)

[12] Assuming that country *B* does not improve its inequality levels.

Finally, country B grows at a lower nominal rate compared to A and C, nevertheless, its nominal equals its potential growth rate derived from the fact that the economy's inequality level is at the optimal rate and there are no distortions to its growth determinants, regardless of their levels.

The workings of this predictions are subject to the assumption that there are no other forces restraining the growth determinants, nevertheless it allows to affirm that the overall empirical tendency should depict a general kinked non linear relationship between nominal growth rates and income inequality (especially when controlling for the specific effects of the growth determinants), as it can be expected that countries achieving higher potential growth will eventually also reach the conditions for performing at the higher nominal growth rates. However, when graphically represented, it is expected to depict a significant degree of dispersion in the data, as the simple two variable correlations will be affected by the differences in level of the growth determinants.

Figure 3: The nominal and potential growth rate in relation to the optimal rate of inequality



Empirical evidence

The following section addresses empirically the main propositions of this paper, namely:

- The existence of a negative relationship between redistribution and inequality.
- The existence of a non linear relationship between inequality and growth, with a negative relationship at high levels of inequality that attenuates as inequality is reduced, until it turns positive at low levels of inequality.
- The existence of a level of inequality that maximizes the growth rate of the economy.

Data

Inequality data measured by the GINI coefficient is similar to the one used by Barro (2008) which was compiled from the United Nations World Income Inequality Database (WIID) and complemented by additional high quality observations from the Deininger & Squire database. The original data before filtering covered 138 countries for the period of 1960 – 2000 with a total of 595 observations. At the end, the availability and correspondence of data for inequality and the dependant variable resulted in a sample of 112 countries with at least one combination of observations. Four additional ex-communist economies were excluded, leaving a total of 108 countries.

The dependant variable was obtained from the Penn World Table mark 6.3 and is expressed in international 2005 prices. The variable was calculated as the average growth rate of per capita GDP for each decade; the four periods (70, 80, 90 and 2000) were calculated averaging the values around each of the four period years so for the 1970`s the values from the years 1965 to 1975 were averaged, and so on for the following periods. The data for initial GDP per capita and the investment ratio were calculated from the Penn World Table 6.3.

Total fertility rate (TFR) was compiled from the Barro and Lee (1993) dataset for the period 1960 -1985 in five year intervals and complemented with information from the United Nations data system (UNdata) for the years 1990 and 2000. Life expectancy at birth was also extracted from the Barro and Lee (1993) dataset but complemented by information from the World Bank world databank. The sum of secondary and tertiary total school attainment was obtained from the new Barro and Lee (2010) dataset on educational attainment.

A fundamental variable in the model is the measure for redistribution which originally was intended to be captured by the ratio of government expenditure on health plus education over GDP. Unfortunately, due to data unavailability it was impossible to capture this information for all periods and it was decided to employ only the ratio of education expenditure over GDP. The raw data came from the Barro-Lee dataset and was complemented by data from the UNdata system[13]

Finally, tax revenue expressed as percentage of GDP was obtained in order to use as proxy for discriminating between countries with developed and underdeveloped tax revenue systems. Table 1 presents the descriptive statistics for the main variables.

The model specification is of the following type:

$$\Delta Y = \beta_1 + \beta_2 Gini_i + \beta_i Gini_i^2 + \beta_i X_i + \varepsilon$$

Table 1. Descriptive statistics of main variables

	Definition	Source	Year	Mean	Max.	Min.	Std. Dev.	Obs.
Investment Ratio	Ratio of real domestic investment (private pus public) to real GDP	Barro & Lee[a]	1960	0.17	0.44	0.01	0.10	105
			1970	0.18	0.40	0.02	0.10	107
			1980	0.18	0.39	0.01	0.09	108
			1990	0.18	0.41	0.02	0.09	108
			2000	0.19	0.46	0.04	0.10	108
Inequality	Inequality measured by the GINI coefficient	Barro	1960	.4397	.6410	.1890	.1061	66
			1970	.4261	.6820	.2370	.988	74
			1980	.4110	.6370	.2240	.998	80
			1990	.4456	.7730	.2370	.1119	97
			2000	.4147	.5986	.2370	.1013	64

[13] Data from the UNdata system were obtained expressed as percentages. Because of this it was necessary to divide each figure by 100 in order to make it comparable with the rest of the data.

Redistribution	Ratio of education expenditure over GDP	Barro & Lee[a] / UNdata	1960-65	0.03	0.06	0.01	0.01	95
			1970-75	0.04	0.37	0.01	0.04	83
			1980-85	0.05	0.42	0.01	0.04	90
			1990-95	0.04	0.09	0.01	0.02	87
			2000-04	0.05	0.11	0.01	0.02	90
Fertility	Total Fertility Rate	Barro & Lee[a] / UNdata	1960	1.66	2.08	0.71	0.37	101
			1970	1.57	2.08	0.60	0.42	101
			1980	1.42	2.08	0.36	0.52	101
			1990	1.27	2.09	0.26	0.54	106
			2000	1.11	2.03	0.18	0.53	106
Income	Ln of real GDP per capita expressed in 2005 international prices	Penn W.T. Mark 6.3	1955	8.16	9.64	6.33	0.85	66
			1965	8.07	9.95	6.18	0.98	101
			1975	8.34	10.12	6.43	1.03	107
			1985	8.46	10.34	6.39	1.11	107
			1995	8.57	10.81	6.41	1.22	108
PPPI	Price level of investment. PPP of investment over exchange rate relative to the U.S.	Penn W.T. Mark 6.3	1970	69.05	362.99	13.79	51.41	107
			1980	112.55	1707.9	19.96	169.19	107
			1990	81.66	472.55	16.35	62.02	108
			2000	64.58	315.65	19.08	39.95	108
Education	Sum of secondary plus tertiary total school attainment	Barro & Lee[b]	1965	0.88	4.57	0.00	0.92	100
			1975	1.32	5.82	0.03	1.16	100
			1985	1.86	6.25	0.07	1.31	100
			1995	2.40	6.38	0.10	1.50	100
			2000	2.62	7.07	0.12	1.58	100
GDP Growth	Average GDP per capita growth expressed in 2005 international prices	Penn W.T. Mark 6.3	1960	2.68	15.67	-4.95	3.00	101
			1970	2.79	14.78	-7.13	2.59	107
			1980	1.26	7.14	-4.91	2.44	107
			1990	1.44	8.03	-6.53	2.29	108
			2000	1.89	7.55	-5.47	1.99	108

Results

A first set of estimations were performed using the complete sample, in order to demonstrate the argument of a negative relationship between inequality and redistribution. Table 2 reports the results. Initially (equation 1), a linear regression with only redistribution as explicative variable was carried out. As expected, a strong and significantly negative coefficient that confirms the effects of redistribution over inequality levels.

Several dummy variables were included in order to increase the explanatory power of the estimation, inspired by the ones employed by Barro (2008), such as Asia and Latina America and dummies that register the characteristics of the data sources for computing inequality such as being from households or individuals or measured as income or expenditure. An additional dummy, which reflected if captured income was gross of net of taxes, was included in the estimations.

Equations 3 to 5 report the results. When including only the regional dummies (equation 3) it was found a still strongly negative and significant effect of redistribution over growth, although slightly lower (-110.35 vs. -143.73) perhaps derived from the fact that the dummies account (especially Latin America) for a lower efficiency of the redistributive efforts in their economy, regardless from the absolute level of redistribution. As in Barro (2008), the signs for the dummies were positive and significant; nevertheless, the Asian dummy had a lower coefficient and was barely significant at the 5%, while the L.A. dummy had a coefficient twice higher and significant at the 1%.

Equation 4 depicts the results of adding the dummies that capture the characteristics of the data used to construct the Gini coefficients. The regression shows a higher explanatory power (the average R^2 for the system is .38 while for equations 1 and 3 was .07 and .26) and the coefficient for redistribution maintained its significance and a highly negative value (-123.71).

An additional system (Equation 5) was estimated including the three before mentioned variables plus the Latin American dummy. The results of this equation confirm once again the proposition of a strong negative and significant effect of redistribution over inequality levels. Furthermore, the coefficients also corroborate the fact that individual instead of household income information tends to compute higher Gini values (Deininger and Squire, 1996), especially when the dataset is mainly constructed with data from low and medium income countries where families tend to have more members. Gross income information (instead of net) tends to show lower inequality coefficients as it does not account for fiscal redistribution.

Table 2. Redistribution vs. Inequality

	Complete sample				
Variables / Equations	**1**	**2**	**3**	**4**	**5**
Redistribution	**-143.73**	**-168.96**	**-110.35**	**-123.71**	**-123.55**
	(0.0006)	(0.0000)	(0.0033)	(0.0053)	(0.0032)
Dummy: Latin America			**10.98**		**7.31**
			(0.000)		(0.0001)
Dummy: Asia			**4.78**		
			(0.0498)		
Dummy: Household vs. Individual				**9.63**	**6.42**
				(0.0000)	(0.0004)
Dummy: Gross or net income				**-10.28**	**-6.77**
				(0.0000)	(0.0019)
Dummy: Income or expenditure data				**-9.19**	**-8.53**
				(0.0005)	(0.0003)
Dummy: Development of tax (revenue) system		**-3.77**			
		(0.0164)			
Dummy: Marginal efficiency of redistribution		**-5.64**			
		(0.0004)			
Intercepts	47.6, 48.2, 51.0, 47.1	51.9, 52.2, 55.6, 52.1	43.4,43.4, 46.4,41.7	53.6,54.2, 57.8,55.0	51.1,51.3, 54.9,51.7
Number of Observations	70, 66, 81, 55	65, 62, 73, 50	70, 66, 81, 55	39, 39, 43, 28	39, 39, 43, 28
R-squared	0.08, 0.02, 0.05, 0.13	0.11, 0.11, 0.18, 0.30	0.16, 0.16, 0.16, 0.58	0.16,0.37, 0.40, 0.60	0.32,0.47, 0.47, 0.69

Dependant variable: Inequality measured by the Gini coefficient. Estimation made by the seemingly unrelated regression (SUR) technique. T-Statistics probability in parenthesis. Explanatory variables are: Latin American dummy, Asia dummy, a dummy that is equal 1 when the inequality data is collected from the person and 0 if from the household (Household vs. Individual), a dummy that reports whether the income registered is gross = 0 or net = 1 of taxes, a dummy that captures whether the Gini coefficient is calculated based on income = 1 or expenditure = 0, A dummy that reports if a country has a developed =1 or under developed tax (revenue) system = 0, finally, a dummy that captures whether the country has a High = 1 or low = 0 marginal efficiency of redistribution.

Finally, contrary to predicted by D & S, the dummy that captures whether data comes from income rather than from expenditure has a negative sign, which means that this kind of information tends to result in a lower Gini value, perhaps capturing some degree of regressive redistribution in the gross of the sample observations.

An inverse estimation was also performed (not shown) where Gini and redistribution variables were shifted in order to look for a reverse causality between the variables. As expected, the coefficient of the Gini variable turned to be almost cero (-0.0002), proving empirically an almost nonexistent effect from inequality to redistribution.

It has been proven that redistribution has a clear effect over inequality levels; nevertheless, not every redistributive effort has the same effect on lowering inequality. A country trying to reach the optimal rate of inequality (ORI) will need to define the necessary levels of redistribution based on how far they are from the ORI, but more importantly, on the efficiency of the redistributive system in reducing inequality. Table 3 reports the results of dividing the sample into countries with low and high levels of development of the redistributive system in order to verify the statement that in economies where the efficiency of redistribution is low, the marginal efficiency of redistribution (MER) will be sensibly lower in comparison to countries with highly efficient redistributive systems.

The measure for the development of the redistributive system was approximated using a proxy that measures the efficiency of one of the most important manifestations of redistribution, namely, expenditure on education. This was obtained by dividing the gross enrolment ratio for primary and secondary education over the ratio of education expenditure over GDP (results/amount). The variable allowed differentiating between countries with low and high efficiency in their redistributive systems. The criterion for dividing the sample was fairly arbitrary, taking as reference the average from the minimum and maximum values as start/end point[14].

Two key results are worth noticing; first, the difference in the intensity of the coefficient for the variable redistribution is quite notable for both samples, especially when including only redistribution as explanatory variable, in this case, the value is 57% higher in the elevated MER sample than the one in the low MER sample (-214.35 against -136.1); second, the intercepts on the system estimation with the high MER are, on average, lower than the ones in the estimation for the low MER sample (3.31% lower). These tendencies maintain when incorporating some of the variables used in Table 2, always obtaining higher coefficients for redistribution in the sample with the higher MER.

[14] For the high quality sample it was necessary to insert additional observation with lower values in order to make a more robust estimation.

Table 3. Redistribution vs. Inequality: segmented sample

	High Marginal efficiency of redistribution			Low Marginal efficiency of redistribution		
Variables / Equations	1	2	3	4	5	6
Redistribution	**-214.35**	**-130.39**	**-115.35**	**-136.1**	**-106.24**	**-112.35**
	(0.0000)	(0.0125)	(0.0323)	(0.0054)	(0.0628)	(0.0351)
Dummy: Household vs. Individual		**13.19**	**12.3**		**12.54**	**9.93**
		(0.0000)	(0.0000)		(0.0000)	(0.0000)
Dummy: Gross or net income		**-6.11**	**-9.88**		**-4.73**	**-10.45**
		(0.004)	(0.0001)		(0.0335)	(0.0001)
Dummy: Income or expenditure data			**-11.9**			**-9.62**
			(0.0004)			(0.0009)
Intercepts	47.2, 47.3, 49.9, 49.0	43.2, 42.9, 47.0, 45.2	54.5, 54.1, 57.4, 56.3	49.0, 50.0, 52.5, 48.0	42.7, 43.5, 46.8, 42.5	53.2, 54.1, 57.1, 53.8
Number of Observations	45, 42, 48, 41	27, 27, 29, 22	25, 25, 27, 21	44, 43, 53, 29	25, 26, 30, 18	25, 26, 30, 18
R-squared	0.17, 0.07, 0.20, 0.22	0.14, 0.38, 0.43, 0.63	0.14, 0.43, 0.6, 0.67	0.10, 0.03, 0.04, 0.14	0.11, 0.31, 0.23, 0.62	0.27, 0.38, 0.38, 0.68

Dependant variable: Inequality measured by the Gini coefficient; estimation made by Seemingly Unrelated Regression (SUR) technique. Independent variables are: Latin American dummy, Asia dummy, a dummy that is equal 1 when the inequality data is collected from the person and 0 if from the household (Household vs. Individual), a dummy that reports whether the income registered is gross =0 or net = 1 of taxes, a dummy that captures whether the Gini coefficient is calculated based on income = 1 or expenditure = 0,

These results confirm that having a more developed and efficient redistributive system will result not only in higher marginal effects of the redistributive efforts in reducing inequality[15], but also in a lower value relation between inequality and growth (see Figure 4) so that that any given level of redistribution (inequality) will be associated with a lower level of inequality (redistribution).

As mentioned before, the relationship between redistribution and inequality is also determined by the level of development of the tax system on its revenue side. A country with high levels of evasion, informality and an inefficient tax collection system will require higher nominal tax rates in order to obtain the same revenues as a country with a more developed tax system and more redistributive effort (on the revenue side) will be needed in order to achieve the same levels of inequality as an economy with a developed tax system.

[15] Notice that the position of the variables (inequality and redistribution) in the graphs has been inverted in order to fit the overall model relating this relationship to the inequality-growth correlation; this is why it would seem that a higher marginal efficiency of redistribution should have a lower coefficient in order to be more efficient in reducing inequality.

Figure 4: Marginal efficiency of redistribution and its effects on the inequality-redistribution relationship

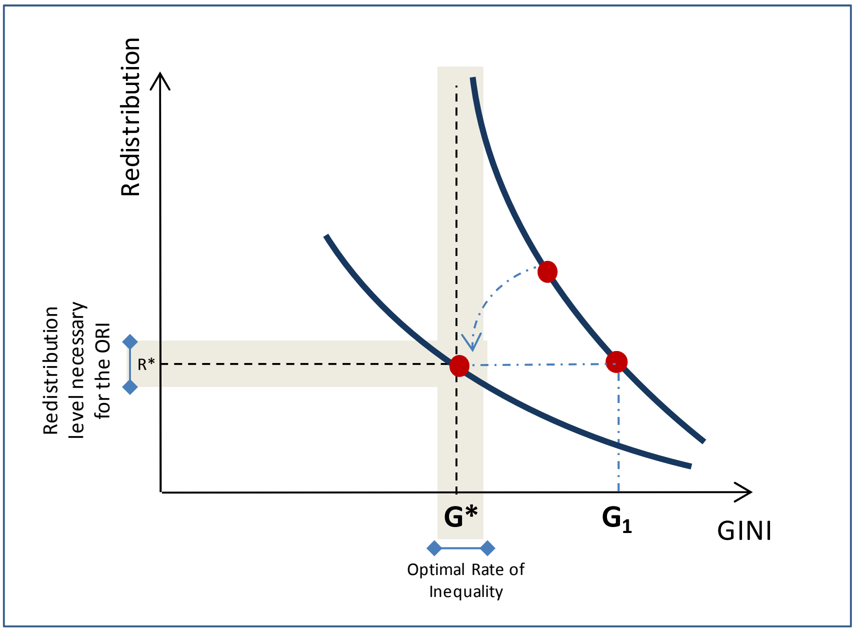


Table 4 details the results of several estimations for a sub-sample of countries with the highest levels of tax revenue measured as percentage of its GDP. As anticipated, the coefficient for redistribution is in all cases higher than in the general sample. In equation 1, were redistribution is the only independent variable; the coefficient is 68% higher than the same system in the general sample estimation (see Table 1, equation 1).

The tendency remains when including the other variables; both the geographical and the data characteristics dummies do not affect the strong negative coefficient in the estimations and they depict a higher value in comparison to the general sample, particularly when including the data characteristics dummies.

When comparing the results of Tables 3 and 4 we find that the effects of having a more developed and efficient tax revenue system has stronger effects on reducing inequality than the development of the redistributive system itself, perhaps because there is a strong causal relationship from the first to the latter. The more developed the tax system is on the revenue side, more resources can be intended for redistribution and there will be a higher probability of having a developed tax system on the expenditure side.

Table 4. Redistribution vs. Inequality (b): segmented sample

	Highly developed tax system			
Variables / Equations	1	2	3	4
Redistribution	**-242.07**	**-162.11**	**-186.85**	**-182.29**
	(0.0003)	(0.0072)	(0.0048)	(0.0025)
Dummy: Latin America		**11.18**		**7.01**
		(0.0000)		(0.0003)
Dummy: Asia		**6.64**		
		(0.0968)		
Dummy: Household vs. Individual			**9.09**	**7.31**
			(0.0001)	(0.0001)
Dummy: Gross or net income			**-8.43**	**-5.06**
			(0.0002)	(0.009)
Dummy: Income or expenditure data			**-10.28**	**-7.67**
			(0.0002)	(0.0006)
Intercepts	50.6, 51.7, 55.5, 49.5	45.1, 44.7, 48.4, 42.2	55.0, 56.8, 61.2, 56.5	50.2, 51.4, 56.1, 50.7
Number of Observations	38, 36, 44, 31	38, 36, 44, 31	20, 21, 24, 18	20, 21, 24, 18
R-squared	0.17, 0.06, 0.05, 0.13	0.21, 0.22, 0.12, 0.58	0.39, 0.48, 0.56, 0.68	0.50, 0.59, 0.54, 0.81

Variables identical to table 2

The next step, after demonstrating the negative relationship between redistribution and inequality, was to test for the non linearity of the relationship between inequality and growth in order to validate the proposed model. Table 5 reports the results of an initial set of estimations via the *Seemingly Unrelated Regression* methodology where the Gini and its square value as well as other explanatory variables[16] were included.

Equation 1 initially demonstrates (in line with most studies based on the Deininger and Squire, 1996 complete dataset) the fact that the majority of the observations and correspondence between inequality and growth data of the complete sample are located on the negative range of the relationship. When including in this first estimation the Gini coefficient together with life expectancy and three religion dummies it was evident the negative overall relationship between inequality and growth. In this general case, a 5% decrease in the Gini coefficient of would raise the GDP per capita growth rate in 1.3%.

[16] The variables included in the system had the objective of giving more explanatory power to the overall equation while trying to achieve non-endogeneity and low correlation with the Gini coefficient.

Equations 2 to 4 test for the non linearity between inequality and growth by incorporating the square value of the Gini coefficient. The estimation results show that the coefficients for both variables are significant, especially when introducing the Latin American dummy.

The sign of the Gini coefficient is positive while the square Gini is negative, demonstrating the fact that at low levels of inequality (lower than the ORI) the relationship is positive, and at high levels of inequality, the relationship is negative.

The level of inequality at which the relationship changes, is at an approximated Gini value of .39. At this level, the economy grows higher than at any other level. These results verify the existence of an optimal rate of inequality, at which the economy is released from any distortion from either high inequality or high taxation/redistribution (and low inequality).

As expected, the reciprocal of life expectancy at birth as well as the religion dummies (Catholic, Protestant and Muslim) show a negative effect on growth rates. Equation 4 includes the price level of investment as explanatory variable as a measure of price distortions in the economy, this variable appeared to account for some of the effects previously captured by the religion dummies and the reciprocal of life expectancy, while increasing the effects of both Gini and Gini^2.

Table 5. Inequality and growth relationship (SUR estimation)

Variables / Equations	1	2	3	4	5
Gini	**-0.022**	**0.10**	**0.13**	**0.15**	**-0.03**
	(0.036)	(0.109)	(0.05)	(0.0200)	(0.0283)
Gini^2		**-0.001**	**-0.0016**	**-0.002**	
		(0.049)	(0.026)	(0.012)	
Latin American dummy			**-0.67**	**-0.8**	
			(0.0448)	(0.0169)	
1/life expectancy at birth	**-194.12**	**-182.61**	**-189.87**	**-162.41**	**-140.56**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0017)
Catholic dummy	**-1.67**	**-1.59**	**-1.14**	**-0.97**	
	(0.0000)	(0.0000)	(0.009)	(0.0289)	
Protestant dummy	**-2.45**	**-2.27**	**-2.16**	**-1.71**	
	(0.0000)	(0.0001)	(0.0001)	(0.0027)	
Muslim dummy	**-1.03**	**-1.05**	**-1.06**	**-1.02**	
	(0.0164)	(0.0139)	(0.012)	(0.0141)	
PPPI				**-0.007**	
				(0.0039)	
Gini x Redistribution					**0.39**
					(0.0359)

Intercepts	8.4, 6.7, 6.8, 7.1	5.6, 3.9, 4.0, 4.3	5.0, 3.2, 3.4, 3.7	4.6, 2.9, 3.06, 3.4	5.9, 4.2, 4.5, 4.8
Number of Observations	63, 69, 76, 92	63, 69, 76, 92	63, 69, 76, 92	59, 67, 74, 91	42, 39, 51, 69
R-squared	0.3, 0.20, 0.25, 0.01	0.3, 0.18, 0.24, 0.07	0.27, 0.17, 0.27, 0.08	0.33, 0.18, 0.30, 0.08	0.15, 0.1, 0.1, 0.13

Independent variable is average GDP growth for each 10 year period (70s,80s, 90s, and 00s). Estimation made by the Seemingly Unrelated Regression technique. Explanatory variables are: Gini, Square Gini, Latin American dummy, the reciprocal of life expectancy at birth, three religion dummies that equals one if the majority of the population profess either Catholic, Protestant or Muslim religion, and the price level of investment (PPPI). Intercepts from equations 1-4 are significant at the 1 and 5 percent, the remaining are significant to the 1 percent.

Equation 5 adds an interaction term between inequality measured by the Gini coefficient and redistribution in order to further validate the non-linearity of the relationship between inequality and growth. The results confirmed that at low levels of redistribution the relationship between inequality and growth is negative (because inequality will be high), but as redistribution increases, this relationship will attenuate and will eventually turn positive when reaching a level of redistribution equivalent to approximately 11% of GDP.

An additional set of systems were estimated via 3SLS based on Barro (2008) in which economic indicators were included as explanatory variables. The potential endogeneity of some of the independent variables is addressed with a set of instruments that comply with the requirements of being correlated with the explanatory variables and not being correlated with the error term (see notes on Table 6). The three stage least squares (3SLS) estimator, proposed by Zellner and Theil (1962), considers the specific error term as random and provides asymptotical efficient estimations that come from exploiting nonzero cross equation covariation.[17]

The systems incorporate typical explanatory variables employed in standard growth models such as the log of per capita GDP and the investment ratio. These level variables resulted in all cases as expected, the first one with a negative coefficient that confirm conditional convergence and the second one with a positive and significant one depicting the contribution of investment to GDP growth.

[17] See Belsley (1988) for an analysis of the advantages and disadvantages of this econometric methodology.

The log of the total fertility rate shows negative effects on growth, although statistically significant to the 5% in most cases. The reciprocal of life expectancy at birth turned to be barely significant in the linear estimation (Equations 1 and 2), but when testing for non-linearity (Equations 3 to 6), it became statistically insignificant. The political instability variable, though surprisingly positive, has almost null effects on growth while total school attainment for secondary and tertiary education turned to be statistically insignificant.

Equations 1 and 2 of Table 6 test for the overall effects of inequality over growth. The results are consistent with the ones in Equation 1 of Table 5. In this case, lowering inequality from a Gini level of .40 to .39 would increase the GDP per capita growth rate in 1.73%. This result and the fact that the average Gini for the four decades is .43 demonstrate once again the fact that the sample as a whole is located predominantly in the negative spectrum of the relationship between inequality and growth. (see Appendixes 1 and 2)

Equations 3 to 6 report the results of testing for the non linearity of the relationship between inequality and growth. This was verified initially by including the square value of the Gini coefficient. In all cases, a positive sign for the Gini coefficient and a negative one for its square value were found. Appendix 3 depicts the kinked non-linear relationship between inequality and growth computed with the coefficients of the regressions.

As in the SUR estimation, is was found that at a Gini of .39 is the breakpoint where the growth rate is maximized and where the sign of the relationship changes Equation 4 incorporates a dummy that accounts for the level of development of the tax system, as well as a dummy for Latin America in order to control for the effects of a tendency for some Latin American countries of having high inequality combined with high growth rates. Both variables turned to be statistically insignificant, nevertheless, when the price level of investment is included in Equation 5, the Latin American dummy turns statistically significant with a negative sign. Price distortions seem to capture whatever was making the L.A. dummy statistically insignificant.

Lastly, Equation 7 includes the interaction term between inequality and growth (Gini x Redistribution). Once again it was verified the fact that as redistribution increases, the relationship turns from being initially negative to positive, in this case, when reaching a level of redistribution equivalent to approximately 5.8% of GDP. This value is considerably lower than the one obtained in the SUR estimation, perhaps because Equation 5 of Table 5 did not include economic variables which could capture a portion of the effects of redistribution on inequality and ultimately on growth.

Table 6. Inequality and growth relationship (3SLS estimation)

Variables / Equations	1	2	3	4	5	6	7*
Gini	**-0.04**	**-0.02**	**0.22**	**0.23**	**0.23**	**0.022**	**-0.06**
	(0.0341	(0.0502)	(0.0076)	(0.0045)	(0.0044)	(0.0074)	(0.003)
Gini^2			**-0.002**	**-0.003**	**-0.003**	**-0.003**	
			(0.003)	(0.0022)	(0.002)	(0.0023)	
Log(per capita GDP)	**-1.56**	**-1.48**	**-1.19**	**-1.39**	**-1.002**	**-1.11**	**-1.68**
	(0.0000	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Log(Total fertility rate)	**-1.67**	**-1.51**	**-1.61**	**-1.59**	**-1.27**	**-1.5**	**-2.07**
	(0.0253	(0.0153)	(0.0151)	(0.0179)	(0.0515)	(0.0212)	(0.0062)
1 / life expectancy at birth	**-166.11**	**-153.32**	**-89.58**	**-88.4**	**-108.5**	**-70.76**	
	(0.0736)	(0.0183)	(0.1618)	(0.2087)	(0.1086)	(0.2889)	
Investment ratio	**7.89**	**4.46**	**6.12**	**8.52**	**5.78**	**6.63**	**9.37**
	(0.0023)	(0.0419)	(0.0038)	(0.0001)	(0.0043)	(0.0013)	(0.0017)
Political instability variable	**0.0086**	**0.01**					**0.007**
	(0.0015)	(0.0005)					(0.0092)
PPPI (Price level of investment)		**0.001**			**-0.005**	**-0.002**	
		(0.3748)			(0.1993)	(0.5218)	
Secondary and tertiary school attainment		**0.12**					
		(0.3748)					
Dummy: developed tax revenue system				**0.19**			
				(0.4231)			
Dummy: Latin America				**-0.28**	**-0.64**		
				(0.3241)	(0.0181)		
Gini x Redistribution							**0.52**
							(0.006)
Intercepts	21.1,19.6, 19.8,19.8	19.8,18.3, 18.1,18.0	11.4,10.1, 9.9,10.1	12.2,10.8, 10.9,10.9	9.8,8.5, 8.4,8.5	10.4,9.1, 9.0,9.1	18.34,18. 6, 18.76
Number of Observations	28,53,47, 49	46,61,66, 82	46,62,69, 87	45,58,65, 82	46,62,69, 87	46,62,69, 87	44,39,40
R-squared	0.25,0.47, 0.57,0.05	0.21,0.4, 0.38,0.03	0.25,0.32, 0.3,0.1	0.23,0.41, 0.31,0.14	0.27,0.3, 0.33,0.1	0.28,0.31, 0.29,0.11	0.53,0.53, 0.16

Independent variable is average GDP growth for each 10 year period (70s, 80s, 90s, and 00s). Estimation made by three stage least squares (3SLS). Explanatory variables are: Gini and Squared Gini corresponding to the prior period in relation to the growth rate period (i.e. for the growth period of 1970 corresponds the Gini value of 1960); the log of per capita GDP and the sum of secondary plus tertiary school attainment are expressed in values for the initial year; the log of the total fertility rate and the reciprocal of life expectancy at birth, both expressed in values for the years 1970, 80, 90 and 2000; the value for the investment ratio, the price level of investment (PPPI) and the variable that proxies political instability by measuring Battle-related deaths are expressed as the average for each decade; a dummy that equals one if the country has a developed tax revenue system; a Latin American dummy and finally an interaction term that multiplies the Gini times the redistribution value for the period corresponding to each of the estimated growth period.

The instruments are: the value of the initial year of the period for the price level of investment; the value of the prior period for the log of the total fertility rate, the investment ratio and the log of the initial GDP per capita.
For the other variables, instruments coincide with the explanatory variable.

* Initial period (70`s) was removed from equation due to data unavailability.

Table 7 reports the results of a set of dynamic panel model estimated via system GMM. This methodology has been proposed to be one of the most reliable estimation technique by some relevant studies of the inequality-growth relationship (Castelló-Climent, 2004; Castelló-Climent, 2010; Voitchovsky, 2005). The reason is that this methodology, developed by Arellano and Bover (1995) and Blundell and Bond (1998), improves the also well known first-difference GMM estimation, developed by Arellano and Bond (1991) and provides a better estimation by exploiting more efficiently the variation in the data as well as the time series information. The technique consists in estimating a system of equations in first differences, with lagged explanatory variables as instruments, and including the original equation in levels.

The validity of the system GMM is tested by confirming the absence of second order serial correlation, as well as with the tests of overidentifying restrictions of Sargan (1958) and Hansen (1982). Additionally, with the difference Hansen test for the validity of the additional moment conditions for the level equation.

A series of growth equations similar to those in the 3SLS estimations were performed, in them, different control variables related to growth where included, as well as others related to the theoretical effects of income inequality, such as education or fertility. All equations confirm the kinked non linear relationship between inequality and growth, with positive and statistically significant coefficients for the Gini variable and negative for its squared value. In this case, the breakpoint level of inequality is reached at a Gini level of .40, differing only by one point with the previous estimations via SUR and 3SLS. In equations 1, 2 and 4 these variables result less significant, the Gini to the 5% and its squared value to the 10%, without an evident reason, unless school attainment affected the Gini coefficients in equations 2 and 4 and life expectancy did as well in equations 1 and 2. There could be some theoretical arguments in favor of this, as they are proxies of human capital, which, as seen in the theoretical framework, has been proposed to be part of the transmission channel by which inequality affects growth. In all equations the log of the total fertility rate depicts the expected negative and statistically significant coefficient, reflecting the deflating effects on GDP growth of a bigger population. Equations 1, 3 and 5 include the investment ratio, which even though results with the expected positive sign, it never achieves statistical significance.

As in the 3SLS estimations, the reciprocal of life expectancy and secondary and tertiary school attainment come out statistically insignificant, nevertheless, in the case of education, when including an alternative measure in the form of male secondary school enrollment in equations 5 and 6, this new variable comes out positive and statistically significant to the 1%. Speculating a bit, one might argue that the reason for this difference of results could come from the fact that male/female school attainment captures the, still existent, inequalities of access to education for women in some countries, which can be growth detrimental.

Table 7. Inequality and growth relationship (System GMM)

Variables / Equations	1	2	3	4	5*	6
Intercept	**20.9**	**16.50**	**15.50**	**17.00**	**16.95**	**17.72**
	(0.0020)	(0.0050)	(0.0080)	(0.0020)	(0.0000)	(0.0010)
Inequality	**0.31**	**0.35**	**0.40**	**0.34**	**0.40**	**0.32**
	(0.049)	(0.0430)	(0.01)	(0.052)	(0.001)	(0.008)
Inequality^2	**-0.003**	**-0.003**	**-0.004**	**-0.003**	**-0.004**	**-0.004**
	(0.0700)	(0.0790)	(0.0200)	(0.0820)	(0.0020)	(0.0110)
Ln (per capita GDP)	**-2.06**	**-2.07**	**-2.11**	**-2.04**	**-2.36**	**-2.12**
	(0.0010)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Investment ratio	**1.27**		**2.28**		**4.30**	
	(0.7340)		(0.544)		(0.158)	
Ln (Total fertility rate)	**-4.71**	**-5.05**	**-4.73**	**-5.00**	**-4.43**	**-2.69**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Secondary and tertiary school attainment		**0.37**	**0.40**	**0.30**		
		(0.1870)	(0.1580)	(0.2810)		
Life expectancy	**-169.96**	**17.61**				**-193.47**
	(0.2040)	(0.886)				(0.088)
Male secondary school enrollment					**2.86**	**3.45**
					(0.001)	(0.0000)
AR(2) test	0.771	0.998	0.952	0.936	0.614	0.781
Hansen J test	0.25	0.554	0.525	0.388	0.603	0.708
Diff Hansen	0.89	0.99	0.985	0.974	0.729	0.88
Wald Chi2	65.49	80.85	64.72	64.03	73.07	88.49
Prob. Chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Independent variable is average yearly per capita GDP growth for the period 1960 -2000. Estimations are made by system GMM. Explanatory variables are: Gini and Squared Gini corresponding to the prior period in relation to the growth rate period (i.e. for the growth period of 1970 corresponds the Gini value of 1960); the log of per capita GDP and the sum of secondary plus tertiary school attainment, as well as the male secondary enrollment rate are expressed in values for the initial year; the log of the total fertility rate and the reciprocal of life expectancy at birth, both expressed in values for the years 1970, 80, 90 and 2000; the value for the investment ratio. The instruments correspond with the explanatory variables and are expressed, according to the methodology, in levels and differences.

* Instruments lagged two periods

Equation 5 performs better in general, but specifically in the inequality variables, the additional feature apart from the shift in the school variable, is that it was estimated with two lags in the instruments of the equation, correcting somewhat more the endogeneity of the specification. Finally, equation 6 presents the most reliable equation, with all variables statistically significant, including life expectancy (although to the 10%).

All equations confirm the absence of second order serial correlation, AR(2), and favorable results for both Hansen's tests of overidentifying restrictions and the test for the validity of the additional moment conditions for the level equation.

An alternative validity test through the Kuznets curve

We now turn to an additional, and perhaps les orthodox, validation for the proposal of the existence of an optimal rate of inequality (ORI), in which growth rates are enhanced due to the absence of any distortion from either high inequality or high redistribution/taxation (low inequality).

This alternative test is meant to use the widely known and generally accepted Kuznets hypothesis as the vehicle for validating the hypothesis that countries will grow faster if they are at the ORI. The idea is quite straightforward; it first assumes that the Kuznets relationship between inequality and development is an empirical regularity[18]. If so, then the implications of the model and the predictions of the Kuznets curve would allow us to propose the following:

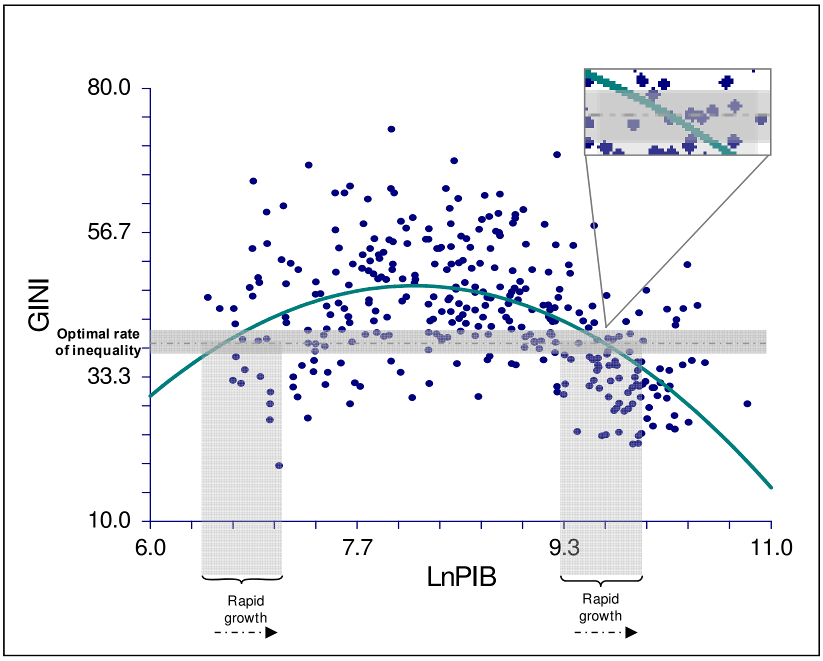
Proposition 1: A country in its path to development will grow faster when it passes through inequality levels within the optimal rate of inequality, during the transition predicted by the Kuznets inverted "U" hypothesis, both in the initial and the later stages of development.

[18] This relationship predicts that any country in its path to development would necessarily pass through a period of high inequality before they decrease when reaching high levels of development.

The previous can be expressed in the context of a sample of countries depicting the Kuznets relationship:

Proposition 2: Within a set of countries that follow the Kuznets inverted "U" relationship, the ones with inequality levels at the ORI will grow faster than the rest, both in the initial as in the later stages of development.

Figure 5: Validation of the optimal rate of inequality trough the Kuznets curve



The first step is to confirm the validity of the Kuznets relationship in the context of the available data set. Graphically it can be seen in Figure 5 that the inverted "U" predicted by Kuznets (1955) performs quite clearly in the tendency line depicted for the same dataset employed in the previous model estimations.

Results

Table 7 presents the estimations for the Kuznets hypothesis. Following Barro (2000) an estimation via the Seemingly unrelated regression is performed with the value of the

Gini coefficient as dependent variable and the log of the average per capita GDP and its square value as independent variables, along with others such as life expectancy, the total fertility rate as well as geographical dummies for Latin America and the Sub-Saharan Africa. The results confirm the Kuznets relationship in all cases, with a positive and statistically significant sign for the per capita GDP and a negative and also significant sign for its square value. This demonstrates the fact that at initial levels of development inequality will tend to grow in order to later be reduced after reaching a per capita income of around $3,700 UDS. Including the additional explanatory variables does not change the tendency and does not affect the sings or significance of the per capita GDP.

Table 8. The Kuznets relationship

Variables / Equations	1	2	3	4
Ln(p/c GDP)	**42.64**	**48.53**	**30.82**	**39.3**
	0.0000	0.0000	0.0002	0.0000
Ln(p/c GDP)^2	**-2.78**	**-3.07**	**-1.9**	**-2.33**
	0.0000	0.0000	0.0001	0
1/life expectancy at birth			**1022.87**	**634.4**
			0	0.0115
Log(Total fertility rate)				**6.84**
				0.0051
Dummy: Latin America			**9.71**	
			0.0000	
Dummy: Sub-Saharan Africa		**-142.96**		
		0.0000		
Intercepts	(117.3), (116.7), (113.3), (113.5)	(146.5), (146.1), (142.9), (142.9)	(102.0), (101.1), (97.1), (97.9)	(143.9), (142.6), (138.0), (137.0)
Number of Observations	71, 80, 96, 64	71, 80, 96, 64	69, 77, 93, 64	68,76,92,63
R-squared	0.30, 0.30, 0.31, 0.36	0.32, 0.33, 0.33, 0.33	0.46, 0.44, 0.38, 0.59	0.42, 0.37, 0.32, 0.35

Dependant variable: Inequality measured by the Gini coefficient; estimation made by Seemingly Unrelated Regression (SUR) technique. Independent variables are: the log of per capita GDP as well as its square value, Latin American dummy, sub-Saharan Africa dummy, the log of the total fertility rate and the reciprocal of life expectancy at birth.

Once the Kuznets curve has been proven as an empirical regularity, we can now continue with the empirical confirmation of the propositions stated previously. First, with simple statistical evidence, obtained from identifying the observations with optimal inequality levels from both sides (less developed and more developed) of the Kuznets curve, as well as the rest of the observations and calculating the average growth rate of the three groups of data. The result of this preliminary approximation is that the average per capita GDP growth rates for both sides of the curve are higher, with 2.63% for the low income group and 2.90% for the high income group. The average GDP per capita growth rate for the rest of the observations in the inverted "U" curve are of 2.06% percent.

Table 9 presents the results of two sets of estimations intended to test for proposition No. 2. The first set of (equations 1 to 3) develop growth regressions similar to those in table 6, estimating via 3SLS and including the values of the Gini, its square value, as well as other variables standard for this type of growth models. The feature here is the addition of a dummy variable that assigns the value 1 to the observations, within the Kuznets curve, that have inequality levels in the ORI, in both ends of the curve[19] (see Figure 5).

The results confirm that, regardless of in which end of the curve the observations are, they will have a positive relation with growth, even at the negative side of the curve. Even with the inclusion of the Latin American dummy (sometimes accounted for the positive effects of inequality on growth in those regions), the coefficients remain positive and statistically significant. The other level and control variables perform as expected; the reciprocal of life expectancy and the log of the total fertility have a negative coefficient, although the inclusion of the Latin American dummy appear to affect their significance. The investment ratio has a positive and significant coefficient, and the per capita GDP (level variable) as expected has a negative and significant sign, depicting the convergence phenomenon.

The second set of estimations (equations 4 to 7) try to further validate the proposition by now identifying separately the observations with inequality at the ORI in the low and high income ends of the Kuznets curve. For this, it was first identified the income level at which the break in the development-inequality relationship occurs in the inverted "U" curve, finding it to be at around $3,700 US dollars. With this information it was possible to generate a dummy variable that identifies only the observations with

[19] Having confirmed the existence of the Kuznets relationship, we know there must be observations in with inequality in the ORI that are situated at the lower and higher income side of the curve.

inequality at the ORI in the lower income side of the curve (below $3,700 US dollars) and another one for the ones at the higher income side of the curve (above $3,700 US dollars). Finally, a third dummy variable that captures the observations with inequality levels different from the ORI in the curve in order to use as control variable.

Table 9. Validation of the Optimal rate of inequality (ORI) through the Kuznets relationship

Variables / Equations	1	2	3	4*	5*	6*	7*
Gini	**0.16**	**0.19**	**0.17**				
	0.0500	0.0156	0.0371				
(Gini)^2	**-0.002**	**-0.002**	**-0.002**				
	0.0268	0.0074	0.0254				
Dummy: Optimal rate of inequality (ORI)	**0.71**	**0.74**	**0.67**				
	0.0090	0.0064	0.0139				
Dummy: ORI low PIB				**1.26**		**0.8**	
				0.0032		0.100	
Dumm: No ORI (rest of sample)					**-1.2**	**-1.01**	**-1.08**
					0.0001	0.0029	0.0159
Dummy: ORI high PIB				**1.06**			**0.31**
				0.0009			0.5301
1/life expectancy at birth	**-87.21**		**-132.86**				
	0.1649		0.0443				
Log(Total fertility rate)	**-1.54**	**-1.67**	**-1.3**				
	0.0157	0.0061	0.0427				
Investment ratio	**5.78**	**6.08**	**5.28**	**10.72**	**10.11**	**10.08**	**10.96**
	0.0052	0.0031	0.0099	0.0000	0.0000	0.0000	0.0000
Log(per capita GDP)	**-1.12**	**-0.99**	**-1.07**	**-0.64**	**-0.63**	**-0.58**	**-0.69**
	0.0000	0.0000	0.0000	0.0005	0.0007	0.0024	0.0001
Dummy: Latin America			**-0.53**				
			0.0413				
Intercepts	11.8, 10.4, 10.4, 10.5	8.71, 7.33, 7.33, 7.39	11.67, 10.26, 10.25, 10.32	6.02, 4.68, 5.03	7.26, 6.17, 6.31	6.65, 5.36, 5.63	7.49, 6.34, 6.63
Number of Observations	46, 62, 69, 87	46, 62, 69, 87	46,62,69, 87	44,61,73	47, 64, 73	45, 62, 73	45, 62, 72
R-squared	0.28, 0.37, 0.30, 0.09	0.25, 0.37, 0.29, 0.14	0.25,0.41, 0.32, 0.09	0.17, 0.42, 0.23	0.15, 0.38, 0.11	0.13, 0.43, 0.14	0.17, 0.41, 0.21

Independent variable is average GDP growth for each 10 year period (70s, 80s, 90s, and 00s). Estimation made by three stage least squares (3SLS). Explanatory variables are: Gini and Squared Gini corresponding to the prior period in relation to the growth rate period (i.e. for the growth period of 1970 corresponds the Gini value of 1960); a dummy variable in which observations where the Gini coefficient is in the Optimal rate of inequality (around 0.39) have a value of 1; the log of per capita GDP; the log of the total fertility rate and the reciprocal of life expectancy at birth, both expressed in values for the years 1970, 80, 90 and 2000; the value for the investment ratio is expressed as the average for each decade; a Latin American dummy; a dummy variable that takes the value of 1 for observations below the Kuznets breakpoint (around $3,700) with Gini around 39; a dummy that takes the value of 1 for observations above the Kuznets breakpoint; finally, a dummy that takes the value of 1 for observations whose value is not in the ORI in the whole sample. Probabilities for the T-statistics are shown in parenthesis.

The instruments are: the value of the prior period for the log of the total fertility rate, the investment ratio and the log of the initial GDP per capita; for the other variables, instruments coincide with the explanatory variable.

* Final period (2000`s) was removed due to data unavailability.

Equation 4 includes both the low and high income dummies and finds that they are both positive and statistically significant, while equation 5 includes the dummy for the non ORI observations and results with a negative and also significant coefficient. The important results comes from comparing both estimations, we can clearly see how the countries with inequality levels in the ORI have a positive influence on growth, while the ones with inequality levels different from the ORI have in fact a negative effect on growth rates, thus validating proposition No. 2.

Equations 6 and 7 compare separately each of the ORI dummies with the control non-ORI variable in order to further confirm this relationship. In the first estimation (Equation 6) it is found once again that the observations in ORI levels for the low income part of the Kuznets relationship are positively related to growth (although barely significant to the 10%), while the rest of the observations are negatively related. The last equation confirms the same for the high income side of the curve; nevertheless, here the dummy turns out statistically insignificant while the control non-ORI dummy remains negative and significant, perhaps because of the limited number of observations within the ORI in both sides of the curve. It is worth mentioning that when attempting to include all three dummies in one equation they perform quite poorly, this, is assumed to be the result of the fact that, together, the three dummies account for all the observations in the curve and for not having a control variable left out from the estimation.

Bibliometric study

In the prior section it was empirically demonstrated the existence of a kinked non linear relationship between inequality and growth. Countries with low levels of inequality exert a positive relationship with economic growth and countries with high inequality have a negative one, additionally, there is a certain level of inequality where the relationship becomes non-significant and where growth is maximized.

In this section it is verified how this principles hold for most previous empirical studies and how the contrasting results in previous literature can be explained in terms of the constitution and the predominant level of inequality in the samples employed by the authors.

The proposition is that the empirical results of some of the most influential studies of the relationship between income inequality and economic growth can in fact be explained under the arguments of the model presented above. In this sense, the following scenarios are expected:

1. In studies where the database was predominantly configured by countries with high levels of inequality the sign of the relationship was negative.
2. In studies where the database was composed mainly by countries with low levels of inequality the sign of the encountered relationship was positive.
3. Studies in which a statistically insignificant relationship was found may fall under the following circumstances:
    a. A sample of countries with balanced levels of inequality that neutralize each other. Approximately, the same values on the positive and the negative side of the income distribution.
    b. A sample of countries with similar levels of inequality at intermediate levels[20].

A sample of 11 empirical studies (widely cited in the literature), which identified the relationship between income inequality and economic growth, were selected. Three of them (Li, 1998; Forbes, 2000; Castelló-Climent, 2004) found a positive relationship and eight (Alesina, 1993; Alesina, 1994; Barro, 2008; Castelló and Doménech, 2002; De la Croix, 2003; Garbis, 2005; Knowles, 2005; Persson and Tabellini, 1994) a negative one.

The procedure was to analyze each dataset used by the above mentioned authors and to classify the countries in the sample according to their average level of inequality[21],

[20] Because of the reasons exposed in the model there is no inequality level or range in which a statistically insignificant relation is expected to be found for all countries, this is why this scenario is highly improbable. Nevertheless, according to the previous empirical results, the inequality level may fall in a Gini value near .39.

[21] The country classification, according to inequality levels, was made by averaging the Gini index value for the period of 1960 to 2000 for the countries included in the datasets. Afterwards the countries were classified in low inequality (Gini index below .355), medium inequality (between .356 and .42) and high inequality (values above .42). The criterion for this classification, although subjective, was based on the results of the empirical estimation.

defining, this way, the predominant level of inequality in that sample and verifying the predictions of the model.

Results

The results confirmed, in all cases, the expected scenarios. Table 1 depicts the results of the analysis[22]. The sample of all eight empirical studies who found a negative relationship between inequality and growth were composed predominantly with observations for countries with high average levels of inequality. Six of them (Alesina and Perotti, 1996; Alesina and Rodrik, 1994; Barro, 2008; Castelló and Doménech, 2002; De la Croix and Doepke, 2003; Garbis, 2005; Knowles, 2005; Persson, 1994), with over 50% of the sample composed of high average inequality countries. In most cases the amount of countries with high inequality was twice as numerous as the ones with low inequality and in two of them the relation was three to one.

Although the majority of the empirical studies have found a negative relationship, there are a few influential papers that claim a positive effect of income inequality over economic growth. Among the most cited are the ones from (Castelló-Climent (2004), Forbes (2000), Li and Zou (1998). These papers were also selected for this bibliometric study in order to find if the positive sign derives from the composition of the sample.

The results, after analyzing the distribution of countries in their sample according to inequality levels, confirm the propositions of the model. Although not with the same proportions as the studies with a negative relationship, all three studies were carried out with samples composed predominantly of countries with low levels of inequality.

Li & Zou (1998) used a sample of 46 countries, extracted from the D & S dataset, of which 48% are low average inequality countries, 39% high inequality and 13% intermediate inequality. Forbes (2000) sample distribution accounts for 45% low inequality countries and 35% high, as cited by the author "regional coverage is far from representative, with no countries from sub-Saharan Africa and nearly half the sample from the OECD" (Forbes, 2000). Finally, Castelló-Climent (2004) employs in her

[22] See Appendix 4 for the complete results of the bibliometric study.

sample 41% and 37% of low and high average inequality countries respectively (see Appendix 4).

The prediction that in studies with databases composed mainly by countries with low levels of inequality the sign of the encountered relationship was positive remains as an empirical regularity.

Although it was impossible to find studies with available datasets that found non-significant coefficient in the inequality-growth relationship, the following comments are presented on two relevant works:

- Panizza (2002) finds a weak negative sign in the relationship between inequality and growth for the US economy, estimating with a panel dataset for the period of 1940 to 1980. Although the dataset is not available, the descriptive statistics in the paper depict an average Gini index of .42 (just above the ORI found in this study) in the referred period. This average Gini level and the lack of robustness in the negative coefficient lead to suspect the possibility of the inequality levels to be just passed optimal rate of inequality and on the initial phase of the negative side of relationship between the variables.

- Barro (2000) finds a statistically insignificant coefficient in the inequality-growth relationship when estimating a system via 3SLS. He employed a 138 country panel data covering from about 1955 to the mid 90`s. Although the inequality dataset is not available, one can see from the descriptive statistics a mean Gini value of 41.2 for the four periods included in the sample. This value suggests average inequality levels near the ORI if we take as reference the results of the empirical study presented above and if we account for the fact that both (Barro´s and mine) samples derive fundamentally from the same D & S dataset.

Even though some authors confirm a reduction in global inequality levels over the last decades (Sala-i-Martin, 2006; Sala-i-Martin, 2009), the amount of countries with high income inequality (higher than the ORI) is still much higher than those with low levels.

The more number of countries included in a sample, the higher the probability of being predominantly composed of high inequality countries.

Table 10. Bibliometric study results

Author	Year	Relation	Methodology	High GINI	Medium GINI	Low GINI
Alesina and Rodik	1991	Negative	OLS, 2SLS	**51%**	23%	26%
Alesina and Perotti	1993	Negative	2SLS	**56%**	20%	24%
Persson and Tabellini	1994	Negative	OLS / 2SLS0	**42%**	27%	31%
Castelló and Doménech	2002	Negative	N/A	**58%**	18%	24%
De la Croix and Doepke	2003	Negative	GMM	**62%**	19%	19%
Garbis Iradian	2005	Negative	GMM and OLS	**41%**	27%	32%
Stephen Knowles	2005	Negative	N/A	**53%, 69%**	12%, 26%	35%, 5%
Robert J. Barro	2008	Negative (with full sample)	GMM	**50%**	21%	29%
Li & Zou	1998	Positive	Fixed effects & Random Effects	**39%**	**13%**	**48%**
Kristin J. Forbes	2000	Positive	Arellano & Bond differential GMM	**35%**	**20%**	**45%**
Amparo Castelló-Climent	2004	Positive	OLS, fixed effects, random eff. Differential-GMM, System-GMM	**37%**	**21%**	**41%**

Discussion

This paper suggests that there could be a fundamental weakness in the way the debate over the "real" relationship between inequality and growth has been developed, and proposes a reformulation of the initial question it is trying to answer: Is inequality *harmful of beneficial for growth?,* as an initial step for reaching a generalized solution. This reformulation would lead to establishing new research questions: *should we expect inequality to exert any single effect over economic performance? Is it acceptable to expect every level of inequality to affect growth in the same manner?*, these and other questions, that take us back to the starting point of a new inequality-growth debate.

The main proposition of this study is that the level of inequality is the one determining the sign of the relationship. At low levels of inequality the relationship is positive and, as inequality increases, the sign of the relationship changes to a negative effect of inequality over growth. Additionally, the model developed above proves the existence of an *Optimal Rate of Inequality* (ORI) in which growth is optimized and the economy is liberated from the negative effects of high inequality or high taxation/redistribution.

The results of the empirical study provide cross country evidence and confirmed the validity of the model. Countries with inequality levels below a Gini index of inequality of 0.39 depict a positive relationship in their inequality and growth relationship. Accordingly, economies with income inequality above that level have a negative relationship with growth, meaning that more inequality affects negatively the growth performance of the economy. The overall relationship turned to be negative, consistently with other studies that employed similar datasets, as the result of having the majority of the observations in the negative range of the relationship. These results also evidence the existence of an ORI, situated at the breakpoint inequality level of 0.39, in which growth rates are maximized, in relation to the negative effects of different inequality levels.

The bibliometric study provided empirical evidence to demonstrate the fact that the proposed relationship between inequality and growth holds for the results of the most widely cited empirical studies in this area, and how the contrasting results in previous literature can be explained in terms of the constitution and the predominant level of inequality in the samples employed by the authors. This can be seen as a conciliatory resolution for the different results in the literature over the inequality-growth relationship.

The policy implications are clear, *inequality does matter for growth*. Policy makers who intend to develop the conditions for enhanced economic growth should take into account the prevailing income inequality levels. Ensuring that they are at the optimal levels, would release the growth determinants from the potentially detrimental effects of too high or too low inequality (and the associated high taxes).

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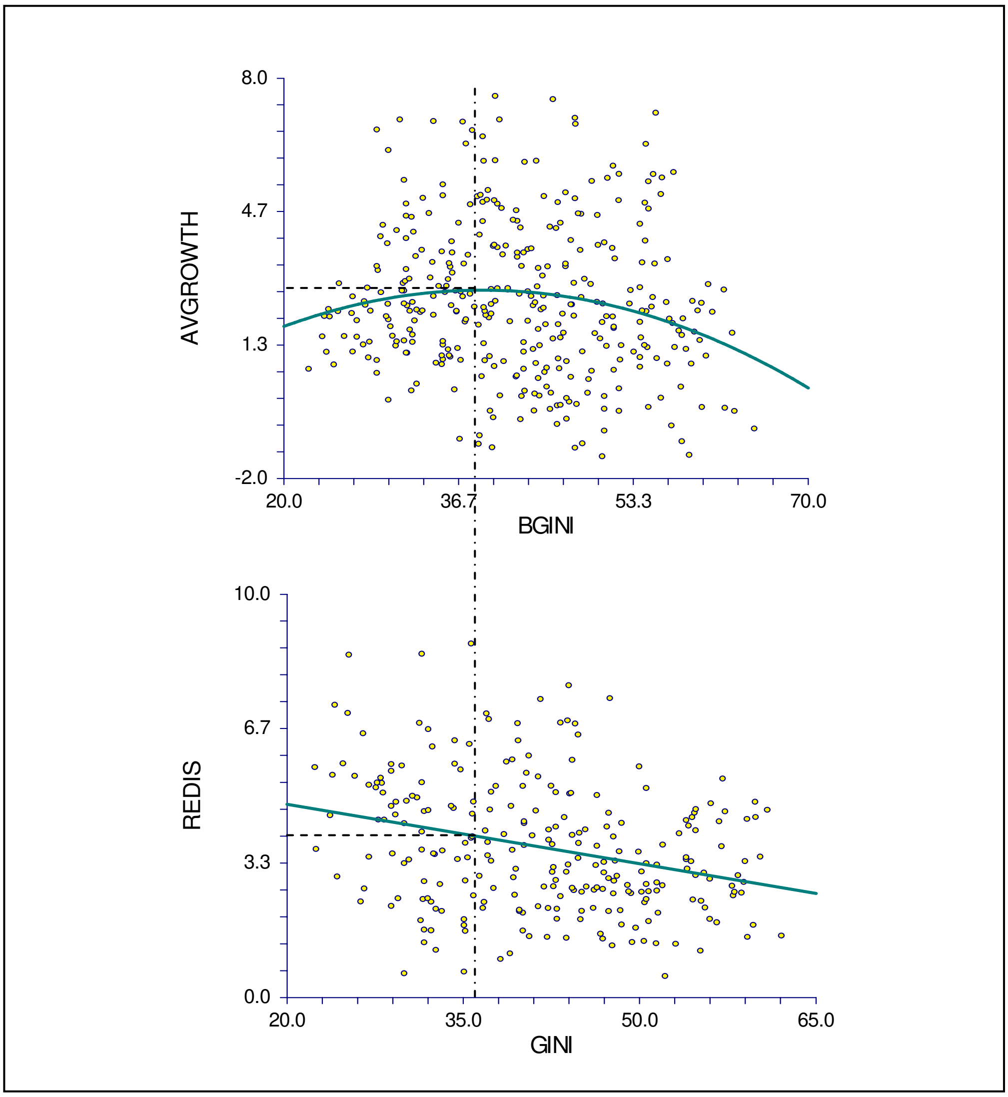
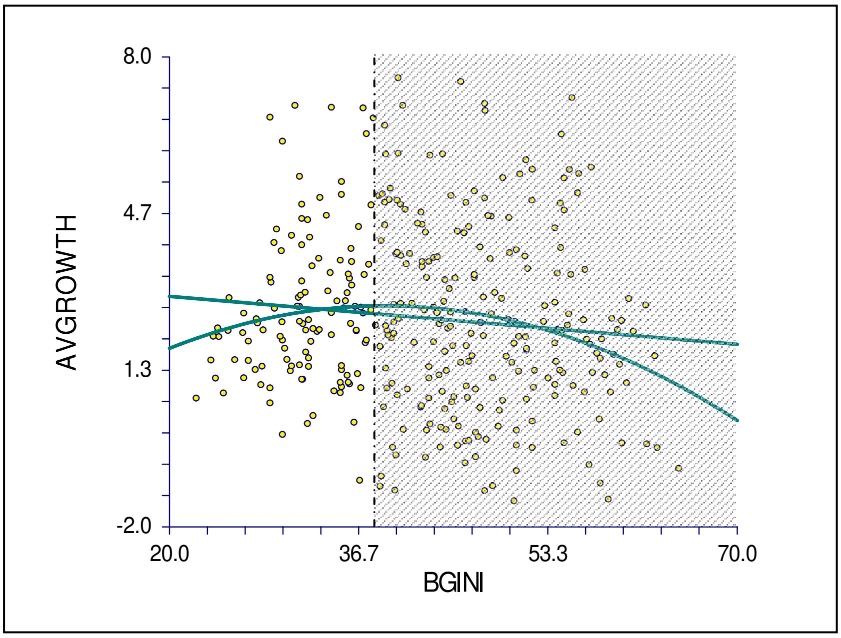
Appendix

Appendix 1: The non linearity in the effect of inequality over growth, the optimal rate of inequality and the level of redistribution necessary to reach it.



Appendix 2: Distribution of the general sample according to the sign of the relationship of inequality and growth.



Appendix 3: Inequality and growth relationship (estimated by coefficients)

Appendix 4. Complete results of bibliometric study.

Author	Year	Relation	Data	Metodology	Unit of measure	Sample	%Low Income	% Medium Income	% High Income	High GINI	Medium GINI	Low GINI	Source
Alesina and Rodik	1991	NEGATIVE	Cross-section & pooled data	OLS, 2SLS	QUINTILES	GENERAL	**43%**	28%	29%	**51%**	23%	26%	Own sample
Alesina and Perotti	1993	NEGATIVE	Cross-section & pooled data	2SLS	QUINTILES	GENERAL	**46%**	29%	25%	**56%**	20%	24%	Perotti
Persson and Tabellini	1994	NEGATIVE	Cross-section & pooled data	OLS / 2SLS0	QUINTILES	GENERAL	**58%**	10%	31%	**42%**	27%	31%	Paukert
Castelló and Doménech	2002	NEGATIVE	Panel data	N/A	GINI , HUM. CAP. GINI & QUNTILES	GENERAL	**52%**	24%	23%	**58%**	18%	24%	Deininger & Squire and own
De la Croix and Doepke	2003	NEGATIVE	Cross-section	GMM	GINI	GENERAL	**66%**	22%	11%	**62%**	19%	19%	Deininger & Squire
Banerjee and Duflo	2003	NEGATIVE	Panel data	OLS / DiffGMM / 3SLS / SUR	GINI	GENERAL	**55%, 41%**	24%, 35%	21%, 24%	**41*%, 46%**	20%, 21%	39%, 33%	Barro and D. & Squire
Garbis Iradian	2005	NEGATIVE	Panel data, cross section	GMM and OLS	GINI	GENERAL	**50%**	29%	21%	**41%**	27%	32%	Wold Bank, IMF, OECD
Stephen Knowles	2005	NEGATIVE	Cross-section	N/A	GINI	GENERAL	**33%, 87%**	36%, 10%	30%, 3%	**53%, 69%**	12%, 26%	35%, 5%	WIID
Robert J. Barro	2008	NEGATIVE (with full sample)	Panel data	GMM	GINI AND QUINTILES	GENERAL	**57%**	25%	18%	**50%**	21%	29%	WIID
Li & Zou	1998	POSITIVE	Panel data	Fixed effects & Random Effects	GINI	GENERAL	20%	34%	**46%**	**39%**	**13%**	**48%**	Deininger & Squire
KRISTIN J. FORBES*	2000	POSITIVE	Panel data	Arellano & Bond diferencial GMM	GINI	GENERAL	22%	31%	**47%**	**35%**	**20%**	**45%**	Deininger & Squire
Amparo Castelló-Climent	2004	POSITIVE	Cross-section & pooled data	OLS, fixed effects, random eff. diferencial-GMM, System-GMM	GINI	GENERAL	23%	36%	**41%**	**37%**	**21%**	**41%**	Deininger & Squire

* Ex-Comunist contries extracted from the sample