Growth and Income Inequality: A Critical Survey of Recent Literature

by

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Abstract

This article reviews the recent literature on the relationships between economic growth and income inequality. Specifically, I summarize and evaluate empirical and theoretical papers which analyze the controversial relationships between growth and income inequality. Income inequality can affect savings, investment, risk bearing, fertility, education, and the composition of demand and production. Hence, there is a clear link between income inequality and growth. By taking a systematic view of the interactions between income inequality and growth, this article attempts to clarify how these contributions to the literature fit together.

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Economists have devoted decades to the study of relationships between income inequality and growth, since the appearance of Kuznets′ 1955 pioneering paper. The endogenous growth literature has led to an explosion of research that analyzes the effects of economic factors such as education, human capital, economic openness, infrastructure, government spending and redistribution policies, among others. The income distribution literature argues that different initial income inequality conditions may result in different growth paths and the stability of income inequality varies across different stages of growth. Policy questions such as how increases in output will be shared among heterogeneous agents and the constraints that this sharing may put on future growth motivated both lines of research.

The recent trend of increases in inequality and skilled biased economic growth has brought renewed attention to this interesting but controversial subject. Many people argue that the period of diminishing inequality after the Second World War has come to an end and has been replaced by a period of widening differences. According to Alderson and Nielsen(2002, p1246), "...after four decades of moderating inequality, income inequality in the United States began to increase around 1970. Since then, it has risen at a steady rate." Income inequality can affect savings, investment, risk bearing, fertility, education, and the composition of demand and production. Hence, one would expect links between income inequality and growth. However, it is unclear whether or not initial income inequality slows down growth and whether rapid growth increases income inequality. For surveys of the literature, please see Benabou (1996)

and Barro (2000) among others.

In some empirical research, a negative relationship has been reported between income inequality and growth. For example, Alesina and Perotti (1993), Persson and Tabellini (1994), Birdsall et al. (1995), Clarke (1995), and Deininger and Squire (1995), and others. However, this view has been challenged by more recent empirical studies by Deininger and Squire (1998), Li and Zou (1998), Forbes (2000), Barro (2000) and others who find non-robust or even positive associations, especially in rich countries. In addition, Banerjee and Duflo (2000) and Rehme (2007) have presented theory and empirical evidence that the growth inequality relationships appear to be nonlinear. This seems to be a step forward in untangling possibly complex relationships.

Theoretical efforts at uncovering the linkages between growth and income inequality include studies by Banerjee and Newman (1993), Alesina and Rodrik (1994), Aghion and Bolton (1997), Piketty (1997), Lloyd-Ellis and Bernhardt (2000), Aghion (2002), and others. Their models posit a negative relationship between income inequality and growth. Other theoretical contributions such as those of Saint-Paul and Verdier (1991), Benabou (1996a), Galor and Tsiddon (1997a, b), Garcia-Penalosa and Turnovsky (2006), have developed models that predict a positive relationship between inequality and growth. These theories provide very valuable insights but few robust results about the effects of income inequality on economic growth.

The paper is organized as follows: Section II discusses empirical literature on the relationships between growth and inequality. Section III reviews theoretical insights of several recent papers linking income inequality and growth. Section IV discusses empirical studies which attempt to distinguish between alternative theories. Section V provides a critical discussion of the literature and Section VI concludes.

2 Empirical Literature Review

2.1 Measures of Income Inequality

Before diving into the empirical literature, we note that the first step in testing the relationships between inequality and growth is measuring inequality quantitatively. Since there is no single universally accepted measure, various measures are used, such as the coefficient of variation, Theil′s index, and the Gini coefficient. Among these measures, the Gini coefficient is the most commonly used. It is derived from the Lorenz curve, a graphical device used to represent inequality. A Lorenz Curve is a graphical representation of the cumulative distribution function of the empirical probalility distritribution of wealth. See Figure 1.

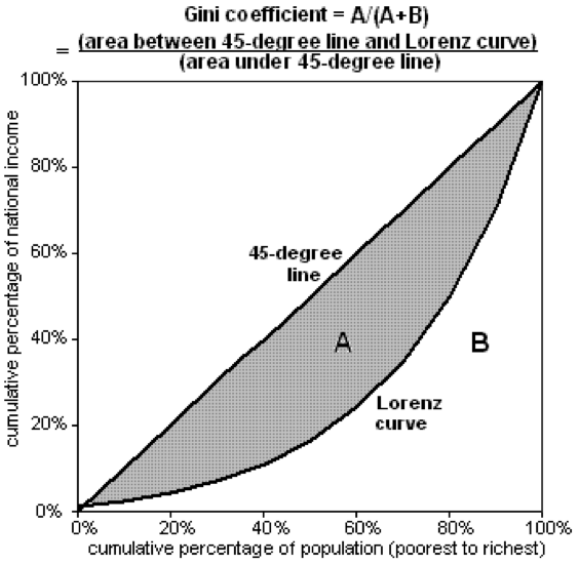

Figure 1: Lorenz Curve

The horizontal axis shows the percentage of population of income earners from lowest to highest income. The vertical axis shows the share of total income received by each percentage of population, which is also cumulative up to 100 per cent. To draw a Lorenz Curve, both the income recipients on the horizontal axis and percentage of income on the vertical axis must be ranked from the lowest to the highest. The line of perfect equality, which is the diagonal (45 degree line), represents a perfectly equal

income distribution in an economy where every household has the same income. On the contrary, the line of perfect inequality, which coincides with the horizontal and vertical axes, represents a perfectly unequal income distribution in an economy where one household has all the income. Thus, the level of income inequality is higher as the actual line bends further away from the 45 degree line.

The Gini Coefficient is also developed from Figure 1, which is named after the Italian statistician Corrado Gini who first formulated it in 1912 and is known as a measure of inequality of a distribution. If "A" represents the area bounded by the 45 degree line and the curve, while "B" is the area that is not covered by "A", then the Gini Coefficient can be calculated by using the formula $A/A+B$. The Gini Coefficient can vary anywhere from 0 (perfect income equality) to 1 (perfect income inequality). The bigger the area covered by "A", the higher the Gini Coefficient and thus higher income inequality.

2.2 The Kuznets Curve

2.2.1 Kuznets′ measures of income inequality

With respect to how to measure income inequality, Kuznets listed five specifications on how we should deal with the complications. First, one should measure family income properly adjusted for the number of persons in each family. Second, the distribution should cover all units in a country rather than a segment either at the upper or lower tail. Third, one should only include incomes associated with full-time, full-fledged participation in the economic activity. The units whose main income earners are either still in the learning stage or already in the retired stage of their life cycle should not be included. Fourth, income should be defined as national income, i.e., received by individuals, including income in kind, before and after direst taxes, excluding capital gains. Fifth, the units should be grouped by secular levels of income, free of cyclical and other transient disturbances. Finally, he points out, For such a distribution of mature expenditure units by secular levels of income per capita,

we should measure shares of some fixed ordinal groupspercentiles, deciles, quintiles, etc.(Kuznets 1955; p1).

Following the above specifications, Kuznets used annual income data before direct taxes and excluded contributions by government (e.g., relief and free assistance) as approximations to secular income levels. Then he said, " a constant percentage share of a given group means that its per capita real income is rising at the same rate as the average for all units in the county; and a reduction in inequality of the shares means that the per capita income of the lower-income groups is rising at a more rapid rate than the per capita income of the upper-income group" (Kuznets 1955; p5). He concluded from his empirical work on data for United States, England, and Germany that the relative distribution of income has been moving towards equality. He also found such reduction in the inequality of the percentage shares was accompanied by significant rises in real income per capita.

2.2.2 The Kuznets Inverted U Hypothesis

Kuznets (1955) introduced the idea of a link between inequality and development. Kuznets′ idea, developed further by Robinson (1976) focused on the movements of persons from agriculture to industry. Kuznets pointed out that development involves the shift of population from traditional to modern activities. This process of population shift from participating in agricultural productions to industrial productions allowed Kuznets to predict the behavior of inequality during the course of development.

In Kuznets′ paper, growth in the developed countries is the shift away from agriculture, a process usually referred to as industrialization and urbanization. The income distribution of the total population, in the simplest model, may therefore be viewed as a combination of income distributions of the rural and of the urban populations. The structure of the two components of income distribution reveals that: (a) the average per capita income of the rural population is usually lower than that of the urban; (b)

inequality in the percentage shares within the distribution for the rural population is somewhat narrower than in that for the urban population. This implies that all other conditions being equal, the increasing weight of urban populations does not necessarily put downward pressure on the process of economic growth: indeed, there is some evidence to suggest that it is stable at best, and tends to widen because per capita productivity in urban pursuits increases more rapidly than in agriculture. If this is so, inequality of the total income distribution should increase (Kuznets 1955).

However, Kuznets claimed that when the level of aggregate income reaches a certain level, income inequality diminishes during the latter stages. He argued that there are four facors counteracting the concentration of wealth: legislative interference and political decisions, demographic, relative freedom of individual opportunity, and inter-industry shift. The relationships between the distribution of income and the degree of development form an inverted U-shaped function as shown in Figure 2.

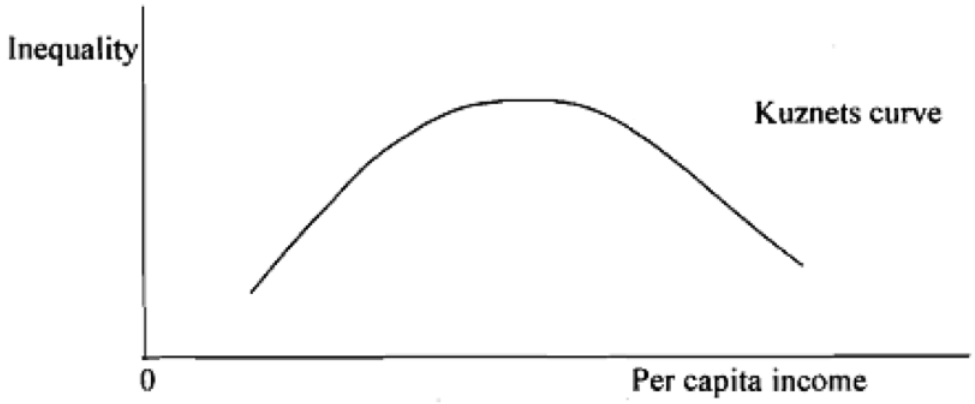

Figure 2: Kuznets Curve

A common criticism of Kuznets′ work revolves around the availability of relevant data. There are no statistics that can be used directly for the purpose of measuring the secular income structure. Measurement error is another concern in cross-country studies. Countries have different definitions of key variables and varying degrees of accuracy in data collection. One of the variables subject to the most severe measure-

ment error is inequality. Few countries have compiled data on income distribution on a regular basis and much of the data is unreliable. Coverage is generally uneven, and there is a lack of consistency in the definition of income and the unit of account.

In addition, the time series dimension of the available data is not long enough compared to the cross sectional dimension to make an informative conclusion about long run trend. Another limitation is that we can only answer the question of how income inequality changed in the process of a country′s economics growth— for growth under defined initial economic and social conditions. The third problem is that it is difficult to find the cut off point where inequality starts to decrease, i.e. how much per capital income is required for income inequality to decrease during the development process.

Kuznets himself has commented, "The paper is perhaps 5 per cent empirical information and 95 percent speculation, some of it possibly tainted by wishful thinking." He also points out, "speculation is an effective way of presenting a broad view of the field; and that so long as it is recognized as a collection of hunches calling for further investigation rather than a set of fully tested conclusions, little harm and much good may result" (Kuznets 1955; p26). Hence, Kuznets′ hypothesis leaves open research questions to be further investigated with refined and longer-term data.

2.3 Empirical studies that find a negative relationship

Motivated by Kuznets′ argument that there is a trade-off between reducing inequality and promoting growth, many economists have attempted to measure this relationship by adding inequality as an independent variable to some variant of Barro′s (1991,1997) cross-country growth regressions. There studies generally find a negative and just-significant coefficient on inequality. We now briefly discuss some of these papers.

Clarke (1995) claimed that initial inequality is negatively correlated with long-run growth. He conducted a cross-country growth regression by adding inequality variables to a Barro type growth regression. His result is robust to many different

assumptions about the form of the cross-country growth regression. In addition, the observed negative correlation is not dependent on the political regime— whether a country is a democracy or not.

Alesina and Perotti (1993) identified an inverse relationship between income inequality and growth through the channel of political instability and investment. Their paper used a sample of 71 countries for the period of 1960-1985 to test the hypothesis that income inequality, by fueling social discontent, increases sociopolitical stability, hence reduces investment by creating uncertainty in the politico-economic environment. As a consequence, income inequality and investment are inversely related. Since investment is a primary engine of growth, the link between income inequality and growth is established. They tested their hypotheses by estimating a two-equation model in which the endogenous variables are investment and an index of socio-political instability. Their results are also robust to sensitivity analysis on the specification of the model and the measure of political instability, and are unchanged when the model is estimated using robust regression techniques.

Deininger and Squire (1995) developed two new inequality data sets that have the following three features: observations are based on household surveys, on comprehensive coverage of the population, and on comprehensive coverage of income sources, including income from self-employment, nonwage earnings, and nonmonetary income. Deininger and Squire began with about 2,600 observations, but only 682 met the requirements to be included in their high-quality data set. Carefully and painstakingly compiled, the new inequality data set is far more consistent and comprehensive compared to data sets used in previous studies and is a building stone for future empirical studies in income inequality.

Deininger and Squire (1998) used the new data sets, which were developed in Deininger and Squire (1995), but a similar methodology to Clarke (1995). They run a reduced form cross-country regression to find that income inequality has a significant effect on subsequent growth but is not a robust determinant of future growth when

regional dummy variables are included.

Although the above three papers all found a negative relationship between income inequality and growth, the interpretations of the findings are quite different. Clarke′s paper focused on the direct relationship between initial income inequality and long run growth, whereas the Alesina and Perotti paper focused on the indirect relationship between income inequality and growth through a channel of political instability and investment. Deininger and Squire did a similar exercise as in Clarke (1995), but used refined data sets. Hence, their conclusions were slightly different.

One thing that the above studies had in common is that they all used cross-country data. Even though data used in some of the above studies had a time series dimension, the conclusions were derived from the cross-sectional dimension of the available data not the time-series dimension. They also attempted to explain the effect of initial income inequality on growth, not the effect of growth on income inequality.

2.4 Empirical studies that find a positive or no relationship

To understand whether there is any systematic relationships between income inequality and growth, we need to further investigate some more recent literature. With the development of time-series analysis and panel techniques, more recent studies on this relationship reported either positive or an insignificant contemporaneous correlation.

Forbes (2000) reported a significant positive relationship using the data sets compiled by Deininger and Squire (1995). Her paper estimated growth as a function of initial inequality, income, male and female human capital, market distortions, and country and period dummy variables— a model similar to that used in most empirical work on inequality and growth. The only difference is the addition of the dummy variables. The country dummies are included to control for time-invariant omitted-variable bias, and the period dummies are included to control for global shocks, which might affect aggregate growth in any period but are not otherwise captured by the explanatory variables. She claimed that the panel technique used controls for differ-

ences in time-invariant, unobservable country characteristics, thereby removing any bias resulting from the correlation of these characteristics with the explanatory variables. However, this technique only adjusts for time-invariant omitted variables, not for omitted variables whose values change over time. Papers estimating the neoclassical growth model show that using panel estimation can significantly change coefficient estimates (Knight et al. 1993, Islam 1995).

Barro (2000) also used the data set compiled by Deininger and Squire (1995) but found no significant relationship between income inequality and growth after controlling for other variables that affect growth. In his regression, the dependent variable is growth rate of real per capital GDP. The explanatory variables include: log of real per capita GDP, the Gini coefficient, the ratio of government consumption (exclusive of spending on education and defense) to GDP, the ratio of investment to GDP, a rule-of-law index, a democracy index, the inflation rate, the log of total fertility rate, years of schooling, and the growth rate of terms of trade. He then ran three-stage-least squares regression with instruments including the actual values of the schooling, terms-of-trade variables, the lagged values of the other variables aside from inflation, and dummy variables for prior colonial status (which have substantial explanatory power for inflation). With the other explanatory variables mentioned above held constant, differences in the Gini coefficients had no significant relation with subsequent economic growth.

Using similar data sets, why did Forbes and Barro get such different conclusions? Forbes took into account fixed effects by adding regional dummy variables to her regression. She claimed doing so controls for time-invariant, unobservable country specific omitted variables, hence removing any bias resulting from the correlation of these characteristics with the explanatory variables. In contrast, Barro′s specification incorporates random effects. Barro′s framework did not include country specific fixed effects because he argued that would eliminate the cross-sectional information in the data where the main information comes from. In other word, Forbes′ conclusion was

derived from the time series dimension whereas Barros conclusion was derived from the cross-county dimension.

Forbes′s result can be interpreted as a short-run positive relationship between inequality and growth within a given country (which reflects the time-series dimension). It does not directly contradict the previously reported long-run negative relationship across countries. Instead, these results should be taken as a complement to previous existing studies. It suggests that further careful reassessments of the numerous linkages between inequality, growth, and their determinants are necessary.

Both Barro and Forbes′s empirical work appear to have no bearing on the validity of the theories and are not very informative about the overall effect of inequality. First, these studies examine the effect of inequality beyond its effect through education, taxation, fertility and investment. Once controlled for education, taxation, fertility and investment, there is no relationship between inequality and economic growth in the entire sample. These findings suggest that inequality does not have a direct effect on growth beyond its effect through these dominating channels (i.e. education, taxation, fertility and investment), implying perhaps that the dominating channels through which inequality operates are those proposed in the literature (see Section III). Second, these studies examine the effect of inequality in the short run (i.e., the effect of inequality on the average growth rate in the subsequent 5-10 years), while as suggested by the theories, inequality is likely to have mostly longer-run effects.

All the empirical work discussed above investigated growth and inequality independently without taking into account the fact that they are endogenous to each other. That is, all of the above analysis uses the assumption that determinants of growth are orthogonal to inequality. They simply added inequality as an additional regressor to the growth regression. However, several recent articles questioned this assumption. Lundberg and Squire (2003) argued that growth and inequality are the joint outcomes of some variables that simultaneously affect both. They found that simultaneous examination of growth and inequality yields significant different results

and has different consequences for policy from previous studies.

Lundberg and Squire (2003) identified the factors that simultaneously influence both growth and inequality, especially those that are amendable to policy. Those factors are government expenditure, inflation, openness for growth, land distribution, and civil liveries for equality. Factors that only affect inequality are education, $M2/GDP$, and land distribution (in developed countries). A factor that only affects growth is inflation. For the factors that affect both, if they are positively correlated with growth, are negatively correlated with equality. Hence, there are no mutually beneficial variables. These results suggest that there is no single policy, which advances both growth and equity simultaneously. However, mutually exclusive factors offered instruments for policy-makers to improve equality or growth independently. An appropriate combination of policies can allow policy-makers to move towards their preferred location in the growth-equality space.

2.5 Nonlinear Relationships

Both Banerjee and Duflo (2000) and Ravallion and Chen (2003) have proposed non-linear relationships between growth and income inequality. They claimed the data strongly supports the non-linear relationships. This is in sharp contrast to the linear models that have been estimated in the literature. They also argued that the linear regression structure imposed in previous studies is inconsistent with the prediction of the theories and the qualitative findings may be an artifact of the imposed linearity.

Banerjee and Duflo (2000) used cross-country data in a reduced form regression to test the linearity assumption. Their results indicated that the relationships are non-linear. They found that both increases and decreases in inequality are associated with lower subsequent growth. Indeed, this non-linearity is sufficient to explain why different variants of the basic linear model (OLS, fixed effects, random effects) have usually generated very different conclusions. For example, on the increasing part of the inverted U curve, the relationship is positive. On the top of the inverted U curve

where the slope of the curve is zero, there is no relationship. On the decreasing part of the inverted U curve, the relationship is negative. In other words, the relationships between inequality and growth depend on the level of inequality. In many cases, it turns out that the differences arise out of giving different structural interpretations to the same reduced-form evidence.

3 Theoretical Literature Review

Motivated by the controversial empirical evidence, many theories have been constructed to assess the macroeconomic relations between inequality and economic growth. Based on the different channels through which the linkages between income inequality and growth are built, these theories can be classified into three categories: political economy (voting process), credit-market imperfections, technological progress.

3.1 Political Economy Models

The political economy approach underlines the mechanism that if the mean income in an economy exceeds the median income, then a system of majority voting tends to favor redistribution of resources from rich to poor. A greater degree of inequality motivates more redistribution through the political channel. Those redistributions, for example, transfer payments, public-expenditure programs and the associated tax finance, will distort economic decisions, and slow down growth.

There are many papers in the 1990′s following this line of political-economy analyses, see for example, Saint-Paul and Verdier (1991), Fernandez and Rogerson (1995), Perotti (1993), Bertola (1993), Alesina and Rodrik (1994), Persson and Tabellini (1994), and Benabou (1996) among others. Those early studies have argued that inequality generates a pressure to adopt redistributive policies, and that distortion adversely affects investment in physical and human capital and thus the growth process. Therefore, their models supported the viewpoint that inequality is harmful for

economic development.

The model developed by Alesina and Rodrik (1994) has become a basic reference that explained the empirically negative correlation between income inequality and economic growth through political economic channels. They studied this relationship in a simple model of endogenous growth with distributive conflict among agents endowed with varying factor (capital/labor) shares. In their model, growth is driven by the expansion of the accumulative capital stock, which is in turn determined by individual saving decisions. Long-run growth is endogenous, as the aggregate production function is taken to be linearly homogeneous in capital and productive government services taken together. Redistribution is through government services financed by a tax on capital that reduces people′s incentive to accumulate. In such a model, the lower an individual′s share of capital income (relative to labor income), the higher is his ideal tax, and the lower his ideal growth rate.

Their model can be described as follows. The aggregate production function is

$$y = Ak^{\alpha}g^{1-\alpha}l^{1-\alpha}, 0 < \alpha < 1, \tag{1}$$

Where A is a technological parameter, k and l are the aggregate stocks of capital and labor, respectively, and g is the aggregate level of government spending on productive services. To finance spending on public services, the government has access to a linear tax on capital income, τ. The budget is balanced every instant, so that $g = \tau k$. They assume perfect competition in factor markets so that wages and rates of return on capital are determined by the usual marginal productivity conditions. Hence, we obtain

$$r = \alpha A\tau^{1-\alpha} \equiv r(\tau) \tag{2}$$

$$w = 1 - \alpha A\tau^{1-\alpha}k \equiv w(\tau)k \tag{3}$$

They further assume that labor is supplied inelastically, and set the economy′s aggregate labor endowment equal to unity. Note that the marginal productivity of capital r is independent of the capital stock, once the tax on capital that finances

government spending is taken into account. This prevents diminishing returns from setting in. Furthermore, the marginal productivities of labor and capital are both increasing in the tax rate on capital, as higher taxes allow more government spending on productive services for any given level of k. The wage rate is also increasing in the capital stock.

At this point, we can see that the tax on capital plays two critical roles here. First, it affects the net return to capital owners, and hence will alter their incentive to accumulate. Second, it increases productivity by increasing level of wage income $\omega(\tau)$ (while reducing its rate of growth insofar as it also induces a lower rate of capital accumulation). Wage income is increasing in tax rate because a higher rate allows the government to increase its spending on services that increase productivity.

On the consumer side, they assume individuals are alike in all respects except for their initial ownership shares in the economy′s aggregate stocks of capital and labor. Each individual is indexed by his relative factor endowment σ^i:

$$\sigma^i = \frac{l^i}{\frac{k^i}{k}}, \sigma^i \in [0, \infty) \tag{4}$$

An individual with a high σ is capital-poor, while one with a low σ is capital-rich. Each individual can earn income from both capital and labor. Therefore,

$$y^i = \omega(\tau)kl^i + [r(\tau) - \tau]k^i = \omega(\tau)k^i\sigma^i + [r(\tau) - \tau]k^i \tag{5}$$

All individuals have the same logarithmic utility function and live forever. The consumption-saving decision of the i_{th} individual are determined by solving the following problem:

$$maxU^i = \int \log c^i e^{-\rho t} \mathrm{d}t \tag{6}$$

such that

$$y^i = c^i + \frac{dk^i}{dt} \tag{7}$$

where c^i denotes consumption and ρ is the discount rate. The individual consumer takes the paths of r,k, and τ as given. The solution to this problem is given by the

following equation:

$$\dot{c^i} = (r(\tau) - \tau) - \rho, \forall i, \tag{8}$$

Assuming that τ remains unchanged over time, each individual then accumulates along a steady-state path given by

$$\dot{k^i} = \dot{c^i} = r(\tau) - \tau - \rho \equiv \gamma(\tau) \tag{9}$$

This has the implication that all individuals accumulate at the same rate. Therefore, there is a common economy wide growth rate $\gamma(\tau)$, which is independent of the initial distribution of factor endowments. Growth is linear in the difference between the after-tax return to capital and the discount rate. The higher is the after-tax return to capital, the higher the economy′s growth rate. Tax on capital has a nonlinear effect on growth, which can be represented by a U-curve: the growth rate first increases, and then decreases, as τ increases. The growth-maximizing tax rate is given by

$$\tau^\star = [\alpha(1-\alpha)A]^{1/\alpha} \tag{10}$$

Using the median voter theorem, which states that the tax rate selected by the government is the one preferred by the median voter, the more equitable is the distribution in the economy, i.e. the better endowed is the median voter with capital, the lower is the equilibrium level of capital taxation. It can be shown that the pure capitalist who has no labor income, i.e. $\sigma^i = 0$, has the ideal tax rate that equals $\tau^\star$. Since τ^i is increasing in σ^i, an immediate implication is that an individual with some labor income, no matter how small this income is, prefers a tax rate that exceeds $\tau^\star$, a growth rate that less than the maximum. In that range, growth rate is decreasing as τ increases. Hence, more inequality results in the median voter to choose a higher tax rate, thus slows down growth. Furthermore, in their model the distribution of income is monotonically related to the distribution of capital. Thus, the central theoretical result is that income and wealth inequality are inversely related to subsequent economic growth.

There are other approaches in the political economy literature. Persson and Tabellini (1994) developed a simplified overlapping generation model in which heterogeneous individuals are born every period, live for two periods and act as economic agents and voters. In their paper, they put both the theory of endogenous growth and the theory of endogenous policy together. The models politico-economic equilibrium determines a sequence of growth rates as a function of parameters and initial conditions. They also concluded that the greater is income inequality, the lower the equilibrium growth. The intuition is similar to that in Alesina and Rodrik (1994).

Lindner and Strulik (2004) relaxed the assumption that the government credibly commits to constant tax rates and generalizes the model of Alesina and Rodrik (1994) by using a dynamic game. To derive a time consistent solution, they required that government make its current (possibly non-linear) choice of the tax rate depending on the state of the system, namely the median voters current stock of capital, using a Markovian (feedback) strategy. They show that the solution obtained by Alesina and Rodrik (1994) is a time consistent Markovian Stackelberg equilibrium in a differential game between the government and the median voter.

In Alesina and Rodrik (1994), they assumed that the government decides once and for all on a constant tax rate. This approach has been criticized for requiring commitment or violating time-inconsistency when re-optimization is possible. In Lindner and Strulik (2004), they assumed that households expect tax rates to be constant over time. They showed that when the government re-optimizes in favor of the median voter at any point in time it sticks to the initially chosen tax policy. They commented, " We provide the missing proof of time-consistency of Alesina and Rodrik′s solution" (Lindner and Strulik 2004; p442).

Saint-Paul and Verdier (1992) also presented a model of endogenous growth where redistribution, determined by a political equilibrium, is in the form of public education. In their paper, it is argued that redistribution and democratization of a society do not necessarily have adverse effects on growth while the main channel of redistribu-

tion is public education. Typically from a political economy aspect, public education has two following essential features: first it may be an instrument of intergenerational redistribution and therefore is an issue of redistributive politics; second, it is an activity that creates human capital and therefore promotes long-run growth. In their model, public education is provided in an egalitarian way and financed by proportional taxation on labor income. Agents are altruistic in the sense that they care about their childrens human capital levels. Each individuals human capital has an inherited component and a component due to public education. Therefore, more public education fosters growth because it increases a generations human capital relative to the previous generation.

The main result of the model is that for a given structure of political tightness, the economy converges towards a steady-state growth path; during which this convergence process, income distribution becomes more equal, tax rates decline as well as growth rate. The intuition is that as the distribution of human capital gets more even through public education, the median voter gets relatively richer, so that his children will benefit less from public education relative to inherited human capital. Therefore the level of public education implied by the political equilibrium tends to decline. Hence, Saint-Paul and Verdier′s model predicts a positive relationship between income inequality and growth.

3.2 Human Capital Formation under Incomplete Credit Markets

In models with incomplete credit markets, borrowing constraints mean that returns on investment opportunities do not necessarily equate at the margin. The credit market imperfections typically reflect asymmetric information and limitations of legal institutions. With limited access to credit, the exploitation of investment opportunities depends on individuals levels of assets and incomes. Poor agents have to forego human-capital investments that offer relatively high rates of return because they are

borrowing constrained. In this case, a distortion-free redistribution of assets and incomes from rich to poor tends to raise aggregate investment and return on investment. Through this mechanism, a reduction in inequality raises the rate of economic growth.

Loury (1981) was the first to show that the distribution of wealth affects the aggregate amounts of investment in human capital and of output. In his important contribution Loury also showed that under credit market imperfections the effect of wealth distribution disappears in the long run, as all initial wealth distributions in his model converge to a unique ergodic distribution. Galor and Zeira (1993) added another assumption that technology is non-convex and concluded that the inherited distribution of wealth affects the economy not only in the short run but in the long run as well. As a result of the additional assumption, there are multiple long-run equilibria and dynamics are no longer ergodic.

The basic Galor-Zeira model considers a small open economy in a one-good world. The good can be produced by two technologies, one using skilled labor and capital and the other using unskilled labor only. Production functions are described respectively by:

$$Y_t^s = F(K_t, L_t^s), \tag{11}$$

$$Y_t^n = w_n \cdot L_t^n, \tag{12}$$

where F is a concave production function with constant returns to scale. It is assumed that investment in human capital and in physical capital is made one period in advance. Individuals in this economy live two periods each in altruistic overlapping generations. They can either work as unskilled in both periods of life or invest in human capital when young and be skilled workers in the second period of life. The amount of investment in human capital is $h > 0$ (indivisible). The indivisibility of the amount of investment implies that there is a region of increasing returns to scale. An individual supplies one unit of labor in each of the working periods.

Each individual has one parent and one child, which create the connection be-

tween generations within dynasties. People care about their children and leave them bequests. It is also assumed that people consume in the second period of life only. An individual derives utility both from consumption in the second period of life and from any bequest to his/her offspring:

$$u = \alpha \log c + (1 - \alpha) \log b \tag{13}$$

All individuals are born with the same potential abilities and with the same preferences. They differ only in the amounts they inherit from their parents.

The world interest rate is equal to $r > 0$, and is assumed to be constant over time. Individuals can lend any amount at this rate. As for borrowing, they assumed that a borrowing individual can evade debt payments by moving to other places etc., but this activity is costly. Lenders can avoid such defaults by keeping track of borrowers, but such precautionary measures are costly as well. Assume if lenders spend an amount z at keeping track of a borrower, this borrower can still evade the lenders but only at a cost of βz, where $\beta > 1$. This cost creates a capital market imperfections, where individuals can borrow only at an interest rate higher than r. Unlike individuals, firms are unable to evade debt payment, hence can borrow at the lenders interest rate r. Due to the fact that the number of skilled workers is known one period in advance, the amount of capital in the skilled labor sector is adjusted each period so that:

$$F_k(K_t, L_t^s) = r \tag{14}$$

Hence, there is a constant capital-labor ratio in this sector, which determines the wage of the skilled labor w_s, which is also a constant. This wage w_s depends on r and on technology only.

An individual who borrows an amount d pays an interest rate i_d which covers lenders interest rate and lenders costs z:

$$d \cdot i_d = d \cdot r + z \tag{15}$$

Lenders choose z to be high enough to make evasion disadvantageous:

$$d(1 + i_d) = \beta z. \tag{16}$$

This is an incentive compatibility constraint.

Consider an individual who inherits an amount x in the first period of life. If this individual decides to work as unskilled and not invest in human capital, he is a lender with lifetime utility of $U_n(x)$ and a bequest of $b_n(x)$. An individual with inheritance xh, who invests in human capital, is a lender with lifetime utility $U_s(x)$ and a bequest of $b_s(x)$. An individual with inheritance $x < h$, who invests in human capital, is a borrower. Assume investment in human capital pays back more than unskilled labor, lenders will prefer to invest in human capital in the first period. Borrowers will invest in human capital as long as:

$$x \geq f = \frac{1}{i-r}[w_n(2+r) + h(1+i) - w_s] \tag{17}$$

Individuals who inherit an amount less than f would prefer not to invest in human capital but work as unskilled labor. Education is, therefore, limited to individuals with high enough initial wealth, due to credit market imperfections (higher interest rate for borrowers). The amount an individual inherits in the first period of life fully determines his decisions whether to invest in human capital or work as unskilled, and how much to consume and bequeath. Hence the distribution of wealth determines aggregate output and it therefore has a strong effect on the macroeconomic equilibrium. The dynamic evolution of wealth distribution over time can be illustrated in Figure 3. The curve b_n and b_s describe the dynamic relationship between inheritance and bequest for unskilled and skilled workers respectively and f is determined by the intersection of b_n and b_s.

Dynasties in this economy are concentrated in the long run into two groups: rich dynasties, where generation after generation invests in human capital, and poor ones, where generation after generation are unskilled workers. The economy converges to a long-run equilibrium in which the population is divided into two groups: skilled workers with wealth x_s and unskilled workers with wealth x_n. The relative size of these two groups depends on the initial distribution of wealth. The long-run levels of income and wealth are positively related to the initial number of individuals who

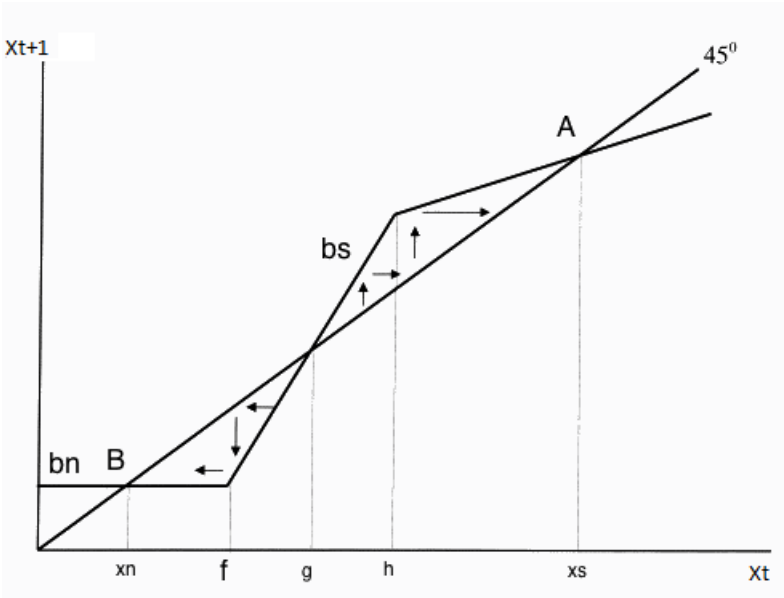

Figure 3: Dynamics of Wealth Distribution

inherit more than g. Thus, an economy, which is initially poor, ends up poor in the long run as well. An economy, which is initially rich and its wealth is distributed among many, ends up rich. But an economy with a large initial amount of wealth, which is held by only a few, ends up poor in the long run. In other words, we could say that a country has better growth prospects if it has relatively larger middle class.

The basic Galor-Zeira model establishes the potential adverse effect of inequality on economic growth. The credit market imperfections approach for the study of the effects of income distribution on economic growth, which subsequently emerged, maintained the two fundamental assumptions of the Galor-Zeira model: i.e., credit market imperfections and fixed cost associated with investment in human capital. Notably, Banerjee and Newman (1994) modeled economic development as a process of institutional transformation by focusing on the interplay between agents′ occupational decisions (i.e., choice between becoming an entrepreneur or a worker, rather than the choice between becoming either a skilled or an unskilled worker) and the distribution of wealth also under the assumption of credit market imperfections. Due to borrowing constraints, poor agents choose working for a wage over self-employment,

and wealthy agents become entrepreneurs. Only with sufficient inequality will there be employment contracts. Initial wealth distributions have long run effects. An economy develops either a widespread cottage industry (self-employment) or engages in factory production (employment contracts), depending on initial distribution.

Other research analyzes the interplay between income inequality and equality of opportunities that was emphasized by Galor and Zeira within the credit market imperfections approach includes but not limited to: Fershtman, Murphy and Weiss (1996), Owen and Weil (1998), Maoz and Moav (1999), and Hassler, Mora and Zeira (2007). Those researches examine the effect of inequality on the degree of intergenerational mobility and thus the efficiency in the allocation of talents across occupations.

Aghion and Bolton (1997) also developed a model of growth and income inequalities in the presence of incomplete credit markets. They analyzed the trickle-down effect of capital accumulation. Moral hazard with limited wealth constraints on borrowers is the source of both credit market imperfections and the emergence of persistent income inequalities. They focused on the supply side of the credit market. In their model, the equilibrium interest rate is determined endogenously by the interplay between the supply and demand for investment funds. The main economic insight in their paper is that, even though wealth does trickle-down from the rich to the poor and leads to a unique steady-state distribution of wealth, there is still room for wealth redistribution policies to improve the long run efficiency of the economy. The reason why redistribution improves productivity is that with redistribution the poor need to borrow less to invest and therefore their incentives to maximize profits are distorted less. Redistribution brings about greater equality of opportunity and accelerates the trickle-down process.

More recently, Koeppl, Monnet and Quintin (2008) argued that it is the combination of credit market imperfections and endowment inequality that leads to slower economic growth and creates a rationale for redistribution. In their model, contract enforcement makes trade possible but requires an aggregate investment of capital.

Redistribution is through investment in contract enforcement. Although investing in institutions is not directly productive, it makes a better allocation of resources possible due to diminishing returns to capital. At the efficient solution, agents at the bottom of the endowment distribution benefit the most from investment in enforcement and these investments lead to a reduction in income inequality. They concluded as institutional investment allowing for inequality to reduce over time, the fall in dispersion of income causes the optimal level of enforcement to fall as well. The economy converges monotonically to a long-run invariant distribution of income and endowments with progressively less inequality and higher output.

3.3 Skill-biased Technological Progress

The technological progress approach argues that cycles of technological progress plays a significant role in determining the evolution of earnings inequality and intergenerational earnings mobility, and that earnings mobility may govern the pace of technological progress and output growth. In periods of major technological progress, ability is the dominating factor and inequality rises. Initially, inventions increase the return to skills, but as technology becomes more accessible the return to skills decline. Existing studies following this research strand include: Stokey (1988), Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1992), Barro et al. (1995), Fershtman et al. (1996), Galor and Tsiddon (1997), Krusell et al. (2000), Aghion (2002) among others.

Galor and Tsiddon (1997) analyzed the relationship between technological progresses, wage inequality, intergenerational earnings mobility and economic growth. They argued that in periods of major technological progress, a decline in the relative importance of initial conditions enhances intergenerational earnings mobility, raises inequality, and generates a larger concentration of high-ability individuals in technologically advanced sectors, stimulating future technological progress and growth. Once technologies become more accessible, mobility is diminished and inequality de-

creases but becomes more persistent. The reduction in the concentration of ability in technologically advanced sectors diminishes the likelihood of technological breakthroughs and slows future growth.

Aghion (2002) developed an Schumpeterian Growth model in which growth is primarily driven by a sequence of quality-improving innovations each of which destroys the rents generated by previous innovations. This paper provides important insights into the income inequality and growth relationship. The main focus of his paper was on the interplay between endogenous technical change arising from quality improving innovation and the dynamics of the wage structure. The paper analyzed two Schumpeterian Growth mechanisms. The first mechanism is based on a market-size effect induced by the increase in the relative supply of skilled labor. The second mechanism emphasizes the notion of Major Technological Change with particular reference to the General Purpose Technologies in industrialized economies and the nonlinear diffusion of the new information and communication technologies.

The model used by Aghion to explain the first mechanism is adapted from Acemoglu (1999, 2000). Aghion assumed that time is discrete and that at any period final output is produced using two kinds of intermediate inputs, x_s and x_u, according to

$$y = x_s + x_u \tag{18}$$

The intermediate inputs x_s and x_u are themselves produced using skilled and unskilled labor respectively, according to the Cobb-Douglas technologies:

$$x_s = A_s \cdot l_s^{\alpha}, x_u = A_u \cdot l_u^{\alpha} \tag{19}$$

where $\alpha \in (0, 1)$, A_s and A_u denote the productivity of a specialized machine used by a skilled and an unskilled worker respectively to produce intermediate goods x_s and x_u, and l_s and l_u denote the employment of skilled and unskilled labor.

There is a continuum of potential producers in the economy, but in any period only one firm knows how to make a technological advance in either sector. To simplify the

analysis, we assume that innovations are always imitated after one period, so that an innovator gets monopoly rents for only one period. Then, if $A_{j,t-1}$denotes the leading-edge productivity in sector $j \in U, S$ in period $(t-1)$, and if $n_{j,t}$ denotes the research and development investment in sector j at time t, we assume

$$A_{j,t} = A_{j,t-1} n_{j,t}^{\beta}, 0 < \beta < 1. \tag{20}$$

For given productivity level $A_{j,t}$, the innovating firm in sector j at time t will make its employment decision $l_{j,t}$ so as to solve the following problem:

$$max\{A_{j,t} l^{\alpha} - w_{j,t} l\} = \pi_{j,t}, \tag{21}$$

In equilibrium the innovating firm at date t must be indifferent between targeting its research and development investment to sector $j = U$ or to sector $j = S$. The increase in marginal revenue induced by one extra unit of research and development input invested in either sector must be the same. Using the envelope theorem, the following research arbitrage equation must hold in equilibrium:

$$\frac{x_{u,t}}{x_{s,t}} = \frac{n_{u,t}}{n_{s,t}}. \tag{22}$$

Now, let $a_t = A_{s,t}/A_{u,t}$. Using the above equation together with the labor market clearing assumption, $l_u = u$ and $l_s = s$, where u and s denote the supplies of unskilled and skilled labor, one can express the equilibrium skill premium $\omega_t = w_{s,t}/w_{u,t}$ at time t as

$$\omega_t = a_t (\frac{u}{s})^{1-\alpha}, where a_t^{1-\beta} = a_{t-1} (\frac{u}{s})^{1-\alpha}, \tag{23}$$

From the above equations, we can see for given a_t an increase in the relative supply of skilled labor s/u reduces the skill premium ω, it also increases the relative productivity $a_t = A_{s,t}/A_{u,t}$, which in turn has the opposite effect of increasing the skill premium. This captures what Acemoglu (1999) refers to as a market size effect: namely, as the relative supply of skilled labor increases, so does the relative size of the monopoly rents of an innovation that would be targeted at the skilled intermediate

sector, thereby resulting in an increase in the relative productivity in the skilled sector and therefore in an increase in the skill premium ω.

The model used by Aghion to explain the second mechanism is based upon the diffusion of so-called General Purpose Technologies (GPT). A GPT is a technological breakthrough that affects an entire economic system, i.e. information technologies embodied in information and communication equipment. The diffusion of a new GPT consists of a wave of secondary innovations, each of which creates a new product or process in a particular sector that improves upon, but yet is closely related to, recent adaptations of the same GPT in other sectors.

The mechanism of the model has two essential features. First, experimentation and adoption of a new GPT requires additional skilled labor so that demand for skilled labor increases as the GPT diffuses throughout the economy. Second, although the spread of a new GPT may take place over a long period of time, most of the skill-intensive experimentation through which the spread takes place tends to be concentrated over a relatively short sub period during which there is an acceleration in the diffusion of the new GPT and therefore an increase in the aggregate demand for skilled labor. This in turn should cause the skill premium to rise in spite of the continuing increase in the supply of skilled labor.

Suppose that aggregate final output is produced by "labor according to the constant returns technologies:

$$\{\int_0^1 A(i)^\alpha x(i)^\alpha \mathrm{d}i\}^{\frac{1}{\alpha}} \tag{24}$$

where $A(i) = 1$ in sectors where the old GPT is still used, and $A(i) = \ > 1$ in sectors that have successfully innovated, while $x(i)$ is the flow of intermediate good currently used in the production of final output. Manufacturing labor produces intermediate goods using a one-for-one technology, so that $x(i)$ also denotes the labor demand flow in sector i. The total labor force L is divided into skilled and unskilled workers. While old sectors with $A(i) = 1$ are indifferent between skilled and unskilled workers, the experimentation and implementation of the new GPT can only be done by skilled

labor.

For simplicity, assume that the supply of skilled workers is monotonically increasing over time, that is:

$$L_s(t) = L - (1 - s) \cdot L \cdot e^{-\beta t}, \tag{25}$$

where $s < 1$ is the initial fraction of skilled workers and β is a positive number measuring the speed of skill acquisition.

Now further assume that in each sector i, moving from the old to the new GPT requires two steps. First, a firm in that sector must acquire a template on which to base experimentation; second, the firm must succeed in making the transition to the new GPT. Let n_0 denote the fraction of sectors that have not yet acquired a template, n_1 denoted the fraction of sectors that are currently experimenting on the new GPT, and $n_2 = 1 - n_0 - n_1$ the fraction of sectors that have completed the transition to the new GPT.

Let $\lambda(n_2)$ denote the Poisson arrival rate of templates for the new GPT in a given sector and suppose that it follows a logistic curve, for example to threshold effects in cross-sector imitations. A special case is when:

$$\lambda(n_2) = \begin{cases} \lambda_0 & \text{if } n_2 \leq \bar{n} \\ \lambda_0 + \Delta & \text{if } n_2 \geq \bar{n} \end{cases} \tag{26}$$

Now, suppose that for a template firm to actually succeed in implementing the new GPT, it must employ at least H units of skilled labor per period. This labor is not used to produce current output. Instead, it allows the sector to access a Poisson process that will deliver a workable implementation of the new GPT with an arrival rate of λ_1. Thus the flow of new sectors that can implement the new GPT will be the number of experimenting sectors n_1, times the success rate per sector per unit of time$_1$. The evolution over time of the two variables n_1 and n_2 is then given by the autonomous system of ordinary differential equations:

$$n_1 = \lambda(n_2) \cdot (1 - n_1 - n_2) - \lambda_1 n_1 \tag{27}$$

$$n_2 = \lambda_1 n_1 \tag{28}$$

with initial condition $n_1(0) = 0$,$n_2(0) = 0$. The time path of n_0 is then given automatically by the identity $n_0 \equiv 1 - n_1 - n_2$.

The time-path of n_2 follows a logistic curve, accelerating at first and slowing down as n_2 approaches 1, with the maximal growth rate occurring somewhere in the middle. Likewise, the path of n_1 must peak somewhere in the middle of the transition. The transition process from the old to the new GPT can then be divided into two subperiods. First, in the early phase of transition (i.e. when t is low) the number of sectors using the new GPT is too small to absorb the whole skilled labor force, which in turn implies that a positive fraction of skilled workers will have to be employed by the old sectors at the same wage as unskilled peers. Thus, during the early phase of transition the labor market will remain unsegmented, with the real wage being the same for skilled and unskilled labor and determined by the labor market clearing condition:

$$(1 - n_2) \cdot x_0 + n_2 \cdot x_N + n_1 \cdot H = L. \tag{29}$$

where $x_(O)$, x_N and H denote the labor demands respectively by an old manufacturing sector, a sector using the new GPT, and an experimenting sector.

In the later phase of the transition, however, where the fraction of new sectors has grown sufficiently large that it can absorb all of the skilled labor force. The labor market will become segmented, with skilled workers being employed exclusively (and at a higher wage) by the new sectors whilst unskilled workers remain in old sectors. Let w_s and w_u denote the real wage of skilled and unskilled workers respectively. We now have $w_s > w_u$, since the two real wages are determined by two separate labor market clearing conditions.

The skill premium, here measured by the ratio w_s/w_u starts increasing sharply when the diffusion of the new GPT across sectors accelerates and the premium keeps on increasing although more slowly during the remaining part of the transition process. Since everyone ends up earning the same (skilled) wage, standard measures of

inequality first rise and then fall. Hence, a faster pace of technological diffusion (i.e. of secondary innovations) may generate both, an increase in the skill premium and a temporary productivity slowdown whilst the new GPT is being experimented by a large fraction of sectors in the economy. In these theories, mobility from old to new requires a process of familiarization and training. Inequality would depend on how long ago a new technological innovation was introduced into the economy.

In addition, the GPT explanation appears to be also consistent with the observed deceleration in the increase in between-group wage inequality during the past decade: we may indeed interpret this trend reversal as reflecting the fact that the diffusion of new communication and information technologies is now entering a mature phase.

4 Empirical Tests of Theories

As discussed in the previous section, many economic theories exist for assessing the relationships between inequality and economic growth. These theories tend to have offsetting effects and generally the predicted net effects of inequality on investment and growth are ambiguous. The theoretical ambiguities do, in a sense, match with empirical findings, which tend not to be robust or significant either. We now discuss papers which attempt to empirically test models of these relationships.

Several attempts have been made to examine the predictions of theoretical models which focus on the political economy channel. Perotti′s (1996) examination of the political economy channel was not favorable to the theories advanced by Alesina and Rodrik (1994) and Persson and Tabelini (1994). His findings refute this early hypothesis of the political economy approach, demonstrating that in contrast to their proposed channel, inequality is in fact associated with lower levels of taxation, while lower levels of taxation, contrary to the theories, are associated with lower levels of economic growth.

A possible explanation for this empirical finding could be that if more economic resources translate into correspondingly greater political influence, then the positive

link between inequality and redistribution need not apply. The rich may prevent redistribution policies through lobbying and buying votes of legislators. Then a higher level of economic inequality would require more of these actions to prevent redistribution of income through the political process. The lobbying activities would consume resources and promote official corruption and tend accordingly to hamper economic performance. Therefore, inequality can have a negative effect on growth through the political channel even if no redistribution of income takes place in equilibrium. This is in line with the empirical findings of the negative relationship of growth and inequality reported by Alesina and Rodrik (1994) and Persson and Tabelini (1994).

In contrast to the political economic channel, Perotti′s (1996) empirical study of the credit market imperfections approach provides support for the Galor-Zeira (1993) hypothesis, showing that inequality is indeed associated with lower levels of investment in human capital, and lower human capital formation is associated with lower levels of economic growth. Further support for the main predictions of the human capital channel in the context of the credit market imperfections approach has been put forth by Deninger and Squire (1998). Utilizing the distribution of land as a proxy for the distribution of income, they find that initial inequality has a significant adverse effect on education and economic growth. Moreover, consistent with the theories advanced by the credit market imperfection approach, they found that this imperfection ought to have a larger effect on the investment decisions of individuals with lower income; in other words, initial inequality primarily hurts the poor.

If capital markets and legal institutions tend to improve as an economy develops, then the effects of credit market imperfections are more important in poor countries than in rich ones. Therefore, the predicted effects of inequality on economic growth would be greater in magnitude for poor countries than for rich ones. Barro′s (2000) cross-country empirical study provides support for such argument. He found that higher inequality tends to retard growth in poor countries and encourage growth in

richer countries. In particular, he reported, "the effect of inequality on growth is negative for values of per capita GDP below $2,070 (1985 U.S. dollars) and then becomes positive" (Barro 2000; p21).

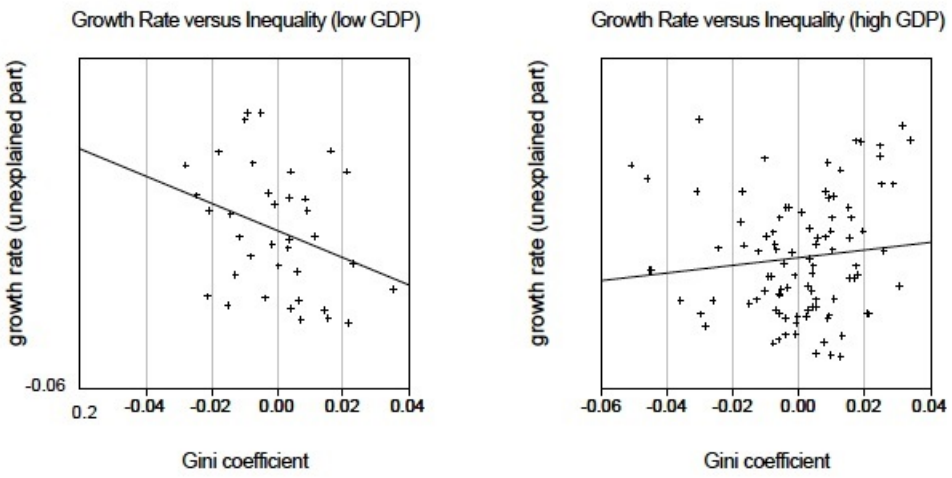

Figure 4: Growth rate versus inequality

Figure 4 from Barro (2000) shows the partial relations between growth rates and the Gini coefficient for the low and high ranges of per capital GDP. In the left panel, where per capital GDP is below $2,070, the estimated relation is negative. In the right panel, where per capital GDP is above $2,070, the estimated relation is positive.

Recently, Easterly (2007) has also confirmed the hypothesis that inequality has an adverse effect on human capital formation and economic development. Utilizing agricultural endowments as an instrument for inequality, in order to overcome concerns about measurement errors and the endogeneity of inequality, his cross-country analysis suggests that inequality has been a barrier to schooling and economic prosperity.

Another channel through which inequality affects growth is skill-biased technology progress. A number of empirical studies have pointed to a significant impact of skill-biased technological progress on the evolution of wage inequality. For example,

using research and development expenditures and computer purchases as measures of technological progress, Berman-Bound-Griliches (1994) found that these two factors could account for as much as 70 percent of the move away from production to nonproduction labor over the period 1979-1987. Murphy-Welch (1992) find that the share of college labor has increased substantially in all sectors since the mid-seventies, which, together with the observed increase in college premium, provides further evidence of skill-biased technological progress. More recently, Acemoglu (2000) estimates that the relative productivity of college graduates has increased from 0.157 in 1980 to 0.470 in 1990 whereas this relative productivity had risen at a lower rate prior to the early 1980′s (assuming an elasticity of substitution of 1.4 between skilled and unskilled labor). These empirical findings suggest early 1980′s was the start of the skill-biased technological change.

More recently, Beaudry, Green and Sand (2013) documented a reversal in the demand for skilled workers in the US labor market since 2000. This is in line with the prediction of the theory as a sign of the diffusion of new communication and information technologies is now entering a mature phase. All of the above findings seem to be generally consistent with the theoretical predictions through the skilled-biased technological progress channel.

5 Critical Discussion

5.1 Empirical Studies

5.1.1 Cross-country Empirical Studies

Cross-country empirical research on the relationships between distribution and growth can be classified into two main groups: reduced form estimations of the direct effect of inequality on growth and structural estimates of the transmission channels. The reduced form estimation approach generally finds a negative relationship between income inequality and growth. However, these results are not generally robust and suffer from the following three concerns.

First, it is possible that the strong negative correlation between inequality and growth simply reflects the effect of omitted variables. The inequality variable may capture the effects of other omitted variables, which are both correlated with inequality and growth rate. This omission will lead to an over-estimate of the direct effect of inequality on growth.

Second, the extent of the negative direct effect of inequality on growth may be sensitive to the inclusion of regional dummy variables. The negative correlation between initial inequality and future growth might reflect regional variations in omitted characteristics.

Third, all of the existing empirical work suffers from two potentially serious data problems. The first problem is that many of the observations included in the empirical studies of Alesina and Rodrik (1994), Clark (1995) and Perotti (1996) and Persson and Tabellini (1994) do not meet the three main "high quality" criteria stated by Deininger and Squire (1995). The second problem is that the vast majority of the empirical literature studying the relationships between income inequality and economic growth does not measure income inequality in a consistent manner. Due to lack of comparable data, researchers have been forced to combine heterogeneous non-comparable inequality data based on gross income, net income, and expenditure. The measurement unit is also measured at two different levels: individual level and household level. However, combining inequality data that are not consistently measured in the same sample may be an inadequate procedure since we would expect the distribution of income after tax to be more equal than the distribution of income before tax in a country with a progressive tax structure.

To sum up, the cross-country reduced form regressions suggest a negative relationship between initial income inequality and long run growth. But because of the insufficiencies mentioned above, the evidence of a strong direct effect of inequality on growth proves to be rather weak. The statistical loss of significance of the inequality variable following the introduction of new growth determinant variables may mean

that inequality may affect growth indirectly through various transmission channels suggested by the theory. One way of checking the causality link consistent with some theoretical hypothesis is to estimate and test using a structural model.

Structural regressions may be used to check the indirect relationships between inequality and growth through the accumulation of production factors. The structural model that makes it possible to test this assumption on the relationship between inequality and growth contains a series of simultaneous equations including the rates of growth and accumulation of physical and human capital as endogenous variables and some measures of the distribution of income and wealth.

In general, the empirical results differ widely with regard to the effect of inequality on the rate of investment in physical capital. The results are much more satisfactory with regard to effect of inequality on the rate of investment in human capital. There are very few empirical studies which have attempted to test directly the credit market imperfections channel, because the degree of credit market imperfection is generally difficult to measure. Little empirical evidence was found to support that a more unequal initial distribution of income results in greater income redistribution. Hence, the results from the cross-country structural regression are inconsistent with the theoretical predictions of political mechanism.

These overall rather disappointing econometric results thus suggest either that the transmission mechanism at work are different from those which are highlighted in the theory. It may also indicate that the data and instruments at hand are simply not sufficient to estimate and test the true structural models which examine how the degree of inequality of the income distribution affects growth.

5.1.2 Panel Data Reduced Form Empirical Studies

The panel-data estimate techniques have the main advantage of eliminating bias resulting from the correlation between omitted explanatory variables. The panel-data estimates are also capable of revealing short-run relationships between inequality and

growth.

In Forbes (2000), he concluded that income inequality affects positively and significantly the short-term growth rate in a given country, which implies that a redistribution of incomes would have a negative impact on the future short-run growth rate of this economy. The completely opposite conclusions that arise from cross-section studies (a negative effect of income inequality on the long-run growth rate over periods of 25 to 30 years in general) and from panel-data estimates (a positive impact of income inequality on the short-term growth rate usually over periods of 5 to 10 years) reveal that the short- and long-run empirical links between these two variables operate through very different transmission channels and are of opposite signs. This suggests that the positive short-term consequences of income inequality on growth tend to soften and finally reverse over sufficiently long periods. Hence, the panel-data econometric findings indicate that the relationship between inequality and growth is far from resolved, and further careful reassessment of the sign, direction, and strength of the linkages between these two variables is necessary.

5.2 Theories

The traditional political economy approach assumes that credit markets work perfectly and the distribution of incomes and the participation of agents in the political process are exogenous. One can try to relax the strong assumption that the society has a "pure" or "perfect" democracy as a particular political regime in which the distribution of the political power is equal. Extending to a framework where the capital markets are imperfect, one can try to relax assumptions by endogenizing the distribution of income and the participation in the process of political decision-making in relation to the process of growth.

Another drawback of those simple political models with closed-form solutions is that they are not capable of making tight quantitative predictions about issues such as the sources of inequality and how it persists over time. The credit constraint model

makes up for that with theoretical implications on the phenomenon of persistent income inequality. Some economists argue that this is due to structural features of the economy. If this is the case, then different economies will converge to a single regime once these structural features are controlled for. Other economists claim that this phenomenon is due to initial conditions of the economy. If so, then different economies will converge to multiple regimes even if these structural features are held constant. If the world is characterized by a single regime, then economic policies need to be directed toward structural features (technologies, saving rates, population growth rates, etc.). If the world is characterized by multiple regimes, then economic policies need to be directed toward initial conditions (initial stock of human capital, initial distribution of income, etc.).

The model developed by Galor and Zeira (1993) contributes to this single- vs. multiple-regime debate by demonstrating that a particular initial condition (the initial distribution of income), determines whether an economy will converge to a low- or high-income regime. The empirical testing is in favor of the multiple-regime models. Hence, initial conditions matter in the growth process. The policy implication is that there is a need to alter the level of these initial conditions in order for countries to converge to high-income groups. In the Galor-Zeira model, the initial condition is essentially the initial distribution of income. If the initial income distribution is relatively equal, then a particular economy will converge to a high-income equilibrium. If we take these models seriously, then an appropriate course of action to be taken is to provide easier access to education for the poor people so that they are able to escape from the poverty trap.

There is also some quantitative work based on stochastic general equilibrium models, which gives us insights into the key determinants of inequality and its intertemporal transmission. Aiyagari (1994), Huggett (1995), Krusell and Smith (1995) and others developed theories that simultaneously accounts for the joint distribution of income and wealth and for the intertemporal mobility of households. In each of these

models, the economy is populated with heterogeneous infinitely lived agents subject to uninsurable idiosyncratic income risks. Possible long sequences of adverse income shocks naturally lead to borrowing constraints on individuals, and consequently fluctuations in consumption can be mitigated only by precautionary individual savings. Since agents' histories of income shocks are different, the model generates equilibrium joint distributions of wealth, savings and consumptions, which reflect the fact that borrowing constraints are tighter for poor agents. These joint distributions are compared to and/or calibrated to fit their empirical counterparts in the data, and their responses to various policy changes can be analyzed. Unfortunately the uninsured idiosyncratic uncertainty by itself is not rich enough to account for the observed concentration of wealth.

The Aiyagari (1994) and Huggett (1995) models can be developed further to corporate endogenous voting and human capital investment mechanism. Specially, households are required to make voting decisions and human capital investment decisions in addition to the consumptions and savings decisions under incomplete markets. The modified model is capable of analyzing the joint dynamics among inequality, democratization and economic development in an economy where education is both the engine of growth and the determinants of political participation. More dynamics and inequality can be generated from the modified model. In addition, there is a role for the government. Optimal and time-consistent policies can be derived and experimented under different initial conditions. One can also test for the single- vs. multiple-regime convergence hypothesis.

The skill-biased technological progress models rely on three underlying ideas. First, long run growth relies on innovations. These can be process innovations to increase the productivity of factors such as labor and capital or product innovations or organizational innovations that make the combination of production factors more efficient. Second, innovations result from investments in research and development, firm′s investment in skills, search for new markets that are motivated by the prospect

of monopoly rents for successful innovators. Third, creative destruction, namely, new innovations tend to make old innovations become obsolete. Hence, growth involves a conflict between the old and new: the innovators of yesterday resist new innovations that render their activities obsolete. This also explains why innovation-led growth in OECD countries is associated with a higher rate of firm and labor turnover. This third idea opens up the interesting field of political economy of growth: in particular, how one should design constitutions so as to strike the right balance between preserving innovation rents and at the same time not deterring future entry and innovation. For example, new patent length laws (like the Bayh-Dole Act in the US), trade liberalization, macroeconomic policy (which affects interest rates and firms access to credit), education policy (which affects the cost of research and development and training). All these policies have a potential effect on innovation incentives and therefore also affect income distribution and long-run growth. Further research along this line to address some policy issues is desirable.

6 Conclusions

The political economy, imperfect-capital-market, and skill-biased technological progress models are now well understood and have reached the quantitative stage. Existing theories provide valuable insights but few robust results about the effects of income inequality on economic growth. Further research on multiple equilibria and off-equilibrium performance would be interesting. In addition, further developments, perhaps in relation to population structure, globalization, and sector level decomposition of inequality, will surely be valuable. Another potential area for future research is to deal with the insurance concerns raised by the increased variability of lifetime individual incomes resulting from skill-biased technological change.

The gap between the findings of the theoretical literature and direct empirical evidence gives further empirical study a high priority. Signs of the adverse effects of redistribution distortions on growth remain elusive, and inferences about the role of

credit market constraints are indirect. With more time-series dimension observations of panel data and modern econometric techniques, further empirical study on the relationships between income inequality and growth is very promising.

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