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Wealth Distribution and Economic Growth

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WEALTH DISTRIBUTION AND ECONOMIC GROWTH

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Abstract

The role of wealth distribution has been subject to intense scrutiny in the theory of economic growth. This essay examines the interdependence between wealth distribution and economic growth prospects. The impact of wealth distribution on growth is being examined in the contexts of neoclassical growth, human capital and political economy. In addition, implications of wealth condensation in simulated economies are considered briefly. The study reveals that there is a wide, though not unanimous, consensus on income equality having a positive effect on economic growth. Moreover, securing investments in human capital and alleviating market imperfections could be instrumental in achieving higher levels of growth and a more equal distribution of wealth. There are, however, some forces that might deter growth. First, some simulations indicate that wealth condensates to the few in the long run in despite redistributive policies. Second, strong interest groups can use their political clout to alter wealth redistribution and subsequently hamper growth.

Keywords: Economic growth, wealth distribution, human capital accumulation, economic policy.

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1. Introduction

How to share the fruits of labor has been a thought-provoking subject among philosophers and scientists throughout the written history. Many morals and folklore give directions for the rightful division of the economic pie. While normative considerations have prevailed in public discourse, the emergence of economics and scientific methods has also brought positivist aspects to the discussion.

Long before the discipline of economics was born, Greek philosophers laid ground to political economy by pondering on the impacts of inequality on human society. Plato (427-347 B.C.), for example, considered that the most affluent segment of society should own no more than four times the wealth of the poorest segment. Greater inequality, he warned, would lead to social unrest that was harmful to society. Plutarch (46-127 A.D.) shared this view. He proclaimed that "An imbalance between rich and poor is the oldest and most fatal ailment of all republics." These ideas gained little ground during the following centuries. This was a consequence from sluggish economic progress. Welfare depended on agricultural productivity which remained low. For this reason practically every member of society (excluding the elite) was equally poor.

The age of industrialization started rapid economic growth in Western Europe and its offshoots. The consequences of the industrial revolution were both economical and political. Capitalists and labor overshadowed agriculture as the main source of wealth. While new wealth was created at an unprecedented speed, the income disparity between rural and urban populations began to increase (Rubinstein 2004, pp. 26-27). Consequently, political influence of the bourgeois middle-class and labor expanded at the expense of the nobility and clergy. Acemoglu and Robinson (2002) argue that the threat of revolution gave impetus to the political reforms that lead to wider redistribution of wealth.

In this setting, the founders of economic science showed a keen interest in ramifications of distribution of wealth. In the 18th century, a British political economist David Ricardo campaigned against the nobility whose feudal status had granted them the ownership of land during the preceding centuries. He considered the economic rents from the land detrimental to economic development. Since capitalists and labor created wealth, but landowners did not invest their rents as productively as the capitalists did, they were useless in production, he argued. Not everyone viewed the capitalists as favorably. Perhaps the most influential proponent of an equal distribution of wealth was a 19th century German philosopher Karl Marx. His concept of the accumulation of capital to the hands of the few spawned various forms of socialism. Indeed, an Italian economist Vilfred Pareto's empirical research suggested that the distribution of wealth was highly uneven in Western Europe. From this Pareto derived his famous "80-20"-rule which predicts that roughly 20 per cent of the population owns 80 per cent of wealth.

In this paper, I examine how a distribution of wealth affects economic growth. There will be references made to income distribution, though my main concern is wealth distribution. While these are not precisely the same thing, they are intertwined. Some justification for the choice is given by Aghion (et al. 1999). They argue that if one intends to examine how a distribution affects growth, the wealth distribution should be used. More justification is given in Rodríguez (et al. 2002). First, they note that wealth is the most unevenly distributed variable from the distributions of wealth, income and earnings in the United States. Second, accumulated wealth can also affect an individual's income because it diminishes incentives to seek labor income. It is therefore possible that income inequality diminishes while wealth inequality increases. Moreover, their findings include that the income-poor and the earnings-poor are "surprisingly wealthy" and the wealth-poor are relatively well-off in terms of income and earnings. While the American context places some reservations on the universal applicability of this finding, I use the wealth distribution as the general measure of inequality. Since the literature on wealth distributions and economic growth is numerous, it is not possible to give a thorough cross-section of the entire topic. As a consequence, many relevant topics, such as the impact of population growth or market-openness, will be omitted from the discussion. Instead, this paper attempts to introduce basic models and policy implications in an easily accessible form. It must be stressed, however, that some basic knowledge of economics, growth theory and mathematics is needed to understand certain models presented in this paper.

The paper is organized as follows. First, there is a brief look at the origins of the topic. Next I examine the basic neoclassical model of income distribution with representative agents. Then I explore the models that introduce intergenerational accumulation of human capital and an impact of imperfect markets to wealth distribution using representative agent methodology. After this, I consider briefly more exotic models of wealth distribution that attempt to explain wealth condensation in an entire economy. Before conclusion, I discuss implications from the models of political economy.

2. Historical Overview

Contemporary circumstances in economic history have played a major role in the emergence of the interest in the distribution of wealth in society. The modern debate began in the late 19th century. Free trade and the integration of global markets characterized the few decades before the World War I. Economics as a discipline was dominated by classical liberalism. The liberal view on distributional debate is that voluntary exchanges in free markets yield socially optimal outcomes and any attempts to regulate these only decrease social welfare.

A challenge to this view came along the Great Depression and World War II. Mass unemployment and large-scale government intervention in economic affairs reshaped societies as well as economic theories. It is hardly surprising that the theories of John Maynard Keynes on smoothing the business cycles influenced policy makers in modern economies for the next fifty years. In essence, this meant that the government attempts to keep demand constant by distributing wealth more equally over time and across the population. The economic tools for this are taxes, public spending and inflation. While many consumer goods and services were still exchanged in free markets, their role was greatly reduced by welfare programs, public sector services and the government intervention. Several first and third world countries followed a more extreme route by switching to socialism. These political regimes aimed at removing the inequality in society by transferring economic decision-making from the markets to a central authority. The results, however, were far from flattering. Many developing countries witnessed slower or even negative growth rates from 1950s to mid-1990s than in the early 20th century (See Barro & Sala-i-Martin 2004, p. 512-514, 564-565). Their choice over a policy regime alone cannot explain the dismal growth record of the most developing countries, but institutional factors cannot be ignored nevertheless.

The emergence of growth theories in the 20th century provided new theoretical grounds to examine how economic growth and wealth distributions are intertwined. Although there were attempts to crank out a growth theory out of the Keynesian mold, the neo-classical analysis is widely used today. This means that we assume constant returns to scale, diminishing returns from inputs and some elasticity of substitution between the inputs in production. Moreover, representative agents are assumed to optimize their consumption over time and have constant savings rates. Competitive factor markets are included for the sake of technical simplicity, but various more complex models with imperfect markets have also been introduced. The earlier growth models treated technological progress as an exogenous variable. This means that growth in the long-run depends on the exogenous technological development, whereas growth in the short-run is determined by the diminishing returns to capital. As a result, the economies in which a capital to labor ratio is low tend to grow faster than the economies where the ratio is high. In theory, then, the *per capita* incomes in capital-poor and capital-rich economies should converge because the former grow faster than the latter. After Romer (1986), the emphasis has been on growth models that endogenize growth and the technological progress.[1]

The interest in factors that contribute to growth and divergent growth rates between countries has spawned theories that elevate the importance of human capital in economic growth. In other words, the narrow concept of capital being only physical machines and other productive facilities became wider with the inclusion of human capital. This is being seen as the key component in the increase of productivity that is essential for economic growth in the modern growth theory. The economies where a capital to human capital ratio is low are essentially similar to those described in the neoclassical exogenous growth models. In addition, the economies with abundant resources of human capital usually invest more in physical capital, which is relatively scarce. Anecdotal evidence from this are "the economic miracles" of post-war Japan and Germany, whose physical capital was devastated to a greater degree than their human capital in the World War II. Yet they could return to a steady growth path soon after the war and surpass their pre-war incomes and levels of industrialization. Interestingly, the countries that are abundant in natural resources have had difficulties in translating their wealth into economic growth (For discussion, see Sachs & Warner (1997) and Stijns (2005)).[2]

Initial distributions of wealth and issues of political economy are a permanent point of interest in explaining economic growth. A classic treatment that combines economic growth and wealth distribution was presented is Kuznets (1955). Owing much to the neo-classical theory of capital accumulation, he explained how economic growth shapes an income distribution. He proposed that at the early stages of economic development the income distribution becomes more unequal, but later the inequality diminishes forming an inverted U-curve. Soon after its inception, the Kuznets's theory caught widespread support among academics. Although the Kuznets's curve was later contested on various grounds, such as data and methodology, the basic idea of the model remains relevant today (see Moran (2005)).

[1]For more about the growth models, see Barro & Sala-i-Martin (2004).
[2] Barro (1992, pp. 203-205), Rubinstein (2004, pp. 26-27).

The logic behind the Kuznets's inverse U-curve is intuitively simple yet powerful. At the early stages of economic development, an economy is based on agriculture. Due to low productivity the population stays poor and a distribution of wealth is equal. Income inequality begins to rise with industrialization. Workers in the urban industrial sector are paid according to their productivity, which is higher than in the rural sector. As a result, the income inequality between the sectors increases. As the higher productivity raises wages and creates more wealth, the industrial sector expands and attracts more rural workers. Learning by doing, promotions and the rise of a professional services sector (often labeled as a post-industrial sector) ensures that the wages in the industrial sector increase and there is intra-sector mobility that makes room for new entry-level workers from the rural sector to join the urban workforce. In the rural sector, however, migration will eventually make the workforce scarce, which increases the rural wages. As a consequence, the economy-wide income inequality diminishes gradually. Empirical findings indicate that the inverse U-curve seems to show up regularly in various economies (for example, see Barro 2000). It is also noteworthy to bear in mind that this concept is applicable to impacts of industrial change in modern economies.

While Kuznets explained how growth affects the distribution of income, the reverse relationship remained obscure. One of the great mysteries in economics of development has been a divergence in growth rates between countries that appear to be similar. An often cited example is South Korea and Philippines in the early 1960s. These countries were roughly the same in terms of the gross domestic product (GDP) *per capita*, population, political climate, land area and natural resources. Given the similarity of their "initial" conditions, the difference in their economic growth rates became a mystery. During the next four decades, the annual growth rate of the South Korean GDP averaged at six per cent, while Philippines managed to grow meager two per cent. Development economists have found two explanatory factors for the mystery. First, the distribution of income was more equal in South Korea than in Philippines. Second, land-ownership was more equal in South Korea, where agriculture was characterized by small farms, whereas large plantations dominated in Philippines. Indeed, the initial distribution of land might prove to be important for growth prospects at early stages of economic development. Economic historians point out that early forms of democratic institutions, diversification of production away from agriculture and an increase in wealth seem to have developed in ancient Greece and Rome, when their economies were dominated by small farms. In time, the land-ownership concentrated to the few, which lead to a fall of the democratic institutions, increasing tax burdens and eventually to the failed states. More suggestive evidence can be found in the countries like India, Indonesia and South Korea which are characterized by low income inequality with the Gini coefficients around 30[3]. At the same time, their respective coefficients for the distribution of land are 63, 55 and 35, which correspond well to the differences in their current levels of income.[4]

3. Distributions of Wealth in Neo-Classical Economy

Modern economics approaches macroeconomic phenomena from a microeconomic perspective. The approach to wealth distributions is no exception. A general way to model an economy is to use the neo-classical microeconomic theories of consumers and production as an analytical tool. This means also that one has to make several simplifications and assumptions to keep the model analytical.

There are several key simplifications that can be generally found in micro-based macroeconomic models. As an example of such a model, let us consider Bertola (et al. 2006). First, it is assumed that a representative consumer or a household exists. Since our interest lies in macroeconomics, we will treat the representative agent as a household. This can be thought of as if all economic agents in an economy share identical preferences towards savings. Another way to look at the representative household is to consider it as the mean (or the median) from a distribution of households. Second, there are two factors of production: labor (l) and capital (k). Labor is a *non-accumulated* factor. It is endogenously determined by some exogenous factors such as labor market conditions. In contrast, capital is an *accumulated* factor. Individual savings decisions translate into investments on capital, which means that households own the means of production (the firms) by holding their assets. Here we have to make an important distinction between physical and human capital. While it is easy to grasp the physical capital as a reserve of machinery used in production, the human capital is a more abstract concept of accumulated skills and knowledge. As a result, it is considered as an investment that enhances labor productivity, but it is only at use if the representative household supplies labor.

Let us make an assumption that capital and labor markets are perfectly competitive and hence, the factors of production are compensated according to their marginal productivity. As a consequence,

[3] The Gini coefficient is a measure of inequality that is derived from the Lorenz curve. The Lorenz curve represents percentage of income and population in the familiar xy-coordinates. Perfect income equality is thus in an economy where the Lorenz curve is a line that has a 45 degree slope. The Gini coefficient measures the area that is left between the 45-degree-line and another Lorenz curve. The Gini coefficient takes values between zero (perfect equality) and one (perfect inequality).

[4] Bénabou (1998, pp. 11-12), Rubinstein (2004, pp. 57-66), Deiniger & Squire (1997, p. 39).

the representative household receives an amount of income equal to y at any instant of time as a combination of labor and capital income

$$y = wl + rk, \quad (1)$$

in which w is a wage rate and r is an interest rate that are assumed to remain constant[5].

The dynamic properties of capital accumulation are expressed by subtracting the household's consumption, c, from its income. To keep the analysis simple, assume that the economy consumes and produces single good, and it is possible to switch between investment and consumption freely. Using continuous time accounting as an example, we see that the dynamics of capital accumulation follow from a savings equation of the representative household

$$\dot{k} = y - c = wl + rk - c. \quad (2)$$

Here $\dot{k} = dk(t)/dt$ is a time derivative of k that depicts a rate of change in the amount of capital at each instant of time. In a steady state, the rate of change equals zero and consumption and income cancel each other out. A positive derivative indicates that the household accumulates savings, whereas a negative derivative implies that it has to borrow to sustain the level of consumption.

At the aggregate level, we can describe the accumulated wealth of households as a wealth distribution. Let *f(i)* denote a density for a distribution of households over the domain *[0,1]* that integrates into unity: $\int_0^1 f(i)di = 1$. Let N denote a set of households in the economy. Using a Stjelties integral to assign weights into each subset yields $\int_N dF(i) = 1$. The aggregate measures for income (Y), labor (L) and capital (K) are now easily derived from

$$Y = \int_N y(i)dF(i)$$
$$L = \int_N l(i)dF(i) \quad (3)$$

[5] One can use either continuous time *Y(t)* or discrete time Y_t accounting. Additional realism could be attained by having w and r depend on time.

$$K = \int_N k(i)dF(i).$$

Production in the economy is done by neoclassical firms that are owned by the households. They use capital and labor in their output which is described by a production function *f(k,l).* Then firms solve

$$\max_{k,l}\{f(k,l) - rk - wl\}\ . \qquad (4)$$

As the markets are assumed to be competitive, differentiation yields the individual compensations for the factors of production that are equal to their marginal products. Since competitive markets require that these are equal across the economy, we can denote the individual compensations with the aggregate measures *R* and *W* for capital and labor incomes respectively, and *L* for labor as every household supplies an equal amount of labor.

The wealth distribution in a competitive economy results from heterogeneity in households' wealth levels. To see why, assume that consumption from income is linear. Let *s* denote the household's subsistence consumption and *a* and *b* respective shares of consumption from labor and capital incomes. In this case,

$$c = s + ay + bk\ . \qquad (5)$$

Substituting this into equation (2) and rearranging, we get a dynamic equation for capital accumulation

$$\dot{k} = (1-a)(Rk + WL) - s - bk\ . \qquad (6)$$

If a household does not own any assets initially (*k=0*), we can see that wealth accumulates only if the savings from labor income exceed subsistence consumption

$$(1-a)WL > s\ . \qquad (7)$$

Consequently, the growth rate for capital accumulation is

$$\frac{\dot{k}}{k} = (1-a)R - b + \frac{(1-a)WL - s}{k}. \qquad (8)$$

This indicates that the higher wealth levels (k) have a slower growth rate when equation (7) holds. A competitive economy thus displays a tendency towards equality (with the given assumptions). The opposite takes place, if subsistence consumption is large enough to violate the inequality in (7).

In his insightful work, Stiglitz (1969) identified two general growth paths for a wealth distribution in the neoclassical growth model. The growth path associated with a sufficiently high capital-labor ratio is stable and yields an egalitarian distribution of wealth in the long run. In contrast, the growth path associated with a low capital-labor ratio is unstable. The consequences are two-fold. An increase in the capital-labor ratio eventually yields a stable growth path with an egalitarian equilibrium distribution. On the other hand, a decrease pushes the economy into a downward spiral towards a poverty trap, in which the capital-labor ratio decreases forever. Moreover, an equilibrium, where the rich become increasingly wealthy and the poor become increasingly impoverished, could result from an unstable path, if the capital-labor ratio remains constant over time.

Critique to Stiglitz (1969) pointed out that these results rely on the assumption that the savings function is linear (or concave)[6]. Should the marginal propensity to save increase along wealth and thus the individual savings function be convex, the results would change altogether. Taking this approach, Schlicht (1975) finds that unequal distributions – a distribution consisting of "capitalists" and "labor" in this context – have a higher capital-labor ratio than an egalitarian distribution. Bourguignon (1981) further develops this view. He shows that unequal wealth distributions are Pareto superior to egalitarian distributions. This result is contingent on representative agents having positive wealth, which is a condition fulfilled in developed countries but to a lesser extent in developing countries.

Since accumulation of wealth depends on savings, it is possible that the impact of equality on growth depends on the stage of economic development. According to Aghion (et al. 1999), the hypothesis that inequality enhances growth is based on three assumptions. First, the rich save more than the poor, which results in a higher rate of capital accumulation. Second, investment projects

[6] The same critique applies to the version presented in Bertola (et. al 2006).

involve large sunk costs, which could be overcome by wealth condensation if capital markets are inefficient. Third, redistribution of wealth diminishes incentives to accumulate capital because taxes levied on capital depress its rate of return. These conditions could be at place in developing and developed countries alike. While there is no conclusive proof to support the first assumption, the second could be in effect in the developing countries, whereas the third could be more dominant in the developed countries. Todaro (1997) maintains that the savings of the rich in the developing countries are not invested in *productive* capital. Instead, they are spent on luxury goods or invested abroad, so there is no accumulation of productive capital that would drive economic growth. The poor, in contrast, use their incomes in local production. As a consequence, a more equitable distribution of wealth could spur growth in the forms of improved education, health and production incentives. Meanwhile, Partridge (1997) argues that as economies become increasingly complex and skill-intensive due to the economic progress, the negative influence of inequality on growth diminishes or turns positive.

4. Overlapping Generations with Accumulation of Human Capital

While the neo-classical analysis focuses on behavior of single household, many modern macroeconomic models concentrate on dynasties of households. In this context, the overlapping generations models describe how intergenerational wealth condensates.

The households live in a one-good economy that was described in greater detail in the previous section. A household consists of parents and children. A usual restriction is that there are only one parent and child in a household which guarantees that the population in the economy remains constant. To keep the models mathematically simple, one generation lives for two periods. As usual utility is derived from consumption, but an important inclusion is the utility from altruism, which a parent receives from giving a bequest to an offspring (Becker & Barro 1986, p. 69). As a result, the bequest forms the offspring's initial wealth, which she or he can use to acquire human capital. The impact of the parent's wealth on the intergenerational prosperity was first examined in Loury (1981) but somewhat simplified versions from models by Chiu (1998) and Galor and Zeira (1993) provide sufficient insight on the outcomes.

Let us consider first a model by Chiu (1998) as an illustrative example. The economy consists of households that live for two periods. Each generation consists of a parent and an offspring. Capital markets are efficient, so there are no restrictions on receiving credit. Individuals derive utility from consumption such that $u(C_1)$ denotes the utility from consumption C_1 in the first period of an individual's life and $u(C_2, x)$ denotes the utility from consumption C_2 and a bequest x in the second period. With an income m in the second period, the optimal amounts of bequest and consumption are simply $x^*=am$ and $C_2^*=(1-a)m$. As a result, the offspring has initial wealth equal to the amount of bequest at the first period of his/her life.

An investment in human capital takes a form of college education, which in turn determines individual productivity. Only human capital is being used at production of the good. The individuals that are born at the period t have productivity equal to y_{t+1}, if they do not attend to higher education. The individuals who go to college receive human capital equal to $h(i)$ with $h(0)=1$ and $h'(i)>0$, where i indicates the amount of talent an individual possesses. Therefore, their productivity in the second period is $h(i)y_{t+1}$. Given that the markets are competitive, the incomes are equal to their individual productivities. As a result, the offspring chooses to improve his/her productivity by attending to college if

$$v[h(i)y_{t+1}] - v(y_{t+1}) \geq u[x(i)] - u[x(i) - c_t], \tag{9}$$

where $v(\bullet)$ is the utility from the second period income and c_t is the cost of college education. This condition states simply that the investment in human capital is worthwhile, if the expected utility from college education exceeds the utility from being unskilled. Equating the both sides with some threshold level $X(i)$ implies that the individuals with the initial wealth $x \geq X(i)$ acquire human capital. Moreover, if we assume that $X'(i)<0$, the more talent an individual has, the lower initial wealth she or he requires to benefit from college education.

Let F_t represent a distribution of initial wealth at time t for the children of the previous generation. The output that the children with talent i produce is then dependent on their bequest and the level of talent

$$h(i)y_{t+1}\{1 - F_t[X_t(i)]\} + y_{t+1}F_t[X_t(i)]. \tag{10}$$

Aggregate output of the entire generation is by suitable integration

$$y_{t+1}\int_0^1 (h(i)\{1 - F_t[X_t(i)]\} + F_t[X_t(i)])di. \tag{11}$$

Assuming that productivity growth results only from increasing investments in human capital, we can derive a major policy implications concerning income distributions and affecting growth. It is obvious that the level of initial wealth matters. An equal distribution of initial wealth lowers the financial barrier for higher education. Moreover, it also improves probability that the children with high level of talent receive higher education and work skilled with high wages as an alternative to working unskilled with low wages. This is due to the efficient capital markets that enable the talented children to finance their education, though their bequests do not cover the cost of college education. As a consequence, the high wages they earn lead to larger bequests for their children. This, in turn, further improves productivity and the quality of the workforce leading to a higher rate of growth. The policy implications thus include redistribution that is implemented on the initial wealth distribution, and nurturing the level of talent of the children. The policies aimed at meeting these goals could include taxes and universal elementary education.

More complex models take into account market imperfections that are absent in the neo-classical world. One such model is presented in Galor & Zeira (1993) where credit markets are imperfect although capital markets are otherwise efficient, and investments in human capital are indivisible[7]. In addition, physical capital is being used in production and firms can borrow money to investments in physical capital. Individuals in the economy are identical in all other respects except for the amount of their inheritances. Parents are (again) altruistic toward their children.

The children in a generation face two options when they are young. Either they work in both periods of their lives as unskilled workers L^U, or they get education (an investment in human capital h) in the first period and work as skilled workers L^S in the second period. Education is costly and it can be financed by a sufficiently large inheritance or borrowing the money. Since borrowers are suspect to leave their debts unpaid, a monitoring cost $z>0$ is levied on a market interest rate r yielding a lending rate $i=r+z$ to individuals. Firms, however, cannot evade their debts as easily and hence their borrowing costs are equal to r.

Firms produce using skilled labor and capital. Since they know the number of skilled workers in advance, the marginal product of capital is equated with the interest rate $F_K(K, L^S) = r$. In consequence, a constant capital-labor ratio and the interest rate determine the wage w^S paid to

[7] We examine a somewhat simplified version of the model here.

skilled workers. Unskilled workers, on the other hand, are assumed to be working on land *N*. Since the supply of land overall is fixed, and productivity of additional land and an extra worker is diminishing, $(G_N, G_L < 0)$, the wage w^U of the unskilled is a function of their productivity $P(L^U) = w^U = G_L(L^U, N)$. This implies the law of supply and demand: an increase in the supply of unskilled workers lowers their wages, while a decrease has an opposite effect.

Unskilled and skilled workers have to choose whether to invest in human capital or not. An individual who does not invest in human capital can expect a lifetime utility of

$$u[(1+r)(x+w^U)+w^U-c]. \qquad (12)$$

Therefore a bequest $b(x)\geq 0$ a parent leaves to an offspring is

$$b_U(x)=(1+r)(x+w^U)+w^U-c. \qquad (13)$$

The individuals who invest in human capital *h* derive a lifetime utility

$$u[(1+r)(x-h)+w^S-c], \qquad (14)$$

and they leave a respective inheritance of

$$b_S(x)=(1+r)(x-h)+w^S-c. \qquad (15)$$

As a result, an individual who receives a bequest $x\geq h$ find it worthwhile to invest in human capital if

$$w^S-(1+r)h \geq (2+r)w^U. \qquad (16)$$

An individual, whose inheritance is $x<h$, has to borrow for the investment in human capital. Consequently, he or she leaves an inheritance of

$$b_S(x)=(1+i)(x-h)+w^S-c, \qquad (17)$$

which is strictly less than the bequest left by the individuals who receive $x \geq h$ because $i > r$. Hence the wage should be

$$w^S - (1+i)h \geq (r-i)x + (2+r)w^U . \tag{18}$$

It is obvious that no individual invests in human capital if

$$w^S - (1+r)h < w^U (2+r), \tag{19}$$

and there are only unskilled workers in the economy. Using X as a threshold level of bequest in (18) we find that all individuals with inheritances equal or above X invest in human capital and the individuals below X work as unskilled

$$X = \frac{1}{i-r}\left[(2+r)w^U + (1+i)h - w^S\right]. \tag{20}$$

A direct consequence from this is that education and skilled jobs are limited to the individuals who inherit enough wealth to pay for their training. The distributions of unskilled and skilled workers at time t can be derived by integrating over a distribution of inheritances $D(x)$ with the domain $[0,X]$ for the unskilled and $[X,\infty]$ for the skilled.

In the long run, the economy converges into a distribution where there are poor and rich families. Poor dynasties inherit little initial wealth and therefore do not invest in human capital. This leads to working unskilled with low wages and low levels of bequest. Hence the poor remain poor. Meanwhile, rich dynasties inherit enough wealth to pay for education. This opens up doors to the jobs with high wages and leads to high levels of bequest for future generations. As a consequence, the rich stay rich. There is, however, some interchange between the groups at the boundary. Some rich families will fall into poverty, while some poor families will climb up the social ladder. The overall result is nevertheless such that the relative distribution of wealth in the long run depends on the distribution of initial wealth.

Prospects for growth in the long run also depend on the distribution of initial wealth. If the relative size of the poor is initially large (that is the number of individuals with inheritances less than X is large), the economy will remain poor. A high number of relatively rich individuals will have the opposite effect. This implies that inequality is highly detrimental to growth. Wealth concentration to the few leads to a poor economy in the long run, whereas more equally shared wealth, which could be described as "a large middle-class", enhances the economy's growth prospects. A policy implication that improves growth prospects is obviously some kind of redistribution of initial wealth. This could be done by providing a subsidy for the investment in human capital. An example of this could be providing publicly financed education in the first period of life and taxing the skilled workers with higher incomes in the second period. This policy could even be a Pareto-improvement, if monitoring borrowers is more costly than collecting taxes.

Empirical research agrees with most results in the discussed models. According to Bénabou (1998), high enrollment in secondary education reduces income inequality substantially. Moreover, a cross-section of 23 studies almost unanimously agrees on a statistically significant positive correlation between human capital and economic growth (see Bénabou (1998) for details). Barro (2000) finds a negative correlation between primary and secondary education and income inequality, but higher education turns the correlation positive. Interestingly, he discovers a threshold level of the GDP that determines the impact of inequality on growth. If a country's GDP *per capita* is less than $1473, inequality has an adverse effect on growth. The effect is opposite in the countries where *per capita* incomes exceed this value. This implies that if individual savings rates increase with income then rising inequality could actually increase capital accumulation because redistribution would depress the savings rates. Deiniger and Squire (1997) discover a stronger negative correlation between growth and inequality in the ownership of assets than between growth and income inequality. For instance, land has productive value and it can serve as collateral in financial markets. Therefore, amending credit market imperfections could significantly improve growth prospects by removing financial barriers from human capital investment especially in developing countries. While Barro (2000) agrees with this result, he proposes that in the developed countries, where credit market imperfections do not play a significant role, inequality might actually promote growth.

5. Wealth Condensation in Simulated Economies

Pareto's findings on distribution of wealth have inspired some researchers to apply more unorthodox methods to study the dynamics of a wealth distribution in an economy. Instead of the micro-based approach, an economy is modeled as a complex system that is not too different from natural phenomena. How the economy behaves can then be explored with computed simulations. Moreover, statistical and mathematical methods, which are common in science, can be applied to this economic framework.[8]

There are pros and cons in this approach. A negative aspect is that it is not possible to know exactly how single agent behaves. Moreover, there is no economic growth *per* se in the model. The wealth of agents increases either out of luck or successful trading. The exchange of goods is therefore a zero-sum game, in which there are winners and losers but no mutual gain. On the positive side, behavior of a mass of agents becomes predictable as the entire economy is a closed system. This approach also takes into account network effects that play a great role in systems where agents interact and base their actions on expectations on the size of the network. It diminishes the role of single decision-maker and emphasizes the role of interaction between many decision-makers.[9]

A model developed by Bouchaud & Mézard (2000) gives an illustrative example of this approach. The economy is a pure exchange economy in Walrasian tradition. It is populated by agents that trade their endowed goods with other agents. Random events, such as changes in the values of stock market investments or other property, and exchanging goods with other agents cause that the wealth W_i of agent i varies over time. This can be described by a stochastic dynamical equation

$$\frac{dW_i}{dt} = \eta_i(t)W_i + \sum_{j \neq i} J_{ij} W_j - \sum_{j \neq i} J_{ij} W_i, \tag{21}$$

where $\eta_i(t) \sim (m, 2\sigma^2)$ is a Gaussian random variable describing a random change in agent i's wealth, and a matrix J_{ij} is the amount of wealth that agent j spends on agent i's production (the same applies in reverse to agent i).

In a simple version of this model, every agent trades with all other agents at the same rate. Letting N denote the total number of agents in the economy, we get that $J_{ij}=J/N$, and the equation becomes

$$\frac{dW_i}{dt} = \eta_i(t)W_i + J(\overline{W} - W_i), \tag{22}$$

[8] Hayes (2002, p. 400).
[9] Buchanan (2002, 51-52), Hayes (2002, pp. 401-404).

where $\overline{W}$ denotes the average overall wealth. After normalizing individual wealth levels with $w_i = W_i / \overline{W}$ and solving the equations, the result is a distribution of wealth with a Pareto power law tail for large values of w

$$P(w) = Z \frac{\exp - \frac{\mu - 1}{w}}{w^{1+\mu}}, \tag{23}$$

where the exponent $\mu = 1 + J / \sigma^2$ and the normalizing factor is $Z = (\mu - 1)^{\mu} / \Gamma(\mu)$.

An interesting notion in this is that increased trading with other agents (J increases) or less variability in the windfall profits from random chances (σ^2 decreases) leads to a narrower distribution (μ increases). In other words, the distribution of wealth in the economy becomes more equal. Introducing an income and capital tax into the model provides mixed results. The income tax reduces inequality in wealth. In contrast, the capital tax used simultaneously with the income tax tends to *increase* inequality. Partial redistribution of the capital tax, however, decreases inequality.

A more realistic version of the model introduces network effects. Trading, and therefore wealth, depends on how many connections the agents are able to make between each other. Connectivity c describes a number of potential trading partners an agent can have. As this can be random, a probability c/N can be associated to the connectivity, which remains constant. At each time interval τ, the agent chooses a new number c of exchange partners $k(i,t)$ randomly. The wealth equation takes the form

$$W_i(t+\tau) = \left[\frac{J\tau}{c} \sum_{k=1}^{c} W_{k(i,t)} + (1 - J\tau) W_i(t) \right] e^{-V(i,t)}, \tag{24}$$

where $V \sim (0, 2\sigma^2\tau)$ is a Gaussian random variable. In this case, the Pareto power law tail becomes $\mu \cong \ln(\frac{c}{\sigma^2\tau}) / \ln(\frac{c}{J\tau})$.

The results are intuitive. Limiting connectivity ($c \to 0$) leads to less trading and wider inequality. An imbalance between J and σ^2, in which the latter is larger, increases inequality as well. This means that as $\mu < 1$, the few posses the wealth and as $\mu > 1$ the distribution is more equal. In contrast, allowing fast switching between the trading partners ($\tau \to 0$) reduces inequality. A more equal distribution of wealth could be attained by cultivating exchange between agents. This implies that (with the given assumptions) the policy option that equalizes wealth would seek to remove trading barriers either by enhancing competition and decreasing regulation.

The strength of this model is that it captures well the importance of network effects in economic interaction. The number of exchanges depends on an agent's connectivity and the speed she or he can make new connections. The flow of goods and services in the economy, which creates value, is essentially interchanging between nodes in a network. The greater the connectivity of the agent is, the more important node she or he is in the network, which gives rise to positive network effects (See, for example, Katz & Shapiro 1985.). Hence, the agent's wealth increases gradually as she or he makes new exchanges, but positive network effects could amass wealth to those individuals that have a great connectivity. This "the rich get richer" –phenomenon is further enhanced by random gains from investments. Since the relative wealth in absolute terms is far greater to a rich person than to a poor person, the rich are able to invest more and reap bigger gains from the investments. Hence, the wealth condensates to the few as described by the Pareto distribution.[10]

A Paretian macroeconomy has also been a subject to a study in Burda (et al. 2002). A distinctive character of this economy is that a distribution of wealth follows the Pareto distribution. The power law $P(w) \sim w^{-1-\alpha}$ for the amounts of wealth $w \geq w_0$ dictates the distribution of wealth. It stipulates a probability that an already rich agent will get richer. Moreover, the probability depends neither on the agent's current wealth nor the wealth of poorer agents. The index α governs an agent's wealth, because it can be used to distinguish between social preferences. $\alpha > 1$ indicates that society prefers wider redistribution of wealth, while $\alpha \leq 1$ characterizes an economy with liberal *laissez-faire* leanings. Key findings include that with given (fixed) total wealth and a controllable threshold for wealth in the social economy, all wealth above the threshold concentrates to single agent. This does not take place in the liberal economy, because there is no threshold for wealth. In addition, inhabitants of a uniformly poor economy stay poor regardless of the economy's social preferences. As a result, there are no easy policy suggestions that can be derived from the economic simulations,

[10] Buchanan (2002, pp. 51-52).

because wealth seems to condensate to the few even with redistributive policies at place. A redistribution of wealth in revolution or as insurance to secure the safety of the wealthy would most likely follow from this in the real world. One could, however, derive some justification for the views of classical liberals that a free-exchange economy yields socially optimal results, and the best redistributive policy is to amend market imperfections because this gives everyone the best chances to succeed in the pursuit of personal welfare.

6. Political Economy

It is almost impossible to separate distributions of wealth from political processes. Many prominent economists have been interested in political economy as we have already learned. On the one hand, political economy seeks answers which political processes create diverse distributions of income. On the other hand, this subgenre of economics gives policy implications and suggestions that are drawn from theoretical and empirical analysis. Political economy is often normative, and thus, one should approach its results with healthy criticism.

According to Verdier (1994), a basic model of political economy of growth should combine economic and political decision-making. The model should identify a conflict in society at the level of macroeconomy, which implies that agents are heterogeneous in the economy. As a consequence, there should also be political institutions that translate these conflicts into policies. At the microeconomic level, the agents make economic and political decisions by choosing the amount of consumption with given prices and by selecting a preferred policy option by voting. These all can be integrated into a dynamic growth model, where agents maximize inter-temporal utility with relevant constraints.

An aggregate choice over policy regimes is an integral part of political economy of income distributions. In the absence of voting, we are dealing with an autocratic regime, which can decide the distribution of income as it pleases. While social utility maximizing solutions might be available, empirical evidence from the economic history implies that the policy regimes based on a representative government and stable legal institutions yield better growth prospects. Representative governments act as an insurance against political instability and extend capital accumulation across the populace (Acemoglu & Robinson 2002, pp. 196-197). Thus, models in political economy often include some form of a representative government whose policy choices are subject to public voting. Many analyses rely on a game-theoretic concept of the median voter theorem. In our present context, a median voter is a voter whose wealth is at the 50th percentile of a income distribution. According to the theorem, political parties have to secure the support of the median voter, because the voters, whose preferences resemble more to a certain party's political stance, will vote for the party in any case. For this reason, the median voter's preferences over policy options become decisive.[11]

As an example of a political economy model that applies the median voter theorem, we take a look at Alesina and Rodrik (1994)[12]. The economy in the model shares properties of the neo-classical model that was discussed earlier. The economy's aggregate output is a slightly modified version from the standard Cobb-Douglas-production function

$$Y = AK^{\alpha} G^{1-\alpha} L^{1-\alpha} \quad \text{with } 0 < \alpha < 1, \tag{25}$$

and where A is a technological parameter and G is government spending on *productive* services[13]. The aggregate labor supply (L) is assumed to be unity. The government spending is financed by levying a tax on capital, $G = \tau K$, where $0 \leq \tau \leq 1$ is a linear tax rate on capital income. This is considered to be capital in a broad sense. It comprises returns from both physical and human capital and technology as well. As a result, government spending redistributes wealth from the individuals that are richly endowed with capital to those that are poorly endowed.

Assume then that the economy consists of individuals that differ only in their endowment of capital. Agent *i*'s share s^i of the total is then

$$s^i = \frac{l^i}{k^i / K}, \qquad s^i \in [0, \infty). \tag{26}$$

The total income of an agent consists of his/her labor income (l^i) and capital income from his share (k^i / K) of the total amount of capital. This ratio indicates that the lower (higher) the value of s, the richer (poorer) an agent is with capital. A pure capitalist has $s^i = 0$ because he or she has no labor

[11] Alesina & Rodrik (1994, p.469). See Rubinstein (2004) for discussion on the impact of legal institutions on economic progress.
[12] For related models, see Persson & Tabellini (1994) and Acemoglu & Robinsion (2002).
[13] To avoid the age-old debate whether all government spending is productive, assume that it is.

income ($l^i = 0$). Meanwhile, the capital-poor have k^i / K approaching zero, which increases the value of s^i.

Assuming a logarithmic utility function $u^i = \log c^i$, which is discounted over time with a discounting factor ρ, and given an equation of motion for an agent's capital

$$\dot{k}^i = w(\tau)k^i s^i + [r(\tau) - \tau]k^i - c^i, \tag{27}$$

where the labor income *w* and return *r* from capital assets depend on the tax rate (τ). Optimizing over time yields an optimal consumption path for each agent *i*

$$\frac{\dot{c}^i}{c^i} = [r(\tau) - \tau] - \rho. \tag{28}$$

If the tax remains constant over time, then all agents accumulate at the same rate, and the economy's growth rate $\gamma(\tau)$ will be

$$\gamma(\tau) \equiv \frac{\dot{c}^i}{c^i} = \frac{\dot{k}^i}{k^i} = \frac{\dot{K}}{K}. \tag{29}$$

This also implies that the distribution of wealth in the economy will remain unchanged over time.

Solving for the level of instantaneous consumption in (27) by using the result from (28) with equality to zero, we obtain $c^i = [w(\tau)s^i + \rho]k^i$. Using this result and (29) as constraints, the benevolent government can then maximize individual utility the tax rate as a control variable. The solution to this exercise is the preferred tax rate τ^i for agent i:

$$\rho(1-\alpha)\frac{w(\tau^i)s^i}{w(\tau^i)s^i + \rho}. \tag{30}$$

As complex as this equation seems, the implications are very simple. Implicit differentiation ($\frac{d\tau^i}{ds^i} > 0$) indicates that the preferred tax rate is increasing in *s*, so the individuals that are poor in capital prefer higher tax rates and vice versa. Since the government spending is productive, even the pure capitalists prefer a positive rate of taxation, $\tau^* = [(1-\alpha)\alpha A]^{-\alpha}$, that maximizes the economy's growth rate[14]. While the benefits from public consumption outweigh low tax rates and increase growth, high tax rates depress the after-tax return to capital and lead to a lower rates of accumulation and growth. The government, which reflects the preferences of its constituents, may opt for a tax rate that is higher than τ^*. Therefore, if the median voter's share of capital falls short from his or her labor income, which is usually the case, then she or he prefers a tax rate that hampers growth. Even if wealth was evenly distributed in the economy, which occurs when $s^i=1$, the representative agent would desire a tax rate that exceeds τ^*[15]. This result shows that distortionary taxes with an equal initial distribution of wealth do not necessarily give the best growth prospects that some models suggest. Another implication is, however, that the more equally capital is distributed in the economy, the less incentive there is to levy high taxes on capital. So, while the growth-maximizing rate cannot be attained, an equal distribution of wealth could yield better growth rates than persistent inequality.

The median voter's wealth can exert a great deal of influence on policy makers *regardless* of the policy regime. As a general rule, the more the median voter's income falls short from the average income, the more there are individuals that have an incentive to demand higher taxes on higher income levels (Bénabou 1998, p. 16). Consequently, the greater the difference, the more political power the poor have. The same applies at the other end of the spectrum: a subsidy on capital replaces the capital tax if the median voter is richer than the average (Persson & Tabellini 1994, p. 604). It is, therefore, evident that democracies and autocracies have to take into account the median voter's preferences. If they did not, democratic governments risk losing elections, while autocracies risk social unrest (Alesina & Rodrik 1994, p. 478). However, no clear evidence exists that would suggest that a democratic form of government is a better choice for economic growth (see Tavares & Wacziarg 2001). Accepting a postulate that the political power of individuals depends positively on their wealth implies that the citizens in democracies are wealthier than their counterparts in

[14] The optimal tax for economic growth, τ^*, can be derived from the aggregate production function by finding the optimal return to capital (assume also that the labor supply is inelastic and thus normalized to unity) and using this result in (29).

[15] This happens when the ratios of labor income to aggregate labor supply and capital income to aggregate capital are equal.

autocracies (Acemoglu & Robinson 2002, p. 199). This could lead to a higher level of capital accumulation on average. However, Tavares and Wacziarg (2001) find that democracy is good for human capital accumulation but less so for physical capital accumulation. This could affect negatively on growth. Barro and Sala-i-Martin (2004) suggest that democracy could be more productive, because it commits the government to honor property rights. Indeed, Deiniger & Squire (1997) warn that while redistribution could theoretically benefit the poor, the policy-makers should be cautious not to hamper investment with redistribution, because it could decrease incomes of the poor.

Although democracy gives equal political power for every citizen, lobbyists exert disproportionate influence on policy-makers, which makes the policy regime less democratic. Bénabou (1998) dubs the policy regimes "elitist", when the pivotal voter group possesses more wealth than the median voter, and "populist", when the group's wealth is below the median. This may create biased redistributive policies that favor some interest groups at the cost of others and alter the distribution of income. Such policies include restrictions on imports and competition, various subsidies, taxes and public spending. For example, import restrictions tend to favor the poor, because they shelter domestic production from international competition. On the other hand, agricultural subsidies, for instance, may boost incomes of the rural poor, but lower disposable incomes of the urban poor. One way to take a pro-wealth bias could be to reduce competition or give export subsidies, which traditionally shift wealth from the poor to the rich. According to Bénabou's model, the democratic regimes that have sufficiently low rates of inequality do not benefit from the pro-poor bias. The populist regimes, in contrast, reap economic benefits from redistribution, while the elitist regimes might gain from inequality. To obtain these results, however, they must fulfill certain assumptions, such as complete asset markets for the elitist regimes and incomplete asset markets for the populist regimes. For this reason, empirical evidence from real countries might give more reliable predictions about the interplay between these forces than theoretical musings.

The empirical evidence shows that the impact of different policy regimes on economic growth is not very clear. A cross-section of 23 empirical studies indicates that no clear link between democracy and economic growth exists (see Bénabou (1998) for details). However, there is an ample amount of evidence that the aim of redistributive policies should be at narrowing wealth inequality. It seems that redistribution is positively correlated with growth and (public) educational expenditure. This supports the views that providing publicly-funded universal education might be one of the most efficient growth-enhancing policies available. Furthermore, an indirect side-effect of inequality could prove harmful to growth unless redistribution takes place. Various studies in the sample find a significant positive link between inequality and socio-political instability. Coincidentally, instability has a strong negative influence on growth. It has to be pointed out here, nevertheless, that instability here can be caused by both socio-political unrest and threats to property rights and corrupt practices. Consequently, a forced equalization, such as nationalization, can be harmful to economic growth because it can cut off sources of investment and drive out the most productive capital, human and physical, out of the country. This was the route that many developing countries opted for in the post-colonial period, and could in part explain their low growth rates.[16]

7. Conclusion

The relationship between wealth distribution and economic growth is complex. The right way to distribute wealth has puzzled many prominent thinkers throughout the written history. Fairly recently, economic models and empirical research have started to give scientifically grounded answers to this puzzle though normative implications can still be found in the literature. There is, however, a relatively widespread agreement on that the level of initial inequality determines an economy's long-term growth in such a way that less inequality increases the economy's growth rate. It also indicates that the degree of inequality varies during the process of economic development naturally, unless redistributive policies are undertaken.

The process of wealth creation is essentially accumulated ownership of capital. Capital, both human and physical, is created through savings and investments. It is obvious that high incomes generate more savings. It is also a fact that increasing productivity raises incomes. According to the theories of endogenous growth, an investment in human capital increases an individual's productivity and subsequently leads to higher rates of capital accumulation. Since this investment is costly, children's ability to invest and generate more wealth is highly dependent on intergenerational transfers of wealth, or the functionality of credit markets. Should there be no efficient way of redistribution or functioning credit markets, economic inequality could rise and eventually stall growth. Thus, providing the intergenerational transfers of wealth through publicly funded education or government-backed credit could be the most efficient ways to promote growth and equality.

[16] Bénabou (1998, pp. 14-15).

Distribution of wealth has always been closely linked to political process. The median voter theorem and different policy regimes influence the choice over redistributive policies. The key implication is this: the more the median voter or the key political pressure group falls short from the average wealth, the more likely it is that they seek redistribution through political process. This could then either increase growth or decrease it depending on the way the redistribution is being put in effect. Some simulated models suggest, however, that redistributive policies are ineffective because network effects will eventually concentrate wealth to the few. They also imply that the most efficient way to equalize wealth is to support free exchange of goods in an economy. These models have a flaw, however, because they assume a pure exchange economy without production. Clearly, it would be very fruitful to include some production into these models and see how the results are affected by this.

In conclusion, there seems to be a link between economic growth and wealth distribution. Wealth is created through savings that can be invested in physical or human capital. There is no clear consensus whether equality enhances or deters economic growth. Most likely, however, some form of redistribution is necessary for stable economic growth, because outside of the economic models political processes play a significant role in economic decision-making. Researchers suggest various policy options that could support economic growth and affect distribution of wealth. Common ground in these options could be found in alleviating market imperfections that could seriously hamper investments in human and physical capital as well as free exchange of goods.

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