The economics of distribution and growth: Recent issues

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[0] This survey draws heavily from joint work Stephen Turnovsky.

1 Introduction

The relationship between growth and income inequality has occupied the attention of the profession for some 50 years, since the appearance of Kuznets (1955) pioneering work, and is both important and controversial. It is important because policy makers need to understand the way in which increases in output will be shared among heterogeneous agents within an economy, and the constraints that this sharing may put on future growth. Its controversy derives from the fact that it has been difficult to reconcile the different theories, especially since the empirical evidence has been largely inconclusive[1]

A first aspect of the debate –both theoretical and empirical- concerns causation. Does the growth process have an impact on inequality? Or does the distribution of income and wealth among agents determine aggregate growth? Despite the controversy, one thing is clear. An economy's growth rate and its income distribution are both endogenous outcomes of the economic system. They are therefore subject to common influences, both with respect to structural changes as well as macroeconomic policies. Structural changes that affect the rewards to different factors will almost certainly affect agents differentially, thereby influencing the distribution of income. Likewise, policies aimed at achieving distributional objectives are likely to impact the aggregate economy's productive performance. Being between endogenous variables, the income inequality-growth relationship – whether positive or negative – will reflect the underlying common forces to which they are both reacting.

A second cause for controversy is that many of the theories proposed

[1] See Aghion, Caroli, and García-Peñalosa (1999), Bertola (2000) and Bertola, Foellmi, and Zweimüller (2006) for overviews of the theoretical literature, and Forbes (2000), Banerjeee and Duflo (2003) and Voitchovsky (2005) for recent empirical analyses.

explore a single mechanism applicable only to particular types of countries. Theories about rural-urban migration, such as the Kuznets hypothesis, cannot describe the relationship between inequality and growth in mature industrial economies; models based on credit market imperfections are applicable only to those economies where such imperfections are substantial; and the concept of skilled-biased technical change adds little to our understanding of the relation between the two variables in countries with stagnant technologies.[2]

In this paper I review recent developments in the theory of growth and distribution. My focus will be on those theories that can help us understand the relationship between these two variables in modern industrial economies. In these countries, the growth process is the result of a combination of technological change, capital accumulation -either physical or human-, and changes in the supply of labour. I will argue that each of these represents a possible mechanism creating a link between inequality and growth. Causation need not be the same in all cases. It could run from growth to inequality, from inequality to growth; and there may also be other factors, such as policies and technologies, that simultaneously determine both. I make no a priori distinction between these, as I believe that all of them are present in one form or another.

The paper is organised as follows. The next section decomposes a country's growth rate into four components: technological change, human and physical capital accumulation, and changes in the labour supply. I then examine the links between inequality and growth considering these components one by once. Section 3 consider the inequality-growth relationship

[2] Surprisingly, the bulk of the empirical literature has paid little attention to which countries should be included in the dataset to test a particular theory. A notable exception is Voitchovsky (2005).

when there is physical capital accumulation. Section 4 looks at technology and human capital, while section 5 addresses the question in terms of the effects of changes in the labour supply on inequality and growth. The last section concludes.

2 A Framework of Analysis

Consider an aggregate production function of the form

$$Y = AF(K, L),$$

where A denotes the level of technology, K the aggregate (physical) capital stock, and L a measure of the aggregate labour input, and the function $F(.)$ exhibits constant returns to scale. We can then write the rate of output growth as

$$g \equiv \frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + s_k \frac{\dot{K}}{K} + s_L \frac{\dot{L}}{L},$$

where s_K and s_L are, respectively, the capital share and the labour share in aggregate output, and $s_k + s_L = 1$. The labour input depends on the quality and the quantity of labour. Let us express it as

$$L = Q \cdot (H \cdot P).$$

The first term, Q, captures the quality of labour, or human capital, while the term brackets is the labour supply, itself the product of the number of hours each employed individual works, H, and the number of employed individuals, P, and hence measures the quantity of labour in the economy. Then, the rate of change of the labour input is given by

$$\frac{\dot{L}}{L} = \frac{\dot{Q}}{Q} + \frac{\dot{H}}{H} + \frac{\dot{P}}{P}$$

Of course, the quality of labour and the hours supplied may vary across individuals, so that we should write $L = \sum_{i=1}^{P} Q_i \cdot H_i$, or more generally $L = G(Q_i, H_i)$ if individuals with different levels of human capital are not perfect substitutes. Then, the rate of growth of aggregate labour would also depend on the distribution of human capital and on the covariance terms of individual's hours and human capital.

In the simple setup in which we can define an aggregate measure of labour as a function of the average Q_i and H_i but independent of their distribution we have

$$g = \frac{\dot{A}}{A} + s_k \frac{\dot{K}}{K} + s_L \left(\frac{\dot{Q}}{Q} + \frac{\dot{H}}{H} + \frac{\dot{P}}{P} \right).$$

That is, the rate of growth depends on the growth rates of technology, physical capital, human capital, and the labour supply, as well as on the (possibly endogenous) factor shares.

Several of these variables will also have an impact on the distribution of income. To see this, consider an individual's market income which is given by

$$Y_i = rK_i + wQ_iH_i,$$

where $Q_i > 0$ and $H_i \geq 0$. Our measure of inequality will be a function of the redistribution of relative incomes. Defining y_i as agent i's income relative to mean income we have

$$y_i \equiv \frac{Y_i}{Y/N} = s_k k_i + s_L q_i h_i \frac{1}{p},$$

where k_i, q_i, and h_i denote, respectively the agent's physical capital, human capital and hours relative to the mean, N is the population, and $p \equiv P/N$ is the participation rate. Alternatively, if the agent's wage rate is not proportional to her human capital so that $w_i = w(q_i)$, we can write

$$y_i = s_k k_i + s_L \omega_i h_i \frac{1}{p},$$

where $\omega_i \equiv w(q_i)/\overline{w}$ is the individual's wage relative to the average wage, $\overline{w}$. An inequality index, I, can then be defined as a function of individuals' relative incomes, that is $I = \Phi(y_i)$. Inequality then depends on factor shares, the distribution of capital (physical and human), the distribution of hours of work, and the participation rate. Each of these elements represents a channel that relates, in a causal or non-causal way, inequality and growth.

3 Physical Capital Accumulation

3.1 A Simple Endogenous Growth Model

Let us start by considering a single source of heterogeneity, unequal initial capital endowments.[3] Consider an economy where output is produced according to an aggregate production function of the form

$$Y_t = {K_t}^{\alpha}(A_t L)^{1-\alpha}, \tag{1}$$

where $0 < \alpha < 1$ is the capital share in aggregate output. The labour input L is given and constant, factor markets are competitive, and agent i maximizes an objective function of the form

$$U_{i0} = \int_0^{\infty} \frac{C_{it}^{1-\sigma} - 1}{1-\sigma} e^{-\beta t} dt, \qquad \sigma > 0, \tag{2}$$

subject to her budget constraint

$$\dot{K}_{it} = rK_{it} + w - C_{it}. \tag{3}$$

[3] The discussion in this subsection follows closely the analysis in Bertola (1993).

This model can be solved to show that the rate of growth of consumption is the same for all agents, equal to the rate of growth of output, and given by

$$g = \frac{\alpha(A_t L/K_t)^{1-\alpha} - \beta}{\sigma}. \tag{4}$$

Suppose also that aggregate productivity depends on the current capital stock so that $A_t = K_t$. We can then express the equilibrium rate of growth as

$$g = \frac{\alpha L - \beta}{\sigma}. \tag{5}$$

We can now turn to individual incomes. Since the only difference between individuals is their initial capital stock, we can write agent i's relative income at time t as

$$y_{it} = \alpha k_{it} + (1 - \alpha). \tag{6}$$

An important feature of this model is that, since there are no transitional dynamics, all agents accumulate capital at the same rate and hence the distribution of relative capital remains unchanged. The distribution of income is then determined by the distribution of endowments and factor shares. A higher capital share, i.e. a higher α, will imply both a faster rate of growth and a more dispersed distribution of income.

3.2 Taxation

The above analysis implies that differences in the technology across countries will result in different rates of growth and distributions of income. Growth and inequality will also be affected by policy parameters. Suppose, for example, that all income is taxed at a constant proportional rate τ and that the revenue is used to finance a lump-sum transfer b, so that the individual budget constraint is now

$$\dot{K}_{it} = (1-\tau)rK_{it} + (1-\tau)w + b - C_{it}. \tag{3'}$$

Then the rate of growth will be given by

$$g = \frac{\alpha(1-\tau)L - \beta}{\sigma}, \tag{5'}$$

while agent i's relative net or after-tax income is given by

$$y_{it}^{N} = \alpha k_{it} + (1-\alpha) + \tau\alpha\left(1 - k_{it}\right), \tag{6'}$$

where we have used the government budget constraint to substitute for b. In this case, higher taxation will be associated with a more equal distribution of income and with a slower rate of growth.

Using this simple model, the early literature on inequality and growth argued that if the tax rate were endogenously determined through majority voting, greater wealth inequality -defined as a greater distance between the capital owned by the median and that owned by the mean individual- would result in a higher tax rate and hence lower growth.[4] This lower rate of growth can be associated with higher or lower income inequality due to the opposing effects of a more dispersed distribution of capital and a higher tax rate on disposable income.

To sum-up, we have found that

(i) differences in the technology (α) result in a *positive* correlation between growth and pre-tax income inequality,

(ii) differences in income tax rates (τ) lead to a *negative* correlation between growth and post-tax income inequality,

(iii) greater wealth inequality -measured in a particular way- leads to slower growth,

[4] See Alesina and Rodrik (1994) and Persson and Tabellini (1994).

(iv) differences in wealth inequality may lead to a positive or negative correlation between growth and post-tax income inequality.

Even in this simple model, the sign of the relation between inequality and growth is not clear, and depends crucially on the way in which we measure inequality. Empirical evidence has overall generated a fuzzy picture. Early studies, such as Alesina and Rodrik (1994) found a negative correlation between income inequality and growth, while a positive correlation and the fact that both variables are jointly determined are consistent with the more recent empirical findings of Barro (2000), Forbes (2000), and Lundberg and Squire (2003). The one consistent result is that there is no support for the "political economy" argument behind (iii) and (iv); tax rates are not correlated with pre-tax income inequality and greater taxation is not correlated with slower growth.[5]

3.3 Wealth and Income Dynamics

One of the major drawbacks of the AK model sketched above is that there are no wealth dynamics. The constant growth rate implies that all agents accumulate at the same rate and hence the distribution of relative wealth remains unchanged. In a Ramsey-type model with diminishing returns to capital this is not the case.

In a recent paper, Caselli and Ventura (2000) have characterized relatively mild conditions under which various sources of heterogeneity are nevertheless compatible with viewing the aggregate (average) economy behaving as if it is populated by a single representative consumer. In particular, when the only difference across agents is their initial wealth and preferences are homothetic, then saving is a constant fraction of total life-

[5] See, among others, Perotti (1996) and Rodriguez (1999).

time wealth, defined as the sum of all future labour earnings and interest payments. Because savings are linear in individual wealth, then aggregate savings are independent of the distribution of capital in the economy. In other words, the behaviour of the aggregate economy with heterogeneous agents is identical to that of the representative consumer economy.

Aggregate dynamics do, however, have a distributional impact. To understand why the evolution of wealth inequality depends on aggregate dynamics consider two individuals having different capital endowments. Homothetic preferences imply that they both spend the same share of total wealth at each point in time and have the same rate of growth of total wealth. Total wealth has two components, physical capital and the present value of all future labor income. Since wages are growing at the same rate for both agents but represent a higher share of total wealth for the poorer individual, then his capital must be changing more rapidly than that of the wealthier agent. When the economy is accumulating capital, this means that his capital stock is growing faster and inequality is diminishing.

What will happen to the distribution of income? Recall that with the Cobb-Douglas production used above, the income of agent i is given by $y_{it} = \alpha k_{it} + (1 - \alpha)$. If the distribution of capital is becoming more equal over time, then the distribution of income will also become more equal.

The effect of on incomes of a narrowing wealth distribution can be weakened or strengthened by changes in the labour share. Instead of the Cobb-Douglas production function, consider a more general production function of the form

$$Y_t = \left(\alpha {K_t}^{\rho} + (1 - \alpha)(AL)^{\rho}\right)^{1/\rho}, \tag{1'}$$

where $\rho \leq 1$ and $1/(1 - \rho)$ is the elasticity of substitution between capital and labour. The share of capital is now

$$s_{kt} = \frac{\alpha}{\alpha + (1-\alpha)(K_t/(AL))^{\rho}}, \tag{7}$$

and individual incomes are given by

$$y_{it} = s_{kt}k_{it} + (1 - s_{kt}) \tag{6''}$$

where $(1-s_{kt})$ is the labour share. With a CES production function, the endogenous labour supply will also determine the shares of capital and labour in total output, and hence the weight of capital income in the individual's budget constraint.

If the elasticity of substitution is less than 1, that is if $\rho < 0$, a growing capital stock implies a falling capital share, reinforcing the effect of declining wealth inequality. However, if the elasticity is greater than 1, income and wealth inequality may move in opposite directions. The capital share increases during the transition and offset, partially or totally, the impact of the changing wealth distribution on income inequality.

4 Technology and the Quality of Labour

Building on the seminal work of Nelson and Phelps (1966), one of the most important lessons that the new growth theories have taught us is that we cannot separate the process of human capital accumulation from that of technological change. Nelson and Phelps argue that a major role for education is to increase the individual's capacity, first to *innovate* and second to *adapt* to new technologies. This complementarity between education and R&D activities has two important implications. First, technological change requires educated workers. Indeed, the new growth theories have emphasized the importance of having an educate labour force in order to have R&D-driven growth. Second, under the Nelson and Phelps approach to human capital, workers with different levels of education are not perfect substitutes. As a result, their relative rewards depend on the speed and on the *type* of technological change. This has given rise to an extensive literature that explores the concept of *biased technical change* and its implications for wage inequality.

4.1 The Effect of Technical Change on Labour Market Inequalities

The basic idea behind the hypothesis of biased technical change is that different types of labour are not perfect substitutes.[6] This can be captured by an aggregate production function of the form

$$Y = K^{\alpha}(\lambda(A_s L_s)^{\beta} + (1-\lambda)(A_u L_u)^{\beta})^{(1-\alpha)/\beta}, \tag{8}$$

where L_s is skilled labour and L_u unskilled labour.[7] The elasticity of substitution between the two types of labour is given by $1/(1-\beta)$, and they use skill-specific technologies, with A_s representing the technology used by the skilled and A_u that used by the unskilled. The relative wage is given by

$$\ln \frac{w_s}{w_u} \simeq \beta \ln \frac{A_s}{A_u} - (1-\beta) \ln \frac{L_s}{L_u}, \tag{9}$$

If $\beta > 0$, i.e. if skilled and unskilled labour are substitutes, then whenever skilled productivity grows faster than unskilled productivity the relative wage will increase. That is, if technological improvements lead to a faster increase in A_s, we will say that there is skill-biased technical change and growth will be accompanied by a higher relative wage.

[6] An excellent review of this literature is provided by Hornstein, Krusell and Violante (2005).

[7] The literature tends to define those with only college education as "unskilled workers" and those with college education as "skilled workers".

One of the problems of this approach is that, although intuitive, it requires large differences in the rate of growth of relative productivity. A complementary approach is to also allow for *capital-skill complementarity*, as suggested by Krussell et al. (2000). They argue that we should distinguish between structure capital, denoted K_s and comprising buildings and infrastructure, and equipment capital, denoted K_e, and propose a production function of the form

$$Y = {K_s}^{\alpha} \left[\lambda \left[\mu (A_e K_e)^{\rho} + (1-\mu)(A_s L_s)^{\rho} \right]^{\beta/\rho} + (1-\lambda)(A_u L_u)^{\beta} \right]^{(1-\alpha)/\beta} . \tag{8'}$$

The degree of complementarity between equipment capital and skilled workers is therefore not the same as that between equipment and unskilled labour. The skill premium is then given by

$$\ln \frac{w_s}{w_u} \simeq \beta \ln \frac{A_s}{A_u} - (1-\beta) \ln \frac{L_s}{L_u} + \lambda \frac{\beta - \rho}{\rho} \ln \frac{K_e}{L_s}. \tag{9'}$$

Their estimates using US data imply $\beta > 0$ and $\rho < 0$, indicating that there is capital-skill complementarity which implies that the skill premium can increase even if the relative productivity of the two types of workers and the relative supplies remain constant. The source of the change in the relative wage is an increase in equipment capital which, since this type of capital is complementary with skilled labour, raises the marginal product of the skilled. In other words, under the assumption of capital-skill complementarity, innovations that reduce the cost of equipment capital and hence raise their supply will tend to increase the skill premium.

4.2 Indirect Effects of Biased Technical Change

The concept of biased technical change has proven to be a powerful tool relating technological progress to wage dynamics. The problem is that because technological progress is hard to measure directly, the only way to identify the effect of biased technological change is by not being able to attribute changes in the skill premium to other causes. These other causes have been argued to be changes in the internal organization of firms and in labour market institutions. Perhaps the most enduring contribution of this literature will be the idea that both organizational change and labour market institutions can be due to the presence of biased technological change.

A number of recent contributions have argued that technological change, and in particular IT-technologies, have changed the internal organization of firms; see, for example, Garicano and Rossi-Hansberg (2006) or Saint-Paul (2001).[8] The overall conclusion of this literature is that technologically-induced organizational change tends to increase inequality both within a firm and across groups of workers, and is seen as largely responsible for the increase in labour earnings of top managers and CEOs.

Technological progress has also been argued to be a source of changes in labour market institutions; see Acemoglu, Aghion and Violante (2001) and Ortigueira (2007). Empirical evidence indicates that changes in labour market institutions can account for part of the recent increase in wage dispersion, and have been shown to have a substantial impact on overall income inequality.[9] What these theories argue is that the collapse of centralised wage bargaining was the result of the increase in the productivity gap across workers brought about by equipment-specific technological progress and equipment-skill complementarity.

[8] Empirical support for the complementarity between technology, organizational change and human capital is provided by Bresnahan at al. (2002) and Caroli Van Reenen (2001).

[9] See Koeninger, Leonardi and Nunziata (2007) and Checchi and García-Peñalosa (2005).

4.3 Entrepreneurship and the Welfare State

A central theme in the literature on inequality and growth has been the role of capital market imperfections.[10] These are usually modelled as high borrowing rates that deter poor but productive individuals from making socially desirable investments in human or physical capital. Such mechanism is likely to be important for countries at early stages of development but less so for mature industrial economies. However, industrial economies are characterized by a different type of capital market imperfection, namely the absence or scarcity of private insurance for those who engage in risky entrepreneurial activities, as argued by Sinn (1996). In this context, redistributive taxation can act as a substitute for private insurance[11] and hence affect entrepreneurship and innovation, as well as the distribution of income.

In order to examine this idea consider an R&D-driven growth model, such as Romer (1990), Grossman and Helpman (1991) or Aghion and Howitt (1992). In all these models the rate of output growth is determined by the occupational choice of highly-educated individuals who decide whether to be employed as workers in manufacturing or become entrepreneurs and engage in R&D.

To illustrate the mechanism consider the model of Aghion and Howitt (1992) where final output is given by

$$Y_t = A_t M_t^{\alpha} U^{1-\alpha} \tag{10}$$

where $0 < \alpha < 1$, A_t is the index of total factor productivity, which depends on the technological vintage used, M_t denotes the number of skilled workers

[10] See, for example, Banerjee and Newman (1993), Galor and Zeira (1993) and Aghion and Bolton (1997).

[11] The idea that redistribution can act as social insurance when private risk-pooling arrangements are absent was first noted by Eaton and Rosen (1980) and Varian (1980).

in manufacturing, and U the number of unskilled workers (which can only work in manufacturing). Each innovation increases the value of A_t. Then, if E_t is the number of entrepreneurs at time t, and λ is the probability that an innovation if found at time t, the (expected) growth rate is a function of the expected rate of innovation

$$g_t = \gamma(\lambda, E_t). \tag{11}$$

The literature generally abstracts from the role of risk, either because innovation is assumed riskless (as in Romer, 1990) or because agents are supposed to be risk-neutral (as in Grossman and Helpman, 1991, and Aghion and Howitt, 1992). The number of entrepreneurs is then determined by an arbitrage condition of the form

$$w_{st} = \lambda V_{t+1} \tag{12}$$

where w_{st} is the skilled wage in manufacturing at time t, and V_{t+1} is the value of the innovation. For simplicity, suppose that the value of the innovation is independent of occupational choices. Since the wage is a decreasing function of M_t, this equation together with the labour market constraint $M_t+E_t = L_s$ will yield a unique solution determining the number of entrepreneurs at t, E^*.

Now suppose that individuals are risk-averse and that their utility is a concave function $U(.)$ of their post-tax income. Then, in the absence of redistribution, the arbitrage condition becomes

$$U\left(w_{st}\right) = \lambda U\left(V_{t+1}\right) \tag{12'}$$

which, by concavity of $U(.)$, implies a lower number of entrepreneurs, $\widehat{E} < E^*$.

Once we introduce risk-aversion two questions arise. The first is what will be the effect of an increase in the riskyness of innovation; the second concerns the effect of redistribution on entrepreneurship, growth and inequality. An increase in riskyness is captured by a lower value of λ. Note that the parameter λ has several possible interpretations. The most standard one is that it is the probability than a particular entrepreneur innovates, but it could also measure other sources of uncertainty about the return to innovation, such as the size of the market in which the innovation will be sold, exchange rate uncertainty if the innovation is sold abroad, or the probability of competition in the product market. It is clear from equations (11) and (12') that a lower value of λ will reduce the number of entrepreneurs and be associated with slower growth. Moreover, since it also increases the number of skilled workers in production it will reduce the wage of the skilled and increase that of the unskilled, leading to a lower wage ratio.

Let us now consider the effect of redistribution on growth. Suppose that redistribution takes the form of a linear income tax, such that all incomes are taxed at a proportional tax rate τ and all individuals receive a lump-sum transfer b. Two groups of individuals have high incomes, the skilled employed in production and the successful entrepreneur, and we suppose that they pay a net tax. The two groups that have low incomes, the unskilled and the unsuccessful entrepreneurs, receive a net benefit. Redistribution will have two effects. On the one hand it will reduce post-tax wage inequality. On the other, it will affect the rate of growth. The arbitrage equation is now

$$U\left((1-\tau)w_{st}+b\right)=\lambda U\left((1-\tau)V_{t+1}+b\right)+(1-\lambda)U\left(b\right) \tag{12"}$$

as the benefit provides insurance to entrepreneurs by providing an income when their research is unsuccessful. Under reasonable assumptions, redistribution has two effects on the arbitrage equation: it reduces the net income and hence the utility of workers, and it increases the expected utility of entrepreneurs. As a result, the number of entrepreneurs increases to $E(\tau) > \widehat{E}$, leading to faster growth. That is, when growth is driven by risky R&D investment, redistributive taxation can simultaneously reduce inequality and increase the rate of growth.[12]

4.4 Inequality and the Welfare State

The determinants of the degree of income inequality in a country include social and political forces as well as economic ones. In particular, government transfers are the second largest source of household income, suggesting that even if growth matters in shaping the distribution of income, policy choices also play a crucial role. For example, in 1993, social security benefits accounted for 14% of household income in the UK (Atkinson, 1997, p. 305), and in the UK the difference between market income and disposable income is of about 15 Gini points (Atkinson, 2006). It is then essential to understand the relationship between taxation and transfers, on the one hand, and growth and inequality, on the other.

We have seen in the previous subsection that redistribution may have a positive impact on innovation while reducing inequality. The next question that arises is what determines the degree of redistribution, or, more generally, the size of the welfare state.[13] The idea that inequality, human

[12] The question of risk and redistribution is alsoe addrssed by Bénabou (2002). He considers a model with risky human capital investment, and compares direct income redistribution with redistributive education finance. He finds that the latter is preferable in terms of growth, but inferior from an insurance point of view.

[13] A more egalitarian welfare state may take the form of direct income redistribution, as well as of stronger labour market institutions that would tend to reduce inequality in market incomes.

capital accumulation, and the welfare state are jointly determined has been explored Bénabou (2000, 2005).

Bénabou examines an overlapping generations model in which growth is driven by the accumulation of human capital. Individuals are endowed with different levels of human capital and with random ability. There are three key elements in the model. First, an individual's disposable income depends on her human capital, her ability, and the degree of redistribution, denoted τ. Second, some individuals are credit constrained and hence invest in the education of their offsprings less than they would in the absence of constraints. Third, individuals vote over the extent of redistribution, and do so *before* they know their own ability.

Two relationships appear. On the one hand, the desired degree of redistribution is a decreasing function of the degree of human capital inequality in the economy, that is,

$$\tau = \Gamma(inequality), \text{ with } \Gamma' < 0. \tag{13}$$

The intuition for this is that redistribution provides social insurance against the uncertainty concerning ability. The more unequally distributed human capital is, the more unequal the distribution of *expected* income is and hence the more expensive insurance is for those with high human capital. As a result there will be less support for redistributive policies.

On the other hand, we have the relationship depicting the process of human capital accumulation. Greater redistribution relaxes the credit constraint of the poor, allowing them to increase the educational attainment of their children and this resulting in a lower degree of long-run inequality. That is,

$$Inequality = \Phi(\tau), \text{ with } \Phi' < 0. \tag{14}$$

Since the two relationships are decreasing, they may intersect more than once and give rise to two stable equilibria for the same preferences and technological parameters. one equilibrium is characterized by low inequality and high redistribution, while the other exhibits high inequality and low redistribution. central

This approach has a number of important implications. First, the equilibrium relation between inequality and redistribution will be negative. Second, different sources of inequality have different impacts on the extent of redistribution. If most of the inequality is due to differences in human capital endowments, the support for redistributive policies will be weaker than when inequality is largely due to random ability shocks. Third, which of the two equilibria results in faster growth is ambiguous. It depends on the distortions created by redistribution -mainly in terms of the labour supply of the rich- and the positive effect of a greater investment in education by the poor. The latter effect is likely to be weak in industrial societies with well-developped financial system, and hence we would expect the former effect to dominate. That is, the equilibrium with a more redistributive policy will exhibit less inequality and slower growth. Slower growth will be due to the reduction in working hours induced by taxation. We turn to this question in the next section.

Note that although Bénabou sees the random term in the individuals income function as innate ability, it can be given alternative interpretations. For example, uncertainty could be related to the overall performance of the sector in which the worker chooses to work, which in turn depends on the degree of openness and competition faced by the sector. If we interpret it this way, an increase in openness would increase the uncertainty faced by individuals with a given level of human capital and lead to greater support for redistribution. That is, trade openness would result in a *lower* degree of inequality. The effect on growth would be ambiguous, as more redistribution would tend to reduce it but openness may itself have other positive effects on output growth.

5 Labour Supply

5.1 Leisure: Extending the basic growth model

The 1990s witnessed a substantial widening of the gap between working hours in the United States and Europe. While in the 1970s both German and French workers spent about 5 percent more time at work, by the mid-90s working hours in these two countries had fallen to 75 and 68 percent of hours worked in the US.[14] This observation has recently sparked a debate about the causes and effects of differences in labor supply; see Beaudry and Green (2003), Prescott (2004) and Alesina et al. (2005). The literature has largely focused on whether taxes or preferences have driven these differences, and on the impact of labor supply on growth. However, little attention has been paid to the distributional implications of an endogenous labor supply. In this section I discuss how an endogenous supply of labour affects both growth and inequality, and the role that taxes play.

5.1.1 Factor returns and factor shares

Consider the AK model with heterogeneous capital endowments of section 3.1, but suppose now that utility depends both on consumption and on

[14] See Prescott (2004).

leisure, denoted l_i, so that agent i maximizes

$$U_{i0} = \int_0^\infty \frac{1}{1-\sigma}(C_{it}l_{it}^\eta)^{1-\sigma}e^{-\beta t}dt, \qquad \sigma > 0, \eta > 0 \tag{15}$$

Suppose also that all agents are endowed with one unit of labour, so that $H_i = 1 - l_i$ are the hours worked by agent i. and the budget constraint is

$$\dot{K}_i = rK_i + w(1 - l_i) - C_i. \tag{16}$$

The first implication of allowing for flexible labour is that the elasticity of leisure in the utility function, η, becomes a crucial parameter determining both the rate of growth and the distribution of income. In particular, the macroeconomic equilibrium is determined by the following expressions

$$\begin{aligned} g &= \frac{r-\beta}{\sigma}, & (17)\\ C &= \frac{w}{\eta}l, & (18)\\ g &= \frac{Y}{K} - \frac{C}{K}, & (19) \end{aligned}$$

where l is average leisure and average hours worked are $H = 1 - l$. The first equation is the Euler equation, the second equates the marginal utility from consumption and leisure, and the third is simply the aggregate budget constrained.

With a Cobb-Douglas production function and normalizing the labour force to one, we can write output as $Y_t = {K_t}^\alpha(A_tH)^{1-\alpha}$. Further assuming that $A_t = K_t$, the macroeconomic equilibrium is given by

$$\begin{aligned} g &= \frac{\alpha(1-l)^{1-\alpha} - \beta}{\sigma}, & \text{(E1)}\\ g &= (1-l)^{1-\alpha}\left(1 - \frac{1-\alpha}{\eta}\frac{l}{1-l}\right), & \text{(E2)} \end{aligned}$$

which jointly determine the rate of growth and leisure. An increase in η, that is, a stronger preference for leisure, will result in a lower average labour supply and slower growth. The intuition for this is straightforward. A stronger preference for leisure tends to reduce the labour supply, which reduces the marginal product of capital and hence the rate of growth.

The degree of income inequality is also affected by the parameter η. Recall that agent i's relative income is given by

$$y_i = (1 - s_L)k_i + s_L h_i \tag{20}$$

and hence depends on her relative supply of hours, h_i. The work time chosen by agent i will depend both on the aggregate labour supply, as it affects the wage rate, and on her capital stock, which creates a wealth effect that induces capital-rich agents to work fewer hours. It is possible to show that

$$h_i - 1 = \left(\frac{1}{1+\eta} \frac{1}{1-l} - 1 \right) (1 - k_i) \tag{21}$$

where the first term in brackets is positive (from the transversality condition).

The key mechanism generating the endogenous distribution of income is the positive equilibrium relationship between agents' relative wealth (capital) and their relative leisure. This relationship has a very simple intuition. Wealthier agents have a lower marginal utility of wealth. They therefore choose to work less and to enjoy more leisure, and given their relative capital endowments, this generates an equilibrium income distribution. There is substantial empirical evidence documenting this negative relationship between wealth and labor supply. [15]

[15] Holtz-Eakin, Joulfaian, and Rosen (1993) find evidence to support the view that large inheritances decrease labor force participation. Cheng and French (2000) and Coronado and Perozek (2003) use data from the stock market boom of the 1990s to study the effects of wealth on labor supply and retirement, finding a substantial negative effect on

We can then write relative income as

$$y_i = k_i + \frac{1}{1+\eta}\frac{s_L}{1-l}(1-k_i) \tag{22}$$

where s_L is the share of labour, in this case $s_L = 1-\alpha$. We can rewrite this expression as

$$y_i - 1 = \left(1 - \frac{1}{1+\eta}\frac{s_L}{1-l}\right)(k_i - 1) \tag{23}$$

which implies that income is less unequally distributed than capital. The reason is that labor supplies are less unequally distributed than are capital endowments, thus reducing the variability of income relative to that of capital.

Moreover, using the equilibrium conditions (E1) and (E2), it is possible to show that a stronger preference for leisure, that is a higher value of η, results in a more equal distribution of income. The reason is that a higher η leads to an increase in leisure and hence a lower income for all agents. However, the capital-rich reduce their working hours by (relatively) more and hence experience a greater decline in income, thus leading to a less dispersed distribution. Another way to think about this, is that a lower labour supply implies a higher wage and a lower return on capital. Since capital endowments are more unequally distributed than labour endowments, the change in factor returns will result in a more equal distribution of income.[16]

The effect of different hours worked can be weakened or strengthened by changes in the labour share. For this we need to consider again a CES

participation. Algan, Chéron, Hairault, and Langot (2003) use French data to analyze the effect of wealth on labor market transitions, and find a significant wealth effect on the extensive margin of labor supply.

[16] The argument that the behavior of capital returns is essential to understanding distributional differences has, however, been emphasized by Atkinson (2003) and is supported by recent empirical evidence for the OECD (see Checchi and García-Peñalosa, 2005).

production function of the form

$$Y_t = (\alpha {K_t}^{\rho} + (1-\alpha)(A_t H)^{\rho})^{1/\rho}\,, \tag{24}$$

so that the labour share is now

$$s_L = \frac{1-\alpha}{1-\alpha+\alpha H^{\rho}}, \tag{25}$$

where we have used the fact that $A_t = K_t$. With a CES production function, the endogenous labour supply will also determine the shares of capital and labour in total output, and hence the weight of of capital income in the individual's budget constraint. If the elasticity of substitution is greater than 1, that is if $\rho > 0$, the lower labour supply induced by a higher η increases the labour share and further reduces income inequality. If the elasticity is less than 1, then the resulting fall in the labour share will mitigate the effect of endogenous labour on inequality.

5.1.2 Taxation

One possible reason why labour supplies differ across countries are different preferences for leisure. As we have seen, a stronger preference for leisure results in a lower labour supply, slower growth and (most likely) a more equal distribution of income. If preferences are the cause of differences in labour supply, growth rates and inequality levels across countries, then there are no strong policy implications.[17] An alternative view, put forward by Prescott (2004) among others, is that different time use is due to differences in taxes. That is, it is the result of government policy.

Prescott's argument that higher labor and consumption taxes are the main cause of the reduction in working hours in Europe raises a puzzle. If

[17] There may be a reason for intervention if preferences are endogenous and multiple equilibria possible; see Alesina, Glasser and Sacerdote (2005).

capital endowments are more unequally distributed than labor endowments, then the increase in labor taxes should also have increased post-tax income inequality. This contrasts with the positive correlation between average hours worked in a country and the Gini coefficient of income reported by Alesina et al. (2005) for OECD economies. Table 1 reports the effective tax rate on labor income (a combination of the consumption tax and the tax on labor income) and the Gini coefficient of disposable income for France, Germany, and the US. It indicates that a higher tax rate is associated with both fewer working hours and a lower degree of post-tax income inequality.

Table 1: Labour supply and income inequality: 1993-96

	Per person, relative to US		$\frac{1-\tau_w}{1+\tau_c}$	Gini coefficient
	Hours worked	Output		
US	100	100	0.40	0.35
France	68	74	0.59	0.29
Germany	75	74	0.59	0.27

Source: Relative hours, output and the tax rate are from Prescott (2004), table 1; the Gini coefficients are computed on household disposable income and are from the Luxembourg Income Study (2007) for the year 1994.

Let us now examine the simultaneous response of the aggregate labor supply and personal income inequality to changes in taxation, and try to understand to what extent increases in the effective tax rate on labor can result in a more equal distribution of income. To do this, consider the model of the previous subsection, but suppose that now capital income, labour income and consumption are taxed at rates τ_k , τ_w, and τ_c, respectively.[18] Then, the individual's budget constraint is

$$\dot{K}_i = (1-\tau_k)rK_i + (1-\tau_w)w(1-l_i) - (1+\tau_c)C_i. \tag{16'}$$

The resulting macroeconomic equilibrium is now given by

$$g = \frac{\alpha(1-l)^{1-\alpha}(1-\tau_k)-\beta}{\sigma}, \tag{E1'}$$

$$g = (1-l)^{1-\alpha}\left(1-\frac{1-\alpha}{\eta}\frac{1-\tau_w}{1+\tau_c}\frac{l}{1-l}\right), \tag{E2'}$$

and it is straight forward to show that higher taxes on wages and consumption lead to a lower labour supply and growth rate, in line with recent empirical evidence; see Cardia, Kozhaya, and Ruge-Murcia (2003).

Now consider what is the effect of taxation on income inequality. Because the taxes have redistributive effects, we need to consider the net (or after-tax) income of agent i, y_i^N, which can be shown to be given by

$$y_i^N = y_i + \frac{1}{1+\eta}\frac{s_L}{1-l}\frac{s_k(\tau_k-\tau_w)}{s_L(1-\tau_w)+s_k(1-\tau_k)}(1-k_i). \tag{26}$$

Clearly, net income will be more equally distributed than market income, y_i, if $\tau_k > \tau_w$. In the mid-90s the tax rate on capital income was about 40 percent in the US, Germany, and France.[19] In the case of the US, since τ_w was also 40 percent, the model implies that y_i^N was approximately equal to y_i and hence taxation had no direct distributive implications. Meanwhile, the tax rates observed in Europe imply negative redistribution.

But taxation also affects the distribution of income indirectly, through its impact on factor returns. Recall that market income is given by

[18] See García-Peñalosa and Turnovsky (2007a) for the details, and well as García-Peñalosa and Turnovsky (2007b) for a similar analysis in the context of a Ramsey model.

[19] See Carey and Rabesona (2004).

$$y_i = k_i + \frac{1}{1+\eta}\frac{s_L}{1-l}(1-k_i). \tag{22}$$

With a constant labour share, the effect of the taxes will operate through leisure, l. Higher taxation of labour and consumption will reduce the labour supply, increasing wages and reducing the return on capital, and thus resulting in a less dispersed distribution of income. This effect can be sufficiently strong to overcome the direct distributive effect of the taxes, so that a higher effective tax on labour is associated both with lower working hours and a more equal distribution of post-tax income, consistent with the positive correlation between average hours worked in a country and the Gini coefficient of income reported by Alesina et al. (2005) for OECD economies.

5.1.3 Income versus welfare

So far we have concentrated on inequality in the distribution of income, either before or after taxes. However, the presence of leisure in the utility function raises the question of "inequality of what"? Generally, welfare assessments of the distributional implications of a change in policy or in parameter values are based on measures of post-tax income distribution, as this is seen as a more appropriate proxy for what a social planner would truly care for, the distribution of welfare. Then why not simply compute the distribution of welfare? When the only argument in the utility function is consumption, and as long as all agents have the same preferences, the ranking of distributions of post-tax incomes will be equivalent to ranking distributions of welfare. However, in the presence of leisure this is no longer the case.

Recall that the utility function was of the form

$$U_{i0} = \int_0^\infty \frac{1}{1-\sigma}(C_{it} l_{it}^{\eta})^{1-\sigma} e^{-\beta t} dt, \tag{27}$$

so that the distribution of welfare depends on both the distribution of consumption and that of leisure. It is possible to show that leisure is less unequally distributed than consumption. This has two implications. First, the presence of leisure in the utility function is an equalizing element, as leisure will be less unequally distributed than consumption. Second, the stronger the preference for leisure, the greater the weight that leisure has on individual welfare. As a result, a higher value of η will result in a more equal distribution of welfare due to two effects. On the one hand, the greater weight given to leisure implies a more equal distribution of welfare for given dispersions of C_i and l_i. On the other, as we saw above, a higher η will be associated with a less dispersed distribution of income and hence of consumption.

5.2 Women in the labour market

One aspect that has received little attention in the recent growth literature is the role of labour market participation. Yet, changes in participation rates can have a substantial impact on per capita GDP growth. Table 1 reports a growth accounting exercise for three EU countries, Ireland, Portugal and Spain, that experienced fast growth in the last two decades of the 20th century. The rate of growth of per capita GDP is decomposed as the sum of the rates of growth of total factor productivity (TFP), the capital-labour ratio, employment, and participation. The table indicates that growth in participation has contributed substantially to GDP growth, in some instances more than TFP growth. Moreover, the increase in participation has been due to the massive entry of women in the labour market. Between 1984 and 1998, both Ireland and Spain experienced an increase in female participation rates of over 3% per year and Portugal of 1 % per year, while male participation rates declined slightly over the period.[20]

Table 2: Growth decomposition

	Ireland		Portugal		Spain	
	1984-93	1994-98	1984-93	1994-98	1984-93	1994-98
TFP	2.2	3.1	0.9	0.6	0.4	0.0
Capital per worker	1.0	-0.3	1.8	1.6	1.8	1.4
Employment Rate	0.3	0.6	0.1	-0.3	-0.6	0.2
Participation Rate	0.4	2.2	0.7	0.9	0.9	0.7
Per capita GDP	3.9	5.6	3.5	2.8	2.5	2.4

Source: Lebre de Freitas (2000). The growth decomposition uses a Cobb-Douglas production function, where the labour share is country specific and equal to the average over the period.

These numbers imply that the contribution of female labour market participation to output growth is of the same order of magnitude as that of TFP growth, and raises the question of what are the implications of women entering the labour market for the relationship between inequality and growth. There are two aspects that I would like to discuss. The first concerns the policies that would promote female participation, and their relationship to inequality between men and women. The second aspect is the impact of increased participation on inequality across households.

Women's decision of whether or not to participate in the labour market is based on a comparison of the forgone home production if they work with

[20] Author's own calculations from "OECD Labour Force Statistics V4.4".

the income obtained if employed. In all industrial countries there is still a large gap between the hourly wages of men and those of women. Wage gaps are particularly evident in two types of jobs. One are female dominated jobs, such as nursing, which tend to command lower wages as compared with jobs with similar employee characteristics. The second are part-time jobs which are characterized by substantially lower hourly wages than similar full-time jobs. Differences in wage rates are aggravated by the fact that the tax rate of the income of married women is higher than that for men or for single women. Encouraging female participation would then require policies that reduce the gender wage gap and that lower the tax rate for second earners (see OECD, 2004). Such policies would then lead to lower gender inequality which would increase participation and hence result in faster growth.

Lower inequality between the wage rates of men and women may nevertheless be associated with increases in inequality when measure for other groups. In particular, reducing the gender wage gap is likely to be due to an increase in the wages of women at the top of the earnings distribution, and hence would increase the dispersion of female earnings. This is precisely what we observe in the US, where the sharp reduction in the gender wage gap at the end of the 20th century was associated with increases in the dispersion of female hourly wages and female earnings, (see Gottschalk and Danziger, 2005; Burtless, 2007). In other words, faster growth will be associated with lower inequality across gender groups but greater inequality within-groups.

So far I we have always considered inequality among *individuals*, yet the empirical literature and policy-makers are often concerned with the distribution of income among *households*. Increased female participation and the increased dispersion of female earnings will have major implications for the distribution of household incomes. It will increase or decrease household inequality depending on whether there is a positive or a negative correlation between the earnings of spouses.

Existing evidence indicates that there is a strong correlation between the labour earning of husbands and wives, implying that increases in female participation rates result in a more unequal distribution of household income. Moreover, in both the UK and the US this correlation increased in the last two decades of the 20th century and was part of the cause of the increase in income inequality across household (see Burtless 1999, 2007, and Breen and Salazar, 2004).

6 Conclusions

In this paper I have discussed recent developments in the theory of growth and distribution, focussing on those approaches that are most relevant for modern industrial economies. I have argued that a country's growth rate can be decomposed into the growth rates of technology, physical capital, human capital, and labour supply, and that each of these represent a channel through which inequality and growth are related. The literature I have reviewed implies that "anything goes": distribution can widen or narrow during the growth process; greater equality may reduce growth if it leads to greater redistribution; policies aimed at fostering growth through increased female participation will reduce inequalities across genders but probably increase it across households. The overall outcome is that the reader looking for policy implications remains without an answer.

Where does this leave us in our understanding of the relationship between distribution and growth? I draw two conclusions from this literature. The first one is that, unlike the Kuznets hypothesis of the 1950s, we cannot expect the growth process to autonomously bring about a reduction of inequality. It may or it may not, and hence redistribution will remain a policy concern even in affluent societies. The second is that despite the poor predictive capacity of these theories they can help us understand ex post the causes of a particular episode of increasing inequality. This understanding is essential if one wants to design suitable redistributive policies.

It is important to emphasize a number of questions that I have not addressed here. My discussion of the role of labour market institutions has concentrated on their impact on the distribution of wages, and I have not considered their impact on unemployment and the way in which unemployment then affects the income distribution. Also, my analysis of the role of risk and uncertainty has been limited, and I have devoted little space to the implications of trade openness. A substantial literature exists on all of these, that complements the approaches reviewed in this paper.

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