Saving Capitalism from the Capitalists: Inequality, Taxation, and Growth in a Financially Concentrated Economy

Guido Cozzi*

Department of Public Economics, University of Rome "La Sapienza"

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Abstract

This paper shows that in a "capitalist economy" where there is no "creative destruction", and in which financial intermediaries collude, if households have perfectly diversified portfolios they will prefer lower R&D investment and growth if they are rich and higher R&D and growth if they are poor. Hence, the richer the wealth group that control the financial sector the lower equilibrium innovation: in this sense inequality harms growth.

If profit taxation is present, the higher the tax rate the faster growth no matter if taxation is purely wasteful or redistributive. This effect disappears as the financial sector becomes competitive.

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1 Introduction

This paper suggests an additional explanation of the often found negative correlation between inequality and growth, and of the positive correlation between taxation and growth (see e.g. Alesina and Rodrik 1994, Persson and Tabellini 1994, Perotti 1996, Benabou 1996): the corporate channel.

Endogenous growth theory (e.g. Shell 1966, 1967, and 1970, Romer 1990, Grossman and Helpman 1991a,b, and c, Aghion and Howitt 1992 and 1996) recognizes the importance of purposeful investment by firms in the research and development (R&D) of better products and processes as a major cause of the growth in the wealth of nations. Cumulated R&D investments generate higher profits and higher wages, in proportion to the productivity advances they bring about.

While the models of "creative destruction" (see Aghion and Howitt 1998) develop and extend some important Schumpeterian insights, this paper will try an analysis of the growth consequences of inequality and taxation in an economic framework perhaps more similar to what Schumpeter (1942) thought should prevail at an advanced stage of capitalism. In the economy of this paper R&D is a routinized and incremental activity that gains a decisive competitive advantage from the firm's production experience, long-term customer/seller or borrower/lender relationships, so that no potential rival would find it profitable to challenge the incumbent firm on its own terrain. Needless to say, there is ample empirical evidence of incremental and successful R&D carried out in large firm's laboratories, as well as evidence of breakthrough innovations realized by small new entrants, and a more complete model should consider both aspects of the industrial world.

Who decides the amount of R&D carried out in this economy? Those who control the firms, that is, in the model, their owners.

Now, if different individuals are differently "rich" in terms of firm ownership, they will likely have different opinions as to the "ideal" R&D investment their firms should carry out. For example, someone who owns no share of any firm and whose income only comes from her labor will like all firms in the economy to invest in R&D as much as possible in order to reap the gains in terms of higher wage income, which increases with the economy-wide productivity. At the other extreme, consider an unrealistically rich "capitalist" who completely owns all the firms in the economy, and whose income mostly derives from the aggregate profits and in very little proportion from her wages.

Then she would be happy to have aggregate productivity grow, but at the same time she would worry about the R&D investment as well: the R&D expenditures have to be deducted from her profits and they crowd out resources from final output. Though total factor productivity advances benefit the labor and profit components of aggregate income in the same proportion, the "capitalist" will desire a lower R&D investment than the "laborer". Her losses would be direct and indirect: even if someone else (a benevolent *dues ex machina*) paid the wages of the workers employed in the labs, the capitalist would still be worried that these workers are diverted away from the production of the outputs whose sale yields profits to the firm.

If instead of one "capitalist" we had a group of them spanning the property of all the horizontally differentiated monopolists of a Schumpeterian "advanced capitalism", their common interest would be to carry out less R&D investment than would be in the common interest of the pure workers.

By the same argument, it is easily understood that groups of individuals whose income comes from intermediate shares of profit/labor sources will have intermediate common interests, with the "richer" (i.e. those with higher share of income coming from profits than from labor) desiring a lower aggregate R&D investment, and the "poorer" desiring more R&D investment and growth.

In a perfectly equal economy, as in a representative agent model, every individual would own the same share of the firms' property, while the more "unequal" a society the more concentrated firm property in the hands of the richer individuals. If property confers control rights, it seems reasonable to assume, as this paper does, that higher inequality is represented by control over the firms by the people whose income is more biased toward profit. We will then assume that the more concentrated property the more the decisions taken by the firms are aimed at satisfying the preferences of the profit earners.

In the models of the political channel (e.g. Bertola 1993, Alesina and Rodrik 1994, Persson and Tabellini 1994) to the negative link between inequality and growth it was individual votes for fiscal policy measures that mattered, with different effects depending on the relative wealth characteristics of the pivotal voters (Benabou 1996). In this model of the "corporate channel" it is the "pivotal shareholder" that decides R&D investment and growth. If the pivotal shareholders in all the firms in the economy have the same wealth compositions they will all prefer the same aggregate R&D investment and the same economy-wide growth rate. If they are able to achieve

a collective action to pursue their common interest they will all impose that their controlled firms undertake the R&D investment that maximizes their lifetime wealth.

To enforce collective action in a simple way, this paper will assume a large conglomerate group that concentrates the property of all the firms in the economy in hands of the same holding, whose shares accurately represent the ownership structure in the economy. This may result from a series of mergers and acquisitions by horizontally differentiated monopolistic firms. The "corporate channel" is then easily explained: in our hypothetical extremely concentrated Schumpeterian advanced economy, the richer the wealthy groups that dominate the corporate decisions the lower the amount of R&D their firms will undertake, and therefore the lower the aggregate growth of their economy.

This is a simple way to guarantee common action, but it is clear that other indirect forms of coordination may work as well. For example, firms may spontaneously want to cooperate at the R&D level to exploit complementary knowledge: what we really need for our results is effective coordination of the R&D activities of firms having similar ownership structure.

The main point of this paper is that in a concentrated market economy in which producer's R&D in the main source of technological progress and in which the capital market allows the households to have perfectly diversified portfolios, the richer are more unfavorable to growth, while the poorer favor innovation more. The ability of individuals to implement their preferences via their control rights over the firms is only a stylized, but consistent, way of finding a channel through which to aggregate their wills, but, similarly to politico-economic models, the real world channels could be more indirect and less smooth.

The channel from more inequality to slower growth is studied in Section 2 and Section 3 in a pure *laissez faire* economy. Government intervention is assumed in Section 4, under the form of a kind of progressive taxation. It is shown that if profits are taxed, the higher the tax rate the higher aggregate growth. The intuition is that profit taxation makes the interest of the "capitalist" more similar to the interest of the "laborer", with her desiring more intense R&D investment and faster growth. In as far as her "desires" are transmitted, through the share ownership channel, to her firms these will invest more and the economy will grow more. It is important to notice that taxation is distortionary, but it need not be redistributive: unlike Aghion

and Bolton (1997) it is not the poorer's, but the richer's negative incentive to underinvest that has to be corrected here.

2 The Model

We assume that each of a continuum of infinitely lived individuals chooses their consumption plans so as to solve

$$\max_{x_h(\cdot,\cdot)\in PC([0,1]\times R_+,R_+)} \int_0^{+\infty} e^{-\rho t}\left[\int_0^1 x_h(i,t)^\alpha di\right]^{\frac{1}{\alpha}} dt \tag{1}$$

subject to

$$\int_0^{+\infty}\left[\int_0^1 x_h(i,t)p(i,t)di\right] e^{-\int_0^t r(s)ds}dt \leq \tag{2}$$

$$\int_0^{+\infty} Lw(t)e^{-\int_0^t r(s)ds}dt + W_h(0) \tag{3}$$

where $x_h(i,t)$ is individual $h \in [0,1]$'s time t's rate per unit time of consumption of good $i \in [0,1]$, $p(i,t)$ its price, $w(t)$ is time t's wage rate, $W_h(0)$ is her initial nonhuman wealth and $r(s)$ the capital market's interest rate at time s, and L is her flow labor endowment bearing no disutility[1].

Linearity of instantaneous utility in the CES consumption index $[\int_0^1 x_h(i,t)^\alpha di]^{\frac{1}{\alpha}}$ implies that the real interest rate is constantly equal to ρ.
From (1) and (3), and aggregation, it follows that the instantaneous demand for each good i is given by:

$$\int_0^1 x_h(i,t)dh \equiv x(i,t) = E(t)\frac{p(i,t)^{-\frac{1}{1-\alpha}}}{\int_0^1 p(j,t)^{\frac{-\alpha}{1-\alpha}}dj} \tag{4}$$

where $E(t)$ denotes the rate per unit time of aggregate nominal expenditure.

[1]Therefore labor is inelastically supplied in this model, but the qualitative results of the paper do not depend on that.

Each good i is produced at each instant $t \geq 0$ by a monopolistically competitive firms under a linear technology using labor as the only primary factor, hired at wage $w(t)$, whose average and marginal productivity is denoted by $f_i(t)$. Product varieties do not change over time. Entry and exit is free, but there is instantaneous Bertand competition and a (however small) positive fixed cost stemming from overhead labor $n < L(1-\alpha)$: therefore there will be only one firm at each location in the product space $[0,1]$.

Labor productivity can be increased by firm-specific R&D investment in a flow of labor $u_i(t)$ allocated to the innovative activity. Firm-made technological advances are generated according to the following law of motion:

$$\dot{f}_i(t) = \frac{a'}{\beta} f_i(t)^{\beta} u_i(t)^{\beta} \tag{5}$$

for all $i \in A$, where $\beta \in (0,1)$, and $a' \in R_{++}$ is a scalar productivity parameter. Notice that we assume decreasing returns to ideas and decreasing return to R&D investment, thus ruling out implausible scale effects (see Jones 1995a,b, and 1999). This particular specification helps calculations, but our qualitative results can be generalized.

In (5) we have made the strong assumption that innovation is "firm-specific", instead of "sector specific": this rules out "business stealing" in a drastic way. Similar results would have been obtained by assuming a competitive advantage in R&D of the firm that has developed the previous inventions and has accumulated the additional practical knowledge of the goods whose production and distribution they control all the time. The previous innovators can have a better innate ability to innovate in that sector; or have better R&D cost conditions (Barro and Sala-i-Martin, 1995). Incumbents can have accumulated a competitive advantage in other dimensions, such as the control of distribution channels (Stein 1997). These ingredients could make our model generate the same equilibrium outcomes. Moreover, the very fact that innovations are incremental at infinitesimally small steps implies that even if no firm had a cost advantage in the R&D, profits would be lasting only one instant (in the absence of patent breadth), and in equilibrium only one firm would occupy each location in the product space; by adding a however small positive "entry fee" (installation cost) we would obtain a unique persistent monopoly along the equilibrium path.

From a motivational perspective, we can also say that this paper departs from the Schumpeterian models of "creative destruction" in order to focus

on a kind of "advanced capitalism" (Schumpeter 1942) in which routinized R&D activities are better carried out by the incumbent monopolist firm run by managers[2].

We will focus on a symmetric setting for simplicity, and therefore we will assume a common initial technological stock $f_i(0) \equiv f_0$.

Since bonds are perfect substitutes in their return and risk aspects, while equities confer control rights, equity holding weakly dominates bond holding, and hence we will concentrate on equilibria where only equities are held by the households.

Moreover we will work under the assumption that there exists a perfectly efficient system of financial intermediaries that operates at no cost and that completely diversifies firms' property across the population so that every individual has a perfectly balanced portfolio of firm equities. The fact that "firms are equally owned by all individuals in the economy" (Aghion et al. 1996, p. 8, footnote 3) allows us to index individual wealth in terms of a scalar instead of an infinite dimensional vector: in fact individual $h \in [0,1]$ owns $\theta_h \in R_{++} \cup \{\infty\}$ shares of every firm's capital in her portfolio, and her non-human wealth will be simply described by scalar θ_h, which will not change over time[3].

Notice that there are infinitely many individuals and firms in this economy, and therefore the ownership of each firm is dispersed among an infinity of agents, while the portfolio of each individual is diversified in the same proportion over the infinity of firm assets. Moreover, since, without loss of generality, we have normalized *both* populations of individuals and of firms (consumer product varieties) to the unit interval, a share of $\theta_h = 1$ means that individual h has mean ownership[4], whereas $\theta_h > 1$, respectively $\theta_h < 1$,

[2]In any case, ruling out "creative destruction" by drastic or sophisticated means is useful to make our new causal channel from inequality to growth more transparent, and maybe gets closer to some Schumpeter's intuition about the future of the capitalist economy; however, in the real world experience we observe several cases that fit our assumption as well as several cases of pure "creative destruction", and a more complete model should incorporate both.

[3]"This dispersed ownership structure entitles individuals to the whole flow of output (net of production and innovation costs) and not just to the wage fraction of it" (Aghion et al. 1996, p. 8, footnote 3): though Aghion, Dewatripont, and Rey's (1996) model is totally different and uses this assumption only for its welfare analysis, it turns out that their assumption is a key ingredient for the results of our "frictionless" model.

[4]If $\theta_h = 1$ for all individuals $h \in [0,1]$ then there is perfectly equality, and we are in a

denote above average, respectively below average, asset ownership.

3 Equilibrium

Since firms are perfectly identical as to their quantitative characteristics[5] and their ownership structures we can concentrate on equilibria in which their choice variables take on the same values. Along a symmetric equilibrium every firm turns out to invest the same amount in R&D and therefore the evolution of their technological stocks shall satisfy

$$\dot{f}(t) = \frac{a'}{\beta} f(t)^{\beta} u(t)^{\beta},$$

where $f(t)$ and $u(t)$ are their numerically identical labor productivity and labor R&D employment.

It follows that the symmetric instantaneous equilibrium prices are $p(i,t) = \frac{w(t)}{f(t)\alpha} \equiv p(t)$. Hence real wages are equal to $f(t)\alpha$. Firms' real gross - of R&D expenditures - profit rates per unit time will all be equal to:

$$\pi(i,t) = C(t)(1-\alpha) - nf(t)\alpha \tag{6}$$

where $C(t) \equiv \frac{E(t)}{p(t)}$ denotes instantaneous aggregate real consumption.

Firm i can improve its technology by hiring workers at rates $u(i,t)$ for doing R&D. Therefore its instantaneous cash flows will be $\pi(i,t) - u(i,t)f(t)\alpha$.

In this hypothetical economy the firms are intended as units that specialize in the production of a consumption variety, but that also contribute to technological improvement by hiring workers to undertake research: therefore specialization in production involves a firm specific ability to innovate.

Notice that this rules out "creative destruction" (Aghion and Howitt 1992), because only a firm that produces product variety j can successfully

representative agent economy. If somebody owns all the firm assets she will have $\theta_h = \infty$, while if $\theta_h = 0$ she only owns her labor endowment.

[5]With enough weak complementarity in the instantaneous utility function it can be shown that in equilibria starting from any asymmetric profile of technological levels accross industries the equalization of all sectorial productivities will be reached in *finite time*: bang-bang optimal strategies guarantee technological catch-up.

improve its productivity and/or the quality of its product[6] and challenge the firm that is actually producing j, but this is discouraged by instantaneous price competition and overhead labor cost. Therefore whoever is most productive at a given date will be the only monopolist at all future dates.

In this model firms are production and research units at the same time, while no other research units can effectively challenge their monopolistic position. However firms cannot be really regarded as independent players. They are connected to each other by their ownership structure. Thanks to our perfectly efficient financial market all firms are owned by the same individuals in the same way. It is as if all firms were different production and R&D units of the same large conglomerate group: the reader can imagine that the owners of all the firms operating indifferent product lines exchanged their stock for that of a holding company. In fact, given our assumption of perfectly competitive financial intermediaries with no overhead cost, the behavior of the financial sector is identical to the case where only one zero profit financial intermediary owned all of the firm assets in the economy, with the θ_hs representing individual h's ownership of this intermediary. In such a case the individual stock holders would possess shares of the holding company that governs the entire economy.

This leads us to the question of who takes the relevant decisions on the firm's actions. In an economy with costless information, perfect rationality, perfect property rights, and perfect control rights, it must be the stock holders that give the relevant indications to the production units about the strategies they should carry out. Of course there are some institutional limitations: for example share holders may desire all of their firms to collude horizontally by jointly fixing prices to maximize joint profits, but this monopolistic behavior would be unacceptable by the antitrust legislation. In our model rich share holders would clearly benefit from having all firm set an infinite nominal price/nominal wage ratio for their product in order to drive the real wage to zero and to enjoy maximal real dividends: this would entail too strong social tensions in the presence of inequality, as people with $\theta_h = 0$ might threaten the whole social contract: therefore we will assume that horizontal collusion is made unfeasible by a perfectly efficient antitrust authority.

[6]Under an obvious quality interpretation of $f_i(t)$ as the flow of utility services stemming from time t's version of consumer good i.

In principle, banning horizontal collusion does not preclude other forms of strategy coordination among firms. In this model firms have to decide their R&D investment, and this analysis is facilitated by the symmetric structure. If all share holders had the same idea about the optimal R&D investment in the economy, the financial intermediary would transmit it to the controlled firms, which in turn would fix their R&D investment accordingly. This would likely maximize aggregate welfare and would not deserve any antitrust intervention.

Industrial concentration coupled with legal prevention of horizontal collusion between different product lines allows the cooperative behavior of the firms on other dimensions considered not harmful from a social point of view: among them is R&D cooperation. R&D cooperation typically entails efficiency gains in the form of avoided duplications, internalized externalities[7], and exploited complementarities between the experience of horizontally differentiated firms, as remarked by a large literature. In this paper we can simply assume that coordinated R&D activities bring about an efficiency gain in the form of a cost saving in the research technology, for example due to better information spillovers that reduce duplications, and that can be represented by a different law of motion of technology given by

$$\dot{f}(t) = \frac{a}{\beta} f(t)^{\beta} u(t)^{\beta}, \tag{T}$$

where $a > a'$ summarizes the efficiency gains from coordinated R&D, and motivates a favorable disposition of the antitrust authorities towards inter-firm R&D coordination, as witnessed by the National Cooperative Research Act of 1984 in the US and successive amendments, and by the exemption from art. 85 in the antitrust regulation of the European Community for cooperative agreements in R&D.

Therefore it seems reasonable to adopt here the assumption that all firms in our stylized economy act as *independent production* units (for antitrust reasons), but as *coordinated research* units: the main reason of such centralization of decision and concentration of property is not to reduce competition, but to internalize positive pecuniary externalities among different sectors and to gain higher efficiency in the research and the developement of ways to improve the quality of the products and the economy wide productivity of labor.

[7]For a recent empirical confirmation of the existence of inter-sector externalities of the R&D in the US industries, see Kelly and Hageman (1999).

For this behavior, literal firms' belonging to the same economy wide large conglomerate group becomes unnecessary: a perfectly functioning research association between symmetrically owned independent firms suffices.

As we shall shortly see, in the presence of unequal individual wealth distribution, unanimity of ideal R&D investment fails. While in a representative agent economy cooperative R&D investment is decided, similarly to Cozzi's (1999) representative agent model[8], by finding a common value function $V_C(f)$ as the solution to the following optimization problem:

$$V_C(f) \equiv \max_{u(\cdot)} \int_t^{+\infty} \Big\{ C(s)(1-\alpha) - u(s)f(s)\alpha - nf(s)\alpha \Big\} e^{-\rho(s-t)} ds \tag{7}$$

subject to: $\dot{f}(s) = \frac{a}{\beta} f(s)^{\beta} u(s)^{\beta}$, $f(t) = f$, $s \geq 0$, here we need to take into account that individuals who own different properties have different objective functions.

In this paper individuals only differ in their firm property, that is in the non-labor component of their wealth, while their labor income is the same. Hence we can rewrite time t's non-human wealth of an individual h with property $\theta_h \geq 0$ as:

$$\theta_h \int_t^{+\infty} \left[C(s)(1-\alpha) - u(s)f(s)\alpha - nf(s)\alpha \right] e^{-\rho(s-t)} ds \quad . \tag{8}$$

In addition to their share of the present value of the economy's future profits every individual works and earns the same wage income $Lw(t) = Lf(t)\alpha$.

Therefore total individual wealth at time t is given by the discounted value of the sum of her profit and labor income streams

$$\int_t^{+\infty} \left[\theta_h \left(C(s)(1-\alpha) - u(s)f(s)\alpha - nf(s)\alpha \right) + Lf(s)\alpha \right] e^{-\rho(s-t)} ds \quad . \tag{9}$$

[8]Despite this formal similarity, the economics of Cozzi (1999) is very different. That paper studies the conditions for enforceability of various forms of R&D cooperation under non-rival R&D and imperfect information. Set aside the different technological framework, individuals are assumed perfectly identical in that model, while here the main focus is on inequality.

The ownership of all the firms in our stylized economy is represented by the factors θ_h, $h \in [0,1]$, that is the market is entirely possessed by the private families through a unique financial intermediary[9]. The board of this financial intermediary will decide on the best possible path for $u(\cdot)$. But "best" in what sense? Clearly it is not guaranteed that all share holders' optimal choice of R&D investment coincide: what is trivial in the representative agent world - i.e. maximizing the economy's present value - becomes controversial in a world with unequal property.

We work here under the assumption that every individual is rational and able to figure out the general equilibriuxxm effects of all possible R&D investment paths. This replicates the extreme assumption on the rationality of voters typically made in the politico-economic models (Bertola 1993, Persson and Tabellini 1994, Alesina and Rodrik 1994, Benabou 1996, etc.), with the only difference that here it is not the political vote that matters, but corporate vote: it is not the median voter that matters, but the pivotal voter is the stock holder whose equity ownership is decisive. With perfect equality $\theta_h = 1$; hence inequality can be represented by a distribution of holdings such that the pivotal voters are characterized by $\theta_h > 1$, that is they are richer than average.

We obtain:

Proposition 1 *Individual h's optimal value of her wealth is given by:*

$$V_h(f) = \frac{(L-n-L\alpha)\,\theta_h + L\alpha}{\rho} f + \theta_h^{\frac{-\beta}{1-\beta}} \frac{1-\beta}{\rho\beta} \left(\frac{(L-n-L\alpha)\,\theta_h + L\alpha}{\rho} a \right)^{\frac{1}{1-\beta}} \tag{10}$$

and the corresponding ideal feedback rule for R&D is:

$$u_h^*(f;\theta_h) = \left(\frac{L-n-L\alpha\left(1-\frac{1}{\theta_h}\right)}{\rho} a \right)^{\frac{1}{1-\beta}} f^{-1}. \tag{11}$$

[9]Of course this financial intermediary will not be in a monopoly position, because the assumed technology allows new entrants to "contest" it, and it will be forced to maximize the utility of the aggregation of its share holders.

It would make no difference if we segregated by shareholders' wealth the different financial intermediaries, as they would have to confront with each other at the single firm level. The crucial assumption is that every firm is equally owned by "the market".

Proof. Using the instantaneous resouce (labor) condition $\frac{C(s)}{f(s)}+u(s)+n = L$, household's h's maximization problem can be written as:

$$\max_{u(\cdot)} \int_t^{+\infty} \left[(L - u(s) - n - L\alpha)\,\theta_h + L\alpha\right] f(s) e^{-\rho(s-t)} ds \tag{12}$$

subject to law of motion (T). The Hamilton-Jacobi-Bellman equation of this problem is then

$$\rho V_h(f) = \max_{u\geq 0} \left[(L - u - n - L\alpha)\,\theta_h + L\alpha\right] f + V_h'(f)\tfrac{a}{\beta} f^{\beta} u^{\beta} \tag{13}$$

By derivating w.r.t. u and equating to zero we get:

$$u_h = \left(\frac{aV_h'(f)}{\theta_h}\right)^{\frac{1}{1-\beta}} f^{-1} \tag{14}$$

Replacing (14) for u_h for u into (13) yields:

$$\rho V_h(f) = \left[(L - n - L\alpha)\,\theta_h + L\alpha\right] f + \theta_h^{\frac{-\beta}{1-\beta}} \tfrac{1-\beta}{\beta} \left(aV_h'(f)\right)^{\frac{1}{1-\beta}} \tag{15}$$

which is solved by (11). Plugging (11) into (14) implies (10). Q.E.D.

Remark. From (11) we immediately see that $\frac{\partial u_h^*(f;\theta_h)}{\partial \theta_h} < 0$. Therefore the higher the firm share controlled by household h the lower her/his ideal R&D investment: the richer prefers less R&D investment than the poorer because a lower proportion of her wealth comes from labor; and driving more workers from the plants to the research laboratories brings about an increase in the labor share of output at the expense of the profit share. In fact, the wage income $L\alpha f$ increases proportionally with labor productivity, while profits $(L-n-L\alpha)f-uf$ increase less than proportionally with f, and it is strictly decreasing with R&D effort u. The cost of R&D is the sum of the wages paid for the R&D workers and of the forgone production of the commodities whose sale generates profits: labor in the labs is costly not only directly (wages)

but also indirectly, because they are not producing a final output that could be sold. Workers do not feel any difference, in as far as they are paid the same real wage and the same real interest rate, but profit earners do. Hence the larger the share of the individual income stemming from profits the lower the incentive to carry out R&D investments.

It easy to see that given the individual share of the firm equities her ideal R&D investment path is entirely determined regardless of the way the firms will finance such investments, as retained profits, outside financing through bonds, new equity issuance, or any combination of these. In the case of debt, it does not matter who finances the firm as well: it can be the individual whose optimal R&D we are analyzing, other individuals or entities, or any combination of them.

It is also easy to see that if the poorer are the ones who make the decision about R&D investment, they will want more investment and growth than they would if property were equally divided: hence an egualitarian economy grows faster than an unequal society where the investment decisions are in the hands of the rich, but it grows more slowly than an unequal society where the investment decisions are in the hands of the poor. By the same argument, we can say - somewhat paradoxically - that under the assumptions of our model, a capitalist economy where the R&D decisions are dictated by the "proletarians" grows more than a socialist economy, while it grows less if the R&D decisions are dictated by the "capitalists".

3.1 Capitalism Saved by Competitive Finance

In our previous analysis a crucial role was played by the fact that firms coordinated the R&D activities in order to pursue the interest of their owners. In this sense cross stock holding facilitated the collective action of the owners in our economy. This led the owners to internalize the negative pecuniary externalities of each other's R&D investment on their profit incomes and the positive externalities on their wage incomes.

If instead each firm was owned by different people who were unable to coordinate actions with the owners of other firms, the R&D decision within each firm would not depend on how rich the decisive shareholder is.

In fact, assuming that individual h only possessed share θ_h of firm i, her

lifetime real wealth would be given by:

$$\int_t^{+\infty} \left[(x(i,s)p(i,s)(1-\alpha) - u_i(s)\alpha f(s) - n\alpha f(s))\,\theta_h + L\alpha f(s)\right] e^{-\rho(s-t)} ds = \qquad (1$$

$$\int_t^{+\infty} \left[\Big((L-u(s)-n)(1-\alpha) f(s)^{\frac{1-2\alpha}{1-\alpha}} f_i(s)^{\frac{\alpha}{1-\alpha}} - u_i(s)\alpha f(s) - n\alpha f(s)\Big)\,\theta_h + L\alpha f(s)\right] e^{-\rho(s-t)}$$

where we have assumed for simplicity that all other firms have equal productivity f, and we have made use of the demand function (4).

Expression (16) is maximized by the same control $u_i(\cdot)$ for any $\theta_h > 0$, that is all of the owners of a firm have unanimous ideal R&D investment for their firm. This emphasizes the role of property concentration in deriving our previous results about inequality and growth. The more someone is a "capitalist" the more she feels the *negative* externality of aggregate R&D investment on her firms' profits. Instead, the more someone is a "proletarian" the more she will feel the *positive* externality of aggregate R&D investment of her wage income.

The following holds:

Proposition 2 *There is a unique equilibrium feedback rule for R&D adopted by all firms and it is equal to:*

$$u(f) = \left(\frac{L-n}{\rho} a\right)^{\frac{1}{1-\beta}} f^{-1}. \qquad (17)$$

Proof. Firm i's current value Hamiltonian, after dropping time indexes, is:

$$(L-u-n)(1-\alpha) f^{\frac{1-2\alpha}{1-\alpha}} f_i{}^{\frac{\alpha}{1-\alpha}} - u_i\alpha f - n\alpha f + \\ +\lambda_i \frac{a}{\beta} f_i{}^{\beta} u_i{}^{\beta}. \qquad (18)$$

The optimal control has to satisfy:

$$u_i{}^{1-\beta} = \frac{\lambda_i a}{\alpha} \left(\frac{f_i}{f}\right)^{\beta} f^{\beta-1} \qquad (19)$$

The adjoint equation is:

$$\dot{\lambda}_i \quad = \lambda_i \rho - (L - u - n) \left(\frac{f}{f_i}\right)^{\frac{1-2\alpha}{1-\alpha}} \alpha - \lambda_i \quad a {f_i}^{\beta-1} {u_i}^{\beta} \tag{20}$$

which in a symmetric equilibrium becomes:

$$\dot{\lambda}_i = \lambda_i \rho - (L - u - n)\alpha + \lambda_i a {f_i}^{\beta-1} {u_i}^{\beta} \tag{21}$$

Applying symmetry to (19), plugging it into (21), setting $\dot{\lambda}_i = 0$ and solving for u_i finally gives:

$$u_i = \left(\frac{(L-n)\,a}{\rho}\right)^{\frac{1}{1-\beta}} f^{-1} \tag{22}$$

Q.E.D.

Notice that (22) does not depend on individual firm market power (inverse) index α. This is a property of the simplified specification adopted.

Therefore industry concentration in terms of its property structure is a channel why higher inequality implies lower the R&D investment desired by those who control the firms' property. This implies that the more "developed" a financial market, in the sense of its achieving a higher degree of diversification of households' portfolios over the entire economy, the more intensely will the richer individuals feel an opposition against innovation and growth. The more they are able to implement their common interest by an efficient use of their property and control rights the lower R&D investment and the poorer the growth performance of the economy. This suggests a negative effect of ownership concentration on growth.

All our results would continue to hold if we assumed that firms were owned by different individuals but had the same proportional representation of each wealth group, and they only coordinated their R&D activities. The advantage of this interpretation of our model is that with cooperation only at the R&D level, the non-cooperative price setting would be the most natural outcome.

Under this alternative interpretation, firms would join the R&D association in order to achieve two results:

1. Increase the efficiency of their R&D by using complementary knowledge from firm operating in different sectors.

2. Maximize the collective interest of their dominant wealth group by internalizing the negative pecuniary externality of R&D investment.

The first positive efficiency effect may or may not overcome the second strategic effect, and should be one of the main arguments in the likely controversies that would arise at the antitrust level.

4 Profit Taxation

In this section we introduce a very simple form of progressive taxation and show that the higher the tax rate on profit incomes the higher the R&D investment and growth in the presence of inequality.

Since the pretax income of individual h is $[(L-n-u-L\alpha)\,\theta_h + L\alpha]\,f$, we decompose it into an "average" income $(L-n-u)$ plus an "excess" income $(L-n-u-L\alpha)\,(\theta_h-1)f$, and assume that this part of income is taxed at rate $\tau \in (0,1)$ if $\theta_h > 1$, while average income is not taxed. Recall that that inequality is defined as an above average firm ownership - $\theta_h > 1$ - by the pivotal share holder. We assume for simplicity that the tax proceeds are simply destroyed.

It follows that the post-tax income of individual h becomes

$$[(L-n-u-L\alpha)\,(\theta_h(1-\tau)+\tau) + L\alpha]\,f, \tag{23}$$

and we can repeat the very same steps as in the proof of Proposition 1, getting to:

Proposition 3 *Individual h's optimal value of her wealth is given by:*

$$V_h(f;\theta_h,\tau) = \frac{(L-n-L\alpha)\,(\theta_h(1-\tau)+\tau)+L\alpha}{\rho} f + \tag{24}$$

$$(\theta_h(1-\tau)+\tau)^{\frac{-\beta}{1-\beta}}\,\frac{1-\beta}{\rho\beta}\left(\frac{(L-n-L\alpha)\,(\theta_h(1-\tau)+\tau)+L\alpha}{\rho}a\right)^{\frac{1}{1-\beta}} \tag{25}$$

and the corresponding ideal feedback rule for R&D is:

$$u_h^*(f;\theta_h,\tau) = \left(\frac{L-n-L\alpha\left(1-\frac{1}{(\theta_h(1-\tau)+\tau)}\right)}{\rho}a\right)^{\frac{1}{1-\beta}} f^{-1} \equiv \psi(\theta_h,\tau)f^{-1}. \tag{26}$$

Notice that $\frac{\partial u_h^*(f;\theta_h,\tau)}{\partial \theta_h} < 0 < \frac{\partial u_h^*(f;\theta_h\tau)}{\partial \tau}$, and therefore:

Corollary 4 *The richer the pivotal shareholder the lower R&D investment and growth, and the higher profit taxation the higher R&D investment and growth.*

Remark. The previous corollary shows that in this model we obtain the well known empirical negative correlation between a measure of inequality and growth, but at the same time we obtain a *positive* correlation between the average and marginal tax rate on personal income and growth, found by Perotti (1996). Unlike Galor and Zeira (1993), Perotti (1993), Benabou (1995) and (1996), Aghion and Bolton (1997), and Piketty (1997), we do not require limited enforceability of obligations, missing markets, or asymmetric information. Not only are credit and labor markets perfect here, but taxation is *not redistributive*, and therefore it is not aimed at improving the incentives for the poor or the middle class to invest. Taxation is only aimed at reducing the incentive for the richer agents to oppose their firms' investment in R&D; and this is achieved by altering the composition of their post-tax incomes toward the labor component.

The economic intuition for Proposition 2 is that since profit taxation reduces the profit share of individual income, it also weakens the adverse incentive effect on R&D investment described in the previous section. Therefore the interest of the shareholders becomes more similar to that of the workers if taxation is higher, which spurs R&D investment and growth. Contrary to the Laffer curve results of previous models, here the relationship between tax rate and growth is *monotonic*: in the limit, as $\tau \uparrow 1$ the individually optimum R&D investment tends to its upper bound $L - n$.

Notice that the result of Proposition 2 carries over to a case of redistributive profit taxation with no change. This proves that in the presence of inequality redistribution is not necessary for tax rates to positively affect growth, but it is not harmful as well.

It is again interesting to compare economic regimes in the light of the previous proposition. In the previous section we have shown that a market economy where R&D investment decisions are taken by the rich and with no

redistribution would grow more slowly than an ideal equally efficient socialist regime that maximizes the welfare of the representative individual (perfect equality), whereas a market economy where those decisions are taken by the poor (a populistic capitalist economy) would grow faster. The results of this section prove that a market economy with strong taxation does better, in terms of growth, than an equally efficient socialized economy: somehow paradoxically, a strongly pro-labor government in a capitalist economy, by maximizing redistribution would maximize growth, and would make that economy grow faster not only than a similar economy governed by a pro-wealth regime, but also faster than any purely socialist regime.

5 Conclusions

This paper has shown that perfectly diversified household portfolios generate a common preference toward innovation (through R&D investment) among individuals who have the same wealth level, and different interests between individuals with different wealth levels. In particular, the poorer like the innovation more than the richer. Hence the different interest groups are indeed the different wealth groups.

Individuals have the same labor endowment, but differ in their stock ownership, that is, they differ in the share of income coming from firm profits. But wages are paid a fraction of their marginal productivity, that in turn increases with the accumulated R&D. Profits are a fraction of aggregate expenditure, that is a fraction of the aggregate supply of final products. This means that having more workers in the research sector does not instantaneously reduce current wages, while it does instantaneously reduce current profits via an aggregate expenditure spillover: if less final output is produced each firm will sell proportionally less. Therefore, the profit earners like R&D relatively less than wage earners.

Though both income sources (wages and profits) benefit in the same proportion from total factor productivity growth, only profits suffer from the fewer resources available for final production as a result of R&D investment. This is the basic mechanism that explains why the larger the profit share of someone's income the less intense her desire for aggregate R&D.

If a wealth group is able to impose its interest to the firms it is clear that the richer this group the lower R&D investment and hence economic growth.

The most natural way that shareholders can control the decision of their firms is to simply exercise their control rights. That is wealth is not only dividends, but also economic power. Consequently, in this paper we have assumed that in an economy with high inequality it is the rich shareholders that can impose their preferred R&D investment path and thus their preferred economic growth rate: this generates a negative relation between inequality and growth. Interestingly, in this model the *de jure* right to influence the economy's decisions correlates perfectly with the dislike for economic growth.

Somewhat at odds with commonsense beliefs, in this model profit taxation turns out to be beneficial to growth because it reduces the incentive for the rich influential shareholders to resist growth, because it links their interest more to the worker's interest: if the government takes away a larger fraction of someone's dividends it will at the same time take away a larger fraction of the cause of her opposition to higher R&D investment.

It is worthwhile to remark that in this paper taxation needs not be redistributive in order to be growth enhancing: wasteful profit taxation would do a good job for growth in our economy. What seems even more paradoxical, the equilibrium growth rate always increases with the marginal tax rate of the richer incomes: as in Perotti's (1996) empirical findings, there is no Laffer curve in our model, because tax rates appear to be monotonically good for growth.

Of course, taxation may not be efficiency enhancing: the trade off is between lower taxation and higher aggregate growth, but it is not claimed that growth is beneficial *per se*. For example the growth rate desired by the pure workers is higher than the growth rate obtained by a utilitarian social welfare functional.

Unlike Galor and Zeira (1993), Aghion and Bolton (1997), Piketty (1997), Benabou (1995 and 1996) there is no limited enforceability of contracts, nor asymmetric information, and missing markets in this economy. Perhaps there is too much enforceability and too perfect information and markets, in the sense that property, though extremely dispersed and diversified, still confers perfect control over firms' actions and perfect agents' coordination in pursuing their common interests: we have outlined a too perfect corporate democracy where the industrial power of the individuals is proportional to their property.

The kind of advanced capitalist economy assumed here is perhaps more

"advanced" than Schumpeter's (1942) vision itself, set aside contemporary real world. However, the effects outlined here may be working on a smaller scale in more realistic economies and with the kinds of imperfections that enrich the analysis. The common interest of the wealth groups may be pursued with more indirect means.

Moreover, a side benefit from the analysis can be that curing limited enforceability and asymmetric information, though important, may not be sufficient to rule out a negative effect of inequality on growth and a positive role for progressive taxation. Compared to the models such as Galor and Zeira (1993), Aghion and Bolton (1997), Piketty (1997), a limitation of the present paper is that it does not have a non-trivial dynamics of the dynasties wealth distribution, which instead remains unexplained and unchanged over time. It would be very interesting and challenging to incorporate the effect highlighted in our simple stylized model in their more complex and realistic distributional dynamics.

References

Aghion, P., Dewatripont, M., and P. Rey (1996), "Competition, Financial Discipline, and Growth", mimeo.

Aghion, P. and P. Howitt (1992), "A Model of Growth Through Creative Destruction", *Econometrica* 60.

Aghion, P. and P. Howitt (1996), "Research and Development in the Growth Process." *Journal of Economic Growth* 1.

Aghion, P. and P. Howitt (1998), "Endogenous Growth Theory", The MIT Press, Cambridge.

Alesina, A. and D. Rodrik (1994) "Distributive Politics and Economic Growth." *Quarterly Journal of Economics* 109.

Barro, R. and X. Sala-i-Martin (1995), "Economic Growth", New York, MacGraw-Hill.

Benabou, R. (1996) "Inequality and Growth." *MIT* WP 96-12.

Benabou, R. (1995), "Unequal Societies." *NBER* WP 5583.

Cozzi, G. (1999), "R&D Cooperation and Growth", *Journal of Economic Theory*, May.

Galor, O. and J. Zeira (1993), "Income Distribution and Macroeconomics", *Review of Economic Studies* 60.

Grossman G. and E. Helpman (1991a), "Quality Ladders in the Theory of Growth", *Review of Economic Studies* 58.

Grossman G. and E. Helpman (1991b), "Quality Ladders and Product Cycles", *Quarterly Journal of Economics.*

Grossman G. and E. Helpman (1991c), "Innovation and Growth in the Global Economy", The MIT Press, Cambridge.

Jones, C. (1995a), "Time Series Tests of Endogenous Growth Models", *Quarterly Journal of Economics* 110.

Jones, C. (1995b), "R&D-Based Models of Economic Growth", *Journal of Political Economy* 103.

Kelly, M. and A. Hageman (1999), "Marshallian Externalities in Innovation", *Journal of Economic Growth* 4.

Perotti, R. (1993), "Political Equilibrium, Income Distribution, and Growth", *Review of Economic Studies* 60.

Perotti, R. (1996), "Growth, Income Distribution, and Democracy: What the Data Say." *Journal of Economic Growth* 2.

Persson, T. and G. Tabellini (1994), "Is Inequality Harmful for Growth? Theory and Evidence." *American economic Review* 48.

Piketty, T. (1997), "The Dynamics of the Wealth Distribution and Interest Rate with Credit Rationing." *Review of Economic Studies* 64.

Romer, P. (1990), " Endogenous Technical Change." *Journal of Political Economy* 98.

Schumpeter, J. (1942), "Capitalism, Socialism and Democracy", Harper & Row, New York.

Shell, K. (1966), "Toward a Theory of Inventive Activity and Capital Accumulation." *American Economic Review*, 16.

Shell, K. (1967), A Model of Inventive Activity and Capital Accumulation, *in* "Essays on the Theory of Optimal Economic Growth" (K. Shell, Ed.), pp. 67-85, MIT Press, Cambridge, 1967.

Shell, K. (1970), Inventive Activity, Industrial Organization and Economic Growth, *in* "Models of Economic Growth" (J. M. Mirrlees and N. H. Stern, Eds.), 77-100, John Wiley & Sons, London and New York, 1973.

Stein, J. (1997), "Waves of Creative Destruction: Firm-Specific Learning-by-Doing and the Dynamics of Innovation", *Review of Economic Studies*, 64.