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FACTOR SHARES AND SAVINGS IN ENDOGENOUS GROWTH

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ABSTRACT

This paper studies the distributive effects of growth when different agents' income is drawn from accumulated and non-accumulated factors of production in different proportions, notes that political interactions may contribute to determine factor shares and growth when income sources are heterogeneous, and suggests that distributional issues should be taken into account both when formulating growth-oriented policy prescriptions and when interpreting the wide dispersion of growth rates across economies and over time.

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1. Introduction

Economic growth is driven by private investment decisions in the models proposed by Romer (1986,1987,1988,1990), Lucas (1988), Jones and Manuelli (1990), Grossman and Helpman (1991), and others; thus, the rate of growth can be accelerated by policy measures which increase the profit flow accruing to new units of capital and/or decrease their price in terms of consumption. From a hypothetical social planner's point of view, such growth-oriented policy interventions are desirable whenever non-accumulated factors of production receive a positive, nondecreasing share of output in *laissez-faire* equilibrium: aggregate production must eventually increase linearly with accumulation for unceasing endogenous growth to be possible, hence positive remuneration of non-accumulated factors is inconsistent with first-best growth unless, as in Jones and Manuelli (1990), those factors are asymptotically unnecessary for production.

If the economy is not populated by "representative" individuals, however, growth-oriented policies need not improve every agent's welfare in the absence of redistribution. To achieve faster growth, less must be consumed in the aggregate: and the impact of growth-oriented policies on individual consumption levels depends on what portion of each agent's income is drawn from non-accumulated factors of production rather than from capital. The key insight is that none of the income accruing to factors of production in exogenously given supply is saved along a balanced growth path (Romer, 1990 notes a related point in the context of a model of trade policy and growth based on learning externalities). Individual agents' propensities to save then depend on how much of their income is drawn from accumulated factors of production, and policies which accelerate growth have distributional consequences.

If the consumption price of capital is not affected by policy, the economy's rate of steady growth is strictly related to factor shares and once-familiar links between income distribution, saving propensities, and growth rates (e.g. Kaldor 1957, Pasinetti 1962) turn out to be valid in a modern optimization-based framework of analysis. Policy measures which accelerate growth by reducing the income share of non-accumulated factors benefit owners of endogenously accumulated factors of production, or "capitalists," more than owners of factors in exogenously given supply, or "rentiers," whose welfare can easily be lowered by faster growth. By contrast, faster growth rates obtained by investment subsidies and consumption taxes are shown below to benefit rentiers more than capitalists.

The results have both normative and positive implications. When income sources are heterogeneous across agents, growth-oriented policies would need to be accompanied by redistributive measures for a Pareto improvement to materialize. Redistribution is seldom observed, however; when it is politically infeasible, observed growth rates may well depend on the relative strength of groups with contrasting interests and on the menu of policy instruments they are called to decide upon.

The rest of the paper is organized in seven short sections. Section 2 studies equilibrium growth in an economy where both (accumulated) "capital" and (non accumulated) "land" or "labor" are needed for production, and where saving and investment decisions are taken by optimizing agents in decentralized fashion. Section 3 notes that the aggregate relationships valid in such a framework imply a straightforward link between factor income shares and aggregate savings, and Section 4 abandons the representative-agent framework of macroeconomic growth models to study the welfare implications of growth for agents who own only non-accumulated factors of production. Section 5 notes that the distribution of income across factors is determined by market structure and institutions in suboptimal equilibria, and proceeds to discuss in some detail how political interactions may alter disposable-income shares and the speed of economic growth when agents differ in the composition of their income. Section 6 studies how the rate of investment subsidization may similarly depend on the degree of heterogeneity in individuals' income sources. Section 7 surveys possible sources of factor-income heterogeneity across individuals and their implications for the design of redistributive policies, and Section 8 concludes.

2. Growth and factor shares

This section outlines a simple model of endogenous growth, similar in spirit to (but less detailed than) those discussed in Romer (1986, 1988). Consider a closed economy in which two privately owned factors, K and L, are used to produce aggregate output Y_t according to

$$Y_t = K_t f(L), \quad f'(.) > 0. \tag{1}$$

The first derivative of $f(.)$ is assumed to be positive, and in this sense L is necessary as a factor of production, but the shape of $f(.)$ is not otherwise relevant to much of what follows because L is assumed to be in exogenously given supply (taken to be constant for simplicity) and fully employed. The factor of production denoted by K, conversely, is reproducible: its supply can be increased over time by foregoing consumption, so that

$$\dot{K}_t = Y_t - C_t \tag{2}$$

where C_t denotes aggregate consumption at time t. The price of K in terms of consumption goods is constant and, until Section 6 below, it will be normalized to unity, to imply that the stock of K equals the total excess of production over consumption over the infinite past.[1] For the purpose of this paper, the crucial difference between the two factors is simply the possibility of accumulating K, but not L, by foregoing consumption. The reproducible factor K will be referred to as *capital* in what follows. The notation L is conveniently ambiguous, and might refer to *land* as well as to *labor*, in that the supply of raw manpower is exogenous to economic interactions as long as population growth is not the result of investment decisions based on economic costs and benefits.[2] The same is not true of human capital, of course, and the endogenously accumulated factor K might correspond to education and knowledge as well as to physical capital.

By the technological relationship (1), the capital/output ratio is constant. This ensures that growth will be steady in the absence of parameter changes, simplifying the analysis, and yields roughly realistic implications in light of the evidence discussed by Romer (1988) and others. Linear returns to accumulation make it possible for consumption to grow endogenously forever at a nondecreasing rate. If a fraction $s > 0$ of the output flow is saved and added to the stock of capital, then

$$\dot{K}_t = sK_t f(L), \tag{3}$$

and aggregate income, consumption, and capital all grow at the same exponential rate $\vartheta = sf(L)$ if the aggregate propensity to save s is constant.

Let r_t denote the rental rate of L in terms of aggregate output and consumption at time t, and let γ denote the share of income accruing to L:

$$\gamma = \frac{r_t L}{Y_t}. \tag{4}$$

What follows characterizes the economy's dynamic equilibrium taking γ and r_t as given,

[1] It would be straightforward to allow for depreciation in the current K stock. Gross investment $Y_t - C_t$ should realistically be restricted to be positive, but the aggregate irreversibility constraint is not binding as long as the aggregate growth rate is positive or exceeds the depreciation rate of capital. Bertola (1990) studies a general equilibrium model in which idiosyncratic uncertainty makes for binding irreversibility constraints at the microeconomic level.

[2] It would be easy to let L grow exogenously over time. Also, finite lifetimes can be modeled in an endogenous growth context along Blanchard-Yaari lines: see StPaul (1990), Alogoskoufis and van der Ploeg (1990). Policy should then address issues of intergenerational as well as intragenerational redistribution.

postponing to Section 5 below a discussion of how these quantities may be determined by the microeconomic and political structure of the economy. The supply of L being constant, all intertemporal transfers of resources entail a variation in the supply of K at two points in time.[3] Let capital K be homogeneous, or let it be measured as a weighted sum of physical units if, as in the models of Grossman and Helpman (1991), more recent investment goods are more efficient and/or less expensive to produce. The consumption price of new capital being fixed at unity in equation (2), the interest rate on consumption loans π_t must equal the operating profit per unit of capital,

$$\pi_t = \frac{Y_t - r_t L}{K_t} = (1-\gamma)f(L) = f(L) - \frac{r_t}{K_t}L, \tag{5}$$

to prevent arbitrage between investment opportunities in loans, in existing capital goods, and in new capital goods.

To model savings in a way that is conducive to steady exponential growth, let the economy be populated by agents, indexed by i, who maximize identical objective functions in the form

$$U_0 \equiv \int_0^\infty e^{-\rho t}\,\frac{c_{it}^{1-\sigma} - 1}{1-\sigma}\,dt, \qquad \sigma > 0 \tag{6}$$

subject to appropriate budget constraints. Along any consumption path that maximizes (6) the proportional rate of change of marginal utility, $-\sigma \dot{c}_{it}/c_{it}$, equals the excess of the rate of time preference ρ over the private intertemporal rate of transformation π_t. Every agent's consumption then grows at the same rate and, in the aggregate,

$$\frac{\dot{C}_t}{C_t} = \frac{\pi_t - \rho}{\sigma} \tag{7}$$

for any cross-sectional distribution of consumption levels.

The model can now be closed imposing equality between aggregate savings and aggregate investment. Considering for simplicity the case of a constant capital accumulation rate ϑ, equations (3), (5), and (7) combined yield

$$\vartheta \equiv \frac{\dot{Y}_t}{Y_t} = \frac{\dot{K}_t}{K_t} = \frac{\dot{C}_t}{C_t} = \frac{(1-\gamma)f(L) - \rho}{\sigma} = \frac{f(L) - (r_0/K_0)L - \rho}{\sigma}. \tag{8}$$

Along a path of steady growth, the income share of profits is constant and the rent r_t grows, like output, capital, and consumption, at an exponential rate which is a (linearly) decreasing function of rents' income share.

[3] Output may be storable, but storage is dominated by productive use in a growing economy.

3. Old and new theories of income shares, savings, and growth

The simple analytics of the previous section establish a strict relation between the economy's growth and saving rate and the income shares of profits and rents. Combining (3) and (7), the aggregate saving rate s and the income share of rents γ satisfy

$$s = \frac{1}{\sigma}\left(1 - \gamma - \frac{\rho}{f(L)}\right). \tag{9}$$

This negative relationship between the income share of rents and the aggregate saving rate finds a simple explanation in the fact that *no rent income is saved* along the steady-growth path resulting from a constant capital/output ratio and a constant elasticity of intertemporal substitution. To see this, consider the consumption/saving choice of an agent who owns only a unit of L. In light of the Euler condition (7), maximization of (6) under to the budget constraint

$$\int_0^\infty e^{-\pi t} c_{it}\, dt \leq \int_0^\infty e^{-\pi t} r_t\, dt = \int_0^\infty e^{-(\pi-\vartheta)t} r_0\, dt$$

clearly implies $c_{it} = r_t$ for all t. A rentier never saves, and never becomes a capitalist. Conversely, the owner of one unit of K maximizes (6) under the constraint

$$\int_0^\infty e^{-\pi t} c_{jt}\, dt \leq 1:$$

at time zero, capitalist agent j receives income π, consumes $c_0 = (\pi - \vartheta)$, and saves $\pi - c_0 = \vartheta$ to sustain growth of wealth at rate ϑ.

The result depends crucially on the constancy of the economy's growth rate, and similar relationships would in fact hold true whenever income and consumption grow at the same rate and some agents receive a constant share of aggregate output; in particular, agents who happened to own only labor should never save in the steady state of an exogenously growing neoclassical economy. A constant rate of growth, however, follows immediately from the assumptions made above, which yield steady endogenous growth with no transitional dynamics. The endogenous-growth framework of analysis then turns out to be strikingly and perhaps surprisingly similar to that of the post-keynesian models of growth and income distribution by Kaldor (1956, 1957), Pasinetti (1962), and others. In contrast to neoclassical growth models of Solow (1956), most post-Keynesians took the capital/output ratio to be fixed as in equation (1) above and focused on links between investment and growth rates on one hand, income shares and saving propensities of "capitalists" and "workers" on the other. The simplest of those relationships was based on a zero propensity to save out of wage income, and the very same relation turns out to be valid in the optimizing framework of modern models of steady endogenous growth—*if* the non-reproducible factor L is identified with labor.

The link between savings, growth, and income distribution is more than superficially similar in the two literatures. In a modern growth model, however, Kaldorian saving propensities are endogenously derived rather than assumed, and the two approaches differ in many essential respects. First, it may or may not be appropriate to identify labor with the non-accumulated factor of endogenous growth models, and rents with wages. On the one hand, some portion of measured labor income is "profit" resulting from past investment decisions, as labor productivity is increased by education and human capital accumulation; on the other, the income share of natural resource owners and non-contestable monopolists is certainly part of that paid to L in the endogenous-growth context, while post-keynesian models do not separately account for it.

Second, the relationship between ϑ and γ is interpreted quite differently by the two approaches, with opposite directions of causality. Recent contributions aim to endogenize the rate of economic growth, which post-keynesian models viewed as a technologically given constant and, indeed, as the main determinant of factor income shares along a steady growth path.[4]

Third, and in consequence, income distribution and economic growth need to be *jointly* modeled in a modern framework of analysis, where explicitly optimizing behavioral assumptions make it possible to undertake a utility-based treatment of distributional issues on the one hand and, on the other, to study how an economy's politico-economic structure may explain its growth behavior. The next sections discuss these aspects in turn.

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[4] Following Harrod (1939) and Domar (1946), some post-keynesian contributions studied the off-steady state dynamics due to discrepancies between the rate of capital accumulation and the rate of population growth (or exogenous labor-augmenting progress). A modern theory of growth and fluctuations is not yet well developed.

4. Welfare and rents

As consumption grows exponentially at rate ϑ, the welfare measure (6) integrates to

$$U_0 = \frac{c_{i0}^{1-\sigma}}{(1-\sigma)(\rho-(1-\sigma)\vartheta)} - \frac{1}{\rho(1-\sigma)} \tag{10}$$

provided that $\rho > (1-\sigma)\vartheta$ (or to $U_0 = \ln(c_{i0})/\rho + \vartheta/\rho^2$, if $\sigma = 1$). In the aggregate, faster growth can be traded off against lower initial consumption according to

$$C_0 = (f(L) - \vartheta)\, K_0, \tag{11}$$

and maximization of (10) subject to (11) yields the representative individual's preferred growth rate

$$\vartheta^s \equiv \frac{f(L) - \rho}{\sigma}. \tag{12}$$

The superscript s for *social* refers to the fact that a social planner with access to lump-sum redistribution should set $\vartheta = \vartheta^s$, regardless of distributional preferences, to maximize the size of the economy's welfare "pie." While social planners will be ruled out of existence until Section 7 below, a comparison of (12) to (7) quite intuitively reveals that they should use $f(L)$, the aggregate rate of intertemporal transformation, as an interest rate. By (12) and (8), however, $\vartheta = \vartheta^s$ implies $r_t = 0$ for all t. In words, if investment is freely undertaken by optimizing private agents then non-accumulated factors of production must receive no remuneration at all for the economy to grow at the rate which maximizes the representative individual's welfare. To understand the result, consider that all prices relevant to decentralized decisions should reflect true social values for the economy to achieve a first-best equilibrium. When returns to capital accumulation are constant, as they must be if steady endogenous growth is possible, social optimality of private choices on the savings/consumption margin requires that all income be paid to capital, while the disappearance of rents has no allocational consequences if, as in the model above, the *only* private decisions are investment decisions. Since the income share of rents γ cannot be smaller than zero, equation (8) implies that the social planner's best choice ϑ^s is the maximum growth rate sustainable by undistorted private investment decisions.[6]

[6] Remuneration of non-accumulated factors may well have an allocational role in the microeconomic structure underlying the aggregate relationship (1); most straightforwardly, it would be desirable to bound γ strictly above zero (to imply a growth rate strictly smaller than ϑ) if L had a direct consumption value and could be withheld from productive use by its owners.

Less dramatic but qualitatively similar results would be valid in more general settings, for example ones in which growth were only approximately constant, or were disturbed by stochastic shocks to preferences and technology.

If the economy is not inhabited by identical individuals, the relationship between factor income shares and growth rates is relevant to income distribution across agents and to policy choices. The disappearance of rents is compensated by higher remuneration of capital and faster consumption growth for the representative individual, but not necessarily for individuals who own K and L in proportions different from the aggregate one. Before considering the general case in the next section, it is instructive to first examine briefly the welfare consequences of growth for *pure rentiers*, i.e. agents who own only (one unit of) the non-accumulated factor L and who, as noted in Section 3, never save along any path of balanced growth.

Rentiers have obvious reasons to oppose policies intended to bring about the representative individual's preferred factor-income shares, which would deprive them of all income and all consumption in the simple model under study. High rents, however, reduce the capitalists' incentives to invest and the rate of growth of the rentiers' own consumption, and rentiers (even though they never save and never own any capital) should realize that it is not in their interest to claim too large a share of aggregate income. Setting $c_{i0} = r_0$ in equation (10) and maximizing it under the constraint (8), the rentier's preferred growth rate is found to be

$$\vartheta^r \equiv \frac{f(L) - \rho(1+\sigma)}{\sigma^2}. \tag{13}$$

Using the transversality condition $\rho > (1-\sigma)\vartheta^s$, or

$$\rho > (1-\sigma) f(L), \tag{14}$$

it is straightforward to show that $\vartheta^r < \vartheta^s$. This is certainly not surprising in a model where a pure rentier should abstain from any consumption to let the economy grow at rate ϑ^s, but the mechanism behind the result is again more general than the model under study: as rentiers do not benefit from higher interest rates, their initial consumption level is reduced by more than the representative individual's in a faster-growth equilibrium, and similar effects would be present if an allocational role were recognized for compensation of non-accumulated factors of production, or if the growth rate were allowed to vary over time.

The preferred growth rate in (14) has an interesting interpretation in terms of savings rates and income shares. The income share of capital consistent with growth at rate ϑ^r is

$$1 - \gamma^r = \frac{f(L) - \rho}{\sigma f(L)}, \tag{15}$$

and equals the aggregate *saving* rate that would allow the economy to grow at rate ϑ^s.[7] Thus, the growth rate that maximizes the welfare of rentiers is lower than ϑ^s because part of the income accruing to capital is consumed rather than saved. Rentiers would be happy to let the economy grow at the higher rate preferred by the representative individual, but would want all the required savings to come out of profit income—a situation which, if L were identified with labor, would be reminiscent of the *socialist* growth path in Pasinetti (1962, section 8).

5. Markets, politics, and factor shares

Every (selfish) individual would of course like to appropriate all production and deprive others of consumption: in economic models, and in reality, such conflicts of interest are resolved through economic and political interactions. From this point of view, the distributional role of factor shares in an endogenous-growth framework has several features which would be absent in a static Edgeworth-box model of resource distribution. It is not surprising to find that capitalists would like to use L for free and deprive (pure) rentiers of all consumption; but it is interesting to note that zero rents would maximize the welfare of agents (like the representative individual) who own some non-reproducible factors of production, as well as that of capitalists. For a given growth rate, rentiers would also like to appropriate all production: as long as investment is driven by private saving decisions, however, they cannot do so without decreasing (to zero) the rate of growth of their own consumption. To deprive capitalists of all consumption and achieve maximum welfare while remaining pure rentiers, they would need to force all profits to be saved—as would perhaps happen in a "socialist" economy.

Most importantly, when growth is endogenous the conflict of interest between owners of reproducible and non-reproducible factors cannot be resolved by (Pareto-optimal) competitive interactions. If non-reproducible factors are (asymptotically) needed to produce

[7] Incidentally, this guarantees that (as long as the economy is capable of positive growth) rentiers would not want to reduce capital's income share to zero or below.

output, then an economy capable of endless growth in the absence of exogenous technological change must have increasing returns in production and cannot support complete competitive markets. Factor remunerations may be determined by competitive interactions with externalities as in Romer (1986); if the market for the non-reproducible factor is assumed to be competitive and suppliers of L are rewarded on the basis of their true social marginal productivity then, in the notation of this paper,

$$r_t = \frac{\partial Y}{\partial L} = K_t f'(L) \quad \text{and} \quad \gamma = \frac{r_t L}{Y_t} = \frac{L f'(L)}{f(L)} \tag{16}$$

in equilibrium.

In reality, however, product and (especially) factor markets are typically far from competitive, and excessive attention to competitive equilibrium may be unwarranted. In the models proposed by Romer (1987) and others equilibrium factor shares are derived from a combination of monopoly power in the output market and increasing returns in production; models with non-competitive factor markets could also be constructed, in which rents would not necessarily be such that (16) holds.[8] In general, many institutional features of the economy are relevant to income distribution, and many models of (imperfect) market equilibrium from Labor Economics and Industrial Organization could be used to establish links between an economy's institutional structure, factor rewards, and growth rates. If L is labor, for example, union activity may make it possible for workers to appropriate a larger income share than that in (16), perhaps because work rules would force employers to pay wages in excess of labor's marginal revenue product.

For a given (and necessarily imperfect and/or incomplete) structure of factor and product markets, policy measures can affect the rate of growth in potentially desirable ways (see e.g. Barro and Sala-i-Martin, 1990). What follows takes as given the income share of rents determined by market interactions, and studies how it might be altered by political interactions.[9] Many policy instruments can be used to alter the *after-tax* income shares of

[8] Only a constant γ is consistent with steady growth, of course. As is apparent from equation (16), constant-elasticity production and demand functions ensure that this is the case, and are generally adopted in the growth literature along with the constant-elasticity intertemporal objective function of equation (6). Jones and Manuelli (1990) propose a more complex production technology which on the one hand supports endogenous growth and complete competitive markets in the presence of non-accumulated factors, on the other does not yield a steady-growth equilibrium because, in the notation of this paper, $\{\gamma_t\}$ tends to zero asymptotically.

[9] Politico-economic determination of growth-oriented policies is the subject of a recent and

accumulated and non-accumulated factors. Different tax rates may be imposed on (say) capital and labor income to finance an exogenously given government expenditure path, or indeed revenue from one factor's income tax might be used to subsidize another factor directly. More subtly, the institutional structure of the economy itself should be treated as endogenous to the economy's politico-economic equilibrium, and anti-trust legislation, labor laws, real-estate regulations, etc. can obviously affect the functional distribution of income and the economy's rate of investment and growth.[10]

The remainder of this section studies political equilibrium under two maintained assumptions: first, that investment be driven by privately optimal saving decisions without direct policy interventions on the consumption/savings margin; second, that policy be limited to balanced-budget factor subsidies and taxes with no dead-weight loss distortions other than investment and saving effects. The first assumption constrains policy choices by the tradeoff between growth and rents in equation (8), ruling out the possibility of achieving growth via (public) investment at lower-than-market rates of return or via direct investment subsidies. The second assumption restricts policy choices to the after-tax income share of the two factors, and in particular rules out redistribution of the (given) initial factor endowments and any direct interventions on the *personal* distribution of income. Such a menu of policy choices is to some extent realistic for Western economies (especially less-developed ones), and the results have interesting positive implications. The next sections discuss how the assumptions might be relaxed and draw normative implications.

As the derivations of the previous section were based on privately optimal consumption/saving decision criteria, the income share of rents γ defined in equation (4) should be understood to refer to disposable income. Along any steady growth path where the consumption price of capital is unity and the profit or interest rate is $\pi = (1-\gamma)f(L)$, the rent rate is $r_0 = f(L)(1-\gamma)K_t/L$ at time zero and grows forever at rate $\vartheta = (\pi - \rho)/\sigma$. If $\bar{\gamma}$

rapidly growing literature: Persson and Tabellini (1990), Perotti (1990), and others propose models of voting equilibrium in growing economies where agents differ in terms of the size, not the source, of their income; Alesina and Rodrik (1991) propose a model in which functional income distribution plays an important role, and independently derive some of the results of this paper.

[10] In general, market structure and institutions will affect not only income distribution, but the allocational efficiency of the economy's microeconomic equilibrium as well. For example, Bertola (1990) shows that limits to the flexibility of labor reallocation in the face of idiosyncratic uncertainty affect on the income share of wages at the same time as they reduce the efficiency of labor allocation. In the notation used here, labor mobility costs may increase γ but certainly decrease $f(L)$.

denotes the pre-tax (or, more generally, pre-policy intervention) income share of rents, then a γ larger than $\bar{\gamma}$ indicates that fiscal policy and institutions privilege rental income over capital income, while $\gamma/\bar{\gamma}$ values close to zero will correspond to strongly growth-oriented, pro-capital regimes.

Let the economy be populated by individuals with identical objective functions in the form (6), which differ in the size and composition of the factor bundles they own. At time zero, let individual i own an amount K_i of the reproducible factor(s) of production as well as an amount L_i of non-accumulated factor(s), the economywide factor supplies K and L being the sum (or integral) of K_i and L_i over i. Solving the problem

$$\max_{c_{i\,0\ldots\infty}} \int_0^\infty e^{-\rho t}\, \frac{c_{it}^{1-\sigma}-1}{1-\sigma}\, dt \;\; \text{s.t.} \;\; \int_0^\infty e^{-\pi t}\, c_{it}\, dt \le L_i \int_0^\infty e^{-\pi t}\, r_o\, e^{\vartheta t}\, dt + K_i,$$

agent i chooses a consumption path that starts at

$$c_{i0} = (\pi - \vartheta)K_i + r_0 L_i \tag{17}$$

and grows indefinitely at rate ϑ. Equations (10) and (17) combined yield a measure of individual i's welfare for given γ; defining $k_i \equiv K_i/K$ and $l_i \equiv L_i/L$, the first order condition for maximization of the resulting expression with respect to γ under the constraint (8) can be rearranged to read

$$\gamma_i^* = \frac{f(L)(1-\sigma)-\rho}{f(L)}\, \frac{k_i - l_i}{(1-\sigma)k_i + \sigma l_i} \tag{18}$$

to imply, by (8), that individual i would like the economy to grow at the rate

$$\vartheta_i^* = \frac{\rho\, k_i + (f(L)-(1+\sigma)\rho)\, l_i/\sigma}{(1-\sigma)\, k_i + \sigma\, l_i}. \tag{19}$$

Equation (19) generalizes the results of the previous section, reducing to (12) when $k_i = l_i$ as is true for the representative individual, to (13) when $k_i = 0$ and i is a pure rentier. In general, the preferred growth rate in (19) increases in k_i and decreases in l_i. Agent i would prefer an even larger growth rate than ϑ^* if $k_{i0} > l_i$: but, since the corresponding γ_i^* would infeasibly lie outside of the $[0, 1]$ interval, every agent whose initial k/l ratio exceeds one agrees with the representative individual in preferring $\gamma = r_t = 0$, $\vartheta = \vartheta^*$ to positive rents and lower growth rates.

The preferred growth rate (19) depends on the proportion of capital income and rents in individuals' income. In steady growth, this proportion is kept constant over time by different propensities to save out of profit and rental income: as a fraction $(\pi - \vartheta)/\pi$ of capital income is saved, every individual's capital grows at rate ϑ, while rent income grows at the same rate and none of it is saved. Thus, growth-rate preferences do not endogenously change over time and, absent changes in the decision process, the politically determined after-tax income share of rents γ is stable. Expression (19), conversely, does *not* depend on the absolute size of an agent's income: on issues of capital-income taxation, rich agent i and poor agent j agree as long as $k_i/l_i = k_j/l_j$, no matter how much larger (k_i, l_i) is in comparison to (k_j, l_j). In this respect, the politics of functional income redistribution studied here and in Alesina and Rodrik (1991) are different from, and complementary to, those of the models proposed by Persson and Tabellini (1990) and Perotti (1990)—where the revenue from capital-income taxation is redistributed equally and in lump-sum fashion, to imply that poorer agents will vote for higher tax rates.[11]

How growth rate preferences might translate into policy choices depends, of course, on the policy instruments being decided upon and on the relative political weight of agents with different k_i/l_i ratios. The growth rate preference expressed in (19) is single-peaked since, by (10) and (17), every agent's welfare is concave in ϑ. Under the assumptions of this section, then, every individual will vote (or lobby) for policy measures intended to bring the factor shares and the economy's growth rate closer to those he or she prefers, and political interactions will lead to a large income share of rents and slow growth when reproducible-capital ownership is concentrated in the hands of individuals with little political power. In a democratic one-man-one-vote political system, the growth rate will be lower than ϑ^s whenever the k_i/l_i ratio is below one for 50% or more of the voters — its exact value being determined by (19) evaluated at the median voter's k_i and l_i — and will be lowest at ϑ^r when 50% or more of electorate owns no reproducible capital at all. If matters are not decided by one-man-one-vote elections, the model predicts that uneven political power should affect the economy's growth rate as long as the distribution of political weight across individuals is correlated with that of reproducible and non-reproducible factors of production. In this respect, it is interesting to note that in many historical instances (from feudal times to 19th century democracies) political representation was limited to owners of a non-accumulated factor of production, namely land.

[11] Tax revenues finance provision of public goods in some of the models proposed by Barro and Sala-i-Martin (1990) and Alesina and Rodrik (1991), with distributional implications similar to those of lump-sum redistribution as long as the public good is equally valued by all agents.

The sensitivity of preferred growth rates to differences in income sources depends in intuitive ways on the rate of time preference ρ and on the elasticity of intertemporal substitution σ, and ϑ_i^*'s range of variation is quite wide for realistic values of these parameters. In the logarithmic $\sigma = 1$ case, for example, $\vartheta^s - \vartheta^r = \rho$. Faster consumption growth does little to compensate rentiers for lower initial consumption when they are very impatient, and the difference between the extremes of the preferred growth rates range has the same order of magnitude as that of the individual rate of time preference (possibly adjusted for the probability of death in a Blanchard-Yaari overlapping generations model). Larger values of σ similarly sharpen the conflict of interest between capitalists and rentiers, as lower intertemporal elasticity of substitution makes the latter more reluctant to substitute future for immediate consumption.

In the intermediate range between pure rentiers and the representative individual, the preferred growth rate (19) of agents with mixed sources of income increases linearly in k_i/l_i, with slope ρ, if $\sigma = 1$; it is a convex (concave) function of relative factor incomes for larger (smaller) values of σ. Thus, small discrepancies between the median and average k_i/l_i ratios can dramatically affect the economy's growth rate if σ and/or ρ are large, as shown in Figure 1 where preferred growth rates from equation (19) are plotted against k_i/l_i. To highlight the role of intertemporal substitution in a range of realistic growth rates, the output/capital ratio $f(L)$ is set at $(1 + \sigma)\rho$ across economies with different values of σ: in every economy, then, the representative agent would like the aggregate growth rate to equal the rate of time preference ρ, set to 6% in the Figure, while a pure rentier would rather set the growth rate to zero.[12] If for example the median voter owns 20% less capital than the representative agent, and sits at 0.8 in the Figure, his or her political influence decreases the economy's growth rate below the maximum feasible by little more than a percentage point if $\sigma = 1$, by over four percentage points if $\sigma = 12$.[13]

With so large potential variation in growth rates, much is at stake in terms of welfare.

[12] It is easy to check that each of the economies under consideration satisfies the transversality condition (14). Also, capitalists are not deprived of all consumption even when rentiers are able to impose zero growth: capital's income share is positive and given by (15) but, as the interest rate equals the rate of time preference, a capitalist (like everybody else in the economy) does not find it worthwhile to save and invest.

[13] While steady growth and stable profit rates may be consistent with many (σ, ρ) pairs of (unobservable) preference parameters, Hall (1988) uses empirical evidence from data in which ϑ and π fluctuate over time to argue that $1/\sigma$ is close to zero in reality—to imply that the lower and more dramatic curves in Figure 1 may be the more relevant ones.

The three-dimensional boxes in Figure 2 show the welfare measure (10) for agents with different k_i/l_i ratios, across the range of possible growth rates ϑ implied by the parametric assumptions of Figure 1. For a given ϑ, welfare depends on the absolute size of K_i and L_i as well as on the k_i/l_i ratio. In the Figure, K_i and L_i are chosen so as to equalize (at one) the maximum welfare attainable by agents with different capital income/rental income mixes.[14] The welfare effects of different growth rates are large even when, as in the Figure, the K_i/L_i ratio is never smaller than 60% of the representative individual's. Quite intuitively, the welfare consequences of growth are more dramatic for larger values of σ, reflecting scarcer inclination to substitute future for present consumption.

6. Investment subsidies

The politico-economic model above predicts that economic growth should be slower, for a given capital/output ratio, when agents or groups of agents who own little or no capital have enough political power to sustain an "immobilist" institutional environment and capture a large share of output. This may help explain differences in the growth performance of economies with access to similar technologies. For example, different degrees of social homogeneity among the settlers of North and South America might have allowed faster growth in the former, where "representative" individuals formed a majority, than in the latter, where landowners and peasant-laborers dominated the political arena.

For a given output/capital ratio $f(L)$, the after-tax income share of rents γ univocally determines the profit accruing to each unit of capital in output terms. What matters for private investment decisions, however, is the *ratio* of profits to the output price of capital. The denominator as well as the numerator of this ratio may be affected by growth oriented policies, at least in economies where a well-developed fiscal technology makes it possible to distort private incentives towards faster growth via indirect taxes and investment subsidies; in fact, Barro and Sala-i-Martin (1990) suggest that investment subsidies financed by taxation of labor income might be the best way to bring around faster growth as long as labor, like L in this paper, is assumed to be fully employed and inelastically supplied. Since in balanced-growth equilibrium all investment is financed by savings out of profit

[14] By (10), (17), and (19), the maximum achievable welfare is monotonically increasing in L_i for given k_i/l_i. For every k_i/l_i value, the program that draws Figure 2 chooses L_i so as to equate (10) to one when ϑ equals the welfare-maximizing expression in (19). An analytical solution is available if $\sigma = 1$, and other cases are handled by a simple numerical routine.

income, however, investment subsidies have distributional implications if different agents' income is drawn from accumulated and non-accumulated factors in different proportions.

To explore such issues, let the output prices of consumption and capital (normalized to unity in the above analysis) be denoted p_c and p_k, respectively. The rate of interest in terms of output that prevents arbitrage between investment in new and existing capital goods is

$$\pi = \frac{Y_t - r_t L}{p_k K_t} = \frac{(1-\gamma)f(L)}{p_k},$$

and coincides with the interest rate on consumption loans if p_c is constant over time. The optimality condition (7) then implies that, along a path of steady exponential growth, output, capital, consumption, and rents all grow at rate

$$\vartheta = \frac{(1-\gamma)f(L)/p_k - \rho}{\sigma}, \tag{20}$$

and the budget constraint appropriate for an agent who owns K_i and L_i units of the two factors of production implies an initial consumption level

$$c_{i0} = \left(\left((1-\gamma)f(L) - \vartheta p_k\right)K_i + r_0 L_i\right)\frac{1}{p_c}. \tag{21}$$

Insertion of (20) and (21) in equation (10) above yields a measure of individual i's welfare in terms of γ, $f(L)$, p_c, and p_k, making it possible to evaluate the welfare effects of changes in parameters other than γ. Consider first the role of each parameter in isolation. A higher output/capital ratio $f(L)$ would increase both the rate of growth and the initial level of every agent's consumption, while a lower output price of consumption p_c would leave growth unchanged and increase initial consumption. Thus, any policy measure capable of bringing about such parameter changes by enhancing the economy's static efficiency would be preferred to the status quo by all agents.[15] Different capital prices, conversely, need not affect every agent's welfare in the same direction. Inserting (20) in (21), and recalling that $r_0 = \gamma f(L)K/L$ for K the aggregate stock of capital at time zero,

$$c_{i0} = K\left[\left((1-\gamma)f(L)\frac{\sigma-1}{\sigma} + \frac{\rho}{\sigma}p_k\right)\frac{K_i}{K} + \gamma f(L)\frac{L_i}{L}\right]\frac{1}{p_c}. \tag{22}$$

Hence, a lower p_k yields faster growth by equation (20), but a pure capitalist's (and the representative agent's) initial consumption level is *lower* if p_k decreases. By revealed

[15] In realistic settings, however, increased efficiency generally implies different factor shares in equilibrium, as pointed out in footnote 10 above.

preference, faster consumption growth more than offsets the welfare effect of lower initial consumption in a first-best equilibrium: a smaller p_k would make faster growth possible even for an unchanged initial consumption level, and the social planner willingly chooses an even higher growth rate. The growth effects of a lower p_k, however, are smaller in a distorted equilibrium with $\gamma > 0$, and capitalists (who bear the burden of faster investment) may well suffer in welfare terms from a higher saving rate. The result can be interpreted from a different and perhaps more intuitive perspective: a lower price of capital decreases the consumption value of a pure capitalist's wealth, while the resulting increase in growth rates tends to yield a higher present discounted value for a pure rentier's future income and consumption stream.

Consider then the distributional consequences of indirect-taxation policies aimed at increasing the rate of investment. Normalizing to one the laissez-faire relative price of output, consumption, and capital, growth will be faster if p_k is lowered by investment subsidies. Given the income share of rents γ, growth will proceed at the socially optimal rate if $p_k = 1 - \gamma$ (and, unlike the case in which γ is the policy instrument of choice, might be further accelerated by even lower investment prices). The distributional effects of investment subsidies depend on the way in which they are financed. Taxation of capital income would of course defeat the purpose of enhancing growth, while taxation of rental income would effectively shift the burden of faster investment rate from the capitalists' to the rentiers' consumption levels. The welfare effects of investment subsidies financed by consumption taxes are less obvious since, by the argument given above, a higher consumption price decreases every agent's welfare. If subsidy and tax rates are constant and chosen so as to have no effect on the government's budget, then

$$p_c = \frac{f(L) - p_k\vartheta}{f(L) - \vartheta} \tag{23}$$

in a balanced-growth path along which ϑK_t units of output are invested and $(f(L) - \vartheta)K_t$ are consumed at each time t. Using (20) and (23) in (21) and defining $k_i = K_i/K_t$ and $l_i = L_i/L$, individual i's initial consumption level may be written as a function of the growth rate ϑ obtained via investment subsidies and consumption taxes:

$$c_{i0} = \big(f(L) - \vartheta\big)K_t\Big(k_i + \gamma A(\vartheta)(l_i - k_i)\Big), \quad \text{where} \quad A(\vartheta) \equiv \frac{\rho + \sigma\vartheta}{\rho + \sigma\vartheta - (1-\gamma)\vartheta}. \tag{24}$$

If individual i is representative ($k_i = l_i$), or if $\gamma = 0$, the tradeoff (24) between the level and growth rate of consumption coincides with that for society as a whole in equation (11).

But in the general $0 < \gamma < 1$ case, noting that $A(\vartheta) > 0$ by the transversality condition (14) and that

$$A'(\vartheta) = \frac{(1-\gamma)\rho}{(\gamma\vartheta + \rho + (\sigma - 1)\vartheta)^2} > 0,$$

faster growth rates obtained by consumption taxes and investment subsidies are more expensive, in terms of initial consumption, for individuals whose k_i is larger relative to l_i.

Thus, individual who draw a higher-than-average proportion of their income from accumulated factors will prefer higher capital prices than $(1-\gamma)$, and lower growth rates than ϑ^s. Inserting (24) in the welfare measure (10) and optimizing with respect to ϑ it is possible to compute the growth rate implied by individual i's preferred rate of investment subsidization; no closed-form solution is available, but numerical solutions of the problem's first-order conditions are plotted against k_i/l_i in Figure 3, making the same parametric assumptions as in Figure 1 and taking $\gamma = 0.5$.

The range of k_i/l_i values considered in panel 3a is the same as that in Figure 1; it is apparent that the difference between the social planner's preferred growth rate and those of capital-poor agents are much less dramatic when growth is enhanced subsidizing investment rather than manipulating after-tax income shares. But very large discrepancies between preferred growth rates emerge in Figure 3b, which considers the other end of the relative factor incomes range: agents who draw most of their income from accumulated factors dislike fast growth when achieved by investment subsidies and consumption taxes. In particular, their preferred growth rate is much lower than ϑ^s if σ is small and, by (22), smaller p_k values imply sharply lower initial consumption levels. Thus, the weight of "capitalists" and "rentiers" in an economy has sharply different implications for the extent of political support for different growth-enhancing policy instruments; in general, growth will be slower if policy concentrates on factor shares than if it acts on the relative price of consumption and investment, as it might when a well-developed fiscal structure makes it possible to target investment objectives with indirect taxation.

Of course, investment subsidies should be used together with differential tax treatments for "profit" and "rent" income when both policy instruments are available. With $p_k \neq 1$, the same steps that led to the expression in (18) yield

$$\gamma_i^* = \frac{f(L)(1-\sigma) - p_k\rho}{f(L)} \frac{k_i - l_i}{(1-\sigma)k_i + \sigma l_i} \tag{25}$$

as individual i's welfare-maximizing income share of rents. This expression can be combined with (24) and (10) to set up an optimization problem in which both p_k and γ are decision variables; numerical solutions for the problem's first order conditions are displayed in Figure 4 as functions of k_i/l_i. Agents who draw more income from capital than the economy as a whole (i.e. those with $k_i > l_i$) enjoy maximum welfare when $\gamma = 0$ and investment is *not* subsidized ($p_k = 1$). Conversely, capital-poor agents prefer a large income share for rents, and would like to offset the negative growth effects of a large γ with intensive subsidization of investment.

The implications of Figure 4 for political equilibrium are as straightforward as those of Figures 1 and 3. Voters' preferences are single-peaked in p_k, γ space, and differ only because of different relative weights of profits and rents in their income. Among all possible policy packages involving investment subsidies as well as intervention on factor-income shares, therefore, the political winner will be the one preferred by the median voter in k_i/l_i terms. It is apparent from Figure 4 that, regardless of the relative weight of "profits" and "rents" in the swing voter's income, the growth rate is unlikely to differ from the representative individual's by more than one or two percentage points in the resulting politico-economic equilibrium. Hence, factor-income distribution may have an important role in determining observed growth rates in the early stages of economic development, when sophisticated fiscal instruments are not available; but results of this type, emphasized in the analysis above and in Alesina and Rodrik (1991), essentially disappear when investment subsidies are allowed for. Further, all preferred growth rates lie above the socially optimal rate ϑ^s (6% in Figure 4), only coinciding with it when the median voter is as capital-rich as (or richer than) the average individual in the economy. Interestingly, and somewhat ironically, the model predicts that in the absence of (lump-sum) redistribution an economy will tend to grow *too fast* when political attention is focused on the investment-enhancing policies suggested by the recent literature on endogenous growth at suboptimal rates.

Even though the growth rate is only marginally affected by factor-income distribution in the politico-economic equilibrium under consideration, growth-oriented policy interventions have large effects on the relative welfare level of agents with income from different sources. Manipulation of investment subsidies would allow a capital-poor swing voter to appropriate much of a capitalists' share of a welfare "pie" only slightly smaller than the one from the first-best equilibrium, while a majority of capital-rich agents might be able to deprive pure rentiers of all consumption in the political equilibrium of Figure 4 as well as in that of Figure 1. When income sources across individuals are heterogeneous, then, the welfare effects of different policy packages which yield similar growth rates are in the same order of magnitude as those illustrated in Figure 2 across different equilibrium growth rates—to imply fierce political struggles over the design of growth-oriented policies, and an urgent need to compensate their distributional effects by lump-sum instruments. The next section considers these aspects.

7. Distribution and redistribution of factor incomes

Some dispersion of income sources across individuals is undoubtedly realistic, and the results above indicate that it may have important effects on an economy's equilibrium growth rate. The model, however, does not explain how such dispersion might arise and, as the zero propensity to save out of rental income tends to perpetuate any initial distribution across agents of the capital income/rental income ratio, gives no indication as to the evolution over time of factor-income heterogeneity. Several exogenous (to the model) sources of dispersion in k_i/l_i ratios can be imagined. The preference parameters σ and ρ were assumed constant across agents as well as over time in the previous sections, but of course this approximates a more complex reality of different and variable propensities to substitute future for present consumption. And the distinction between "reproducible" and "exogenously given" factors of production is blurred enough that it may itself be subject to change over time. Owners of land may become "capitalists" when fertilizers and machinery make it possible to effectively increase the supply of agricultural land through investment, and laborers may similarly start earning "profits" rather than "rents" when the changing nature of jobs allows their productivity to be increased by training and education. Together with purely technological changes in the capital/output ratio $f(L)$ and in light of equation (8), such changes in the functional distribution of income across agents, and their effect on γ and possibly p_k via political interactions, might explain much of the variation of growth rates across economies and over time.

It is perhaps equally interesting, however, to explore ways in which the factor composition of income across agents might be *endogenous* to the politico-economic structure of the economy. Growth at rate ϑ^s is Pareto-optimal and, given the large welfare effects illustrated in Figure 2, it should be possible to devise a technically feasible and politically acceptable way to implement growth-enhancing policies in economies where "representative" agents do not form a majority and, in fact, to obtain unanimous support for such policies (provided of course that the structure of the economy's problem, and especially the endogenous nature of its economic growth, are rationally understood by all parties to the decision process).

The personal distribution of capital and rental income might indeed change, quite simply, if agents sell and buy K and L to each other: the factor composition of income is a matter of indifference if such transactions occur at market prices, and those who own proportionately more capital than the economy as a whole might realize that it is in their best interest to make income sources as homogeneous as possible across agents, building political support for growth-enhancing policies. It might be impossible to exchange K for L at any price, however. The algebra in Section 2 was carried out as if all agents could access a perfect financial market but, as nobody ever lends or borrows against rental income, the economy's growth equilibrium derived above also obtains when L is not tradable on the financial market—and this is one more reason why it might be appropriate to identify at least some types of labor with L. Further, even when the politico-economic mechanism of the previous section is well understood and it is possible to trade K for L atomistic agents need not choose to do so order to change the existing political equilibrium: individuals cannot hope to build majority support for pro-growth policies by diversifying their wealth as long as it is an insignificant fraction of the economy's.

When an economy is stuck in an immobilist political equilibrium, then, public policy or other forms of coordination are needed for potential growth to materialize. By Pareto-optimality, of course, many policy packages based on lump-sum redistribution could sustain growth at rate ϑ^s and win unanimous support. If the policy instrument of choice is the income share of rents, as in Section 5, owners of L could be expropriated and compensated with subsidies equal to (or larger than) their status-quo rental income stream. The subsidies could then be financed on an ongoing basis by lump-sum taxation on status-quo owners of capital, who could more than afford to pay such taxes out of their increased profit income.

To implement this policy, however, it would be necessary to ascertain every agent's initial income sources, and to compute lump-sum subsidies and taxes specific to every *individual*: any attempt to finance redistribution by capital-income taxes would defeat the purpose of enhancing growth. An equivalent and much more easily implemented compensation package would simply redistribute a portion of the initial stock of reproducible factors of production. If a one-time proportional levy were imposed on capital and the proceeds were paid out to agents in proportion to their stock of non-accumulated factors of production, it would ex-post be possible to obtain unanimous support for a reduction *to zero* of rent rates, with L becoming a public factor of production.[16]

The policy as a whole would be unanimously preferred to the status quo if the tax rate and the proportional payoff to rentiers were chosen so as to make every agent better off. It is possible, in fact, to choose among a variety of Pareto-preferred capital-levy rates: the lowest would leave pure rentiers (or the most capital-poor agents) as well off as in the status quo, while the highest would leave welfare unchanged for pure capitalists (or for the agents with the most capital-intensive income sources). The corresponding range of welfare levels is very wide when the status-quo growth rate is low and the initial factor distribution is very unequal, and the political struggle over the design of these policies might be so fierce, in reality, to prevent adoption of any of them. Moreover, redistribution of K may conflict with microeconomic efficiency when the concentration of capital ownership is due, for example, to differences in individuals' saving propensities or to an underdeveloped financial market. Still, profit-sharing schemes and Mrs.Thatcher's measures tending to diffusion of stock ownership might perhaps be interpreted along these lines.

8. Concluding comments

This paper's simple framework of analysis and its equally simple results are qualitatively consistent with a large and growing class of endogenous-growth models. In general, any growth-oriented policy package, including those based on investment subsidies, has redistributive effects when agents' income consists of "profits" (from accumulated factors) and "rents" (from non-accumulated ones) in different proportions, because no rent income is saved in a *laissez-faire* equilibrium where steady growth is driven by privately optimal investment decisions. Policy interventions which redistribute income from non-accumulated to accumulated factors of production have positive effects on growth, and alter the relative welfare of agents who own the two types of factors in different proportions. The extent of support for such policy measures depends on the economy's social structure and political institutions, which may help explain the different growth behavior of economies with access

16 Alternatively, some portion of the initial capital stock could be taken over by a public body which would reinvest a constant proportion of its profits and distribute the rest to former rentiers, thus enacting a (partial) "socialist" state. Other government-investment policies could also be designed, and it is worth noticing that, if the growth of the public capital stock were partly financed by (consumption) taxes, public investment could earn below-market return rates along a Pareto-preferred growth path.

to similar technologies.

The skeleton model above and its implications will need to be fleshed out in further work. In principle, the model's stark predictions could be verified empirically: fast rates of economic growth should be accompanied by large after-tax income shares of reproducible factors of production, and the effect of fiscal policy (and institutions) on that income share should be negative when owners of non-accumulated factors of production enjoy preponderant political weight. The relevant data, however, are not readily available. The political clout of "immobilist" factions can probably only be evaluated qualitatively, and the disaggregation of income relevant for this paper's purposes does not necessarily correspond to that between labor and capital income in national accounts. Clearly, not all labor (and not even all land) is exogenous to investment and saving decisions, as much "labor" income accrues to human capital, at least in industrial economies, rather than to raw manpower. Conversely, not all capital (even excluding land) is reproducible: in particular, the profits deriving from natural, non-contestable monopoly positions should not have any effect on saving propensities and growth rates.[17]

For normative as well as empirical applications of the model, it will of course be important to understand which factors are and which are not accumulated, in reality, via rational decisions to reduce consumption. It would perhaps be most important, however, to recognize that income share, interest rate, and growth rate realizations are not constant over time. Allowing for exogenous stochastic shifts in income distribution, and for shocks to tastes and technology, would not only open the way to meaningful empirical work but also equip the model to interpret cyclical dynamics and productivity "slowdowns" at a theoretical level. In general, of course, rentiers *would* save if their income share were not constant over time: and technological or political events leading to a declining income share of non-accumulated factors might, inducing high saving rates for rentiers and for the economy as a whole, provide a powerful stimulus for economic takeoff in a backward economy.

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[17] Persson and Tabellini (1990) and Alesina and Rodrik (1991) find empirical support for a stable relationship between growth and the *personal* distribution of income and wealth, with more unequal distributions causing slower growth. This evidence, though not directly relevant to the model, may be interpreted in light of the results of this paper because most of the variability in the personal income distribution (across time and space) appears explained by variations in factor rewards rather than by variations in individuals' factor bundles (Lindert and Williamson 1985, page 348).

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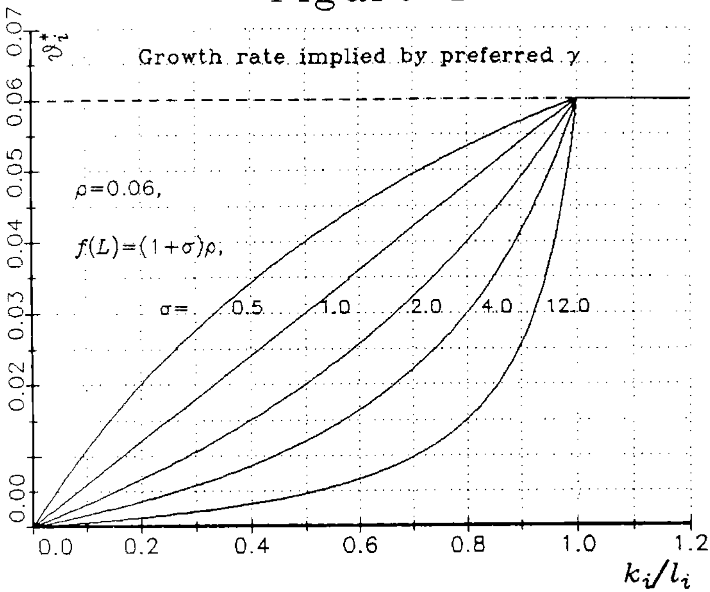
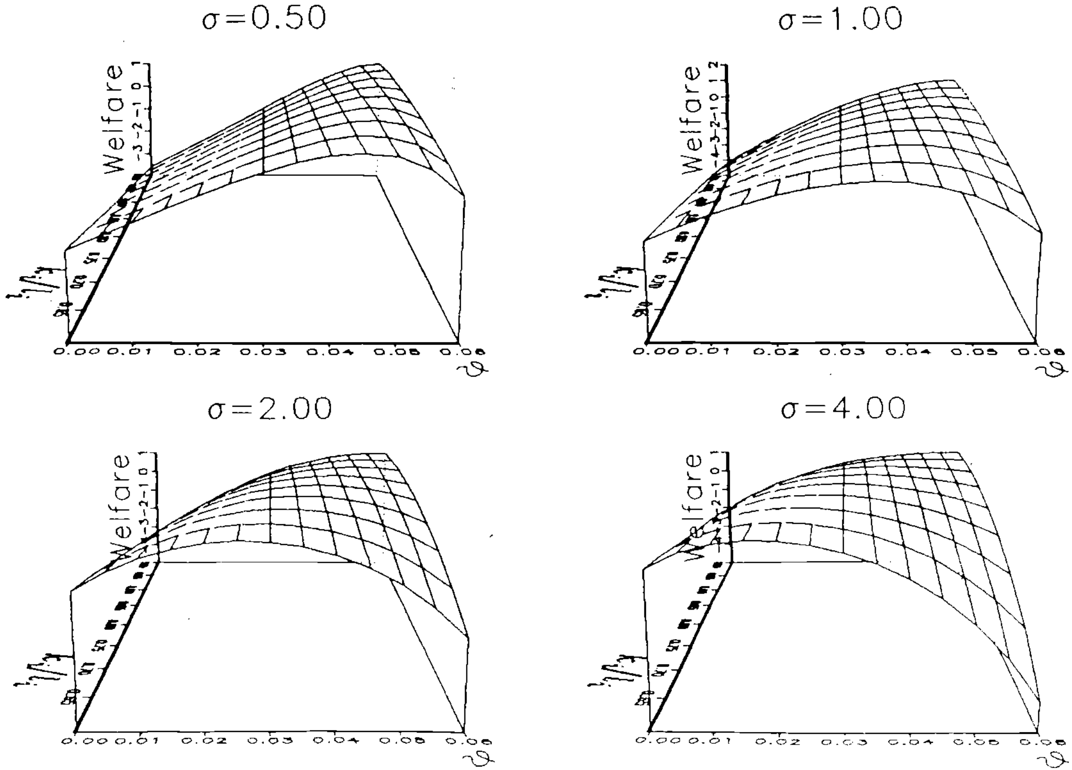
Figure 1



Growth rate implied by preferred γ
ϑ_i^*
$\rho=0.06$,
$f(L)=(1+\sigma)\rho$,
$\sigma=$ 0.5 1.0 2.0 4.0 12.0
0.00
0.02
0.03
0.04
0.05
0.06
0.07
0.0
0.2
0.4
0.6
0.8
1.0
1.2
k_i/l_i

Figure 2



σ=0.50
σ=1.00
σ=2.00
σ=4.00
Welfare
Welfare
Welfare
Welfare
0.00 0.01 0.02 0.03 0.04 0.05 0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06

Figure 3a

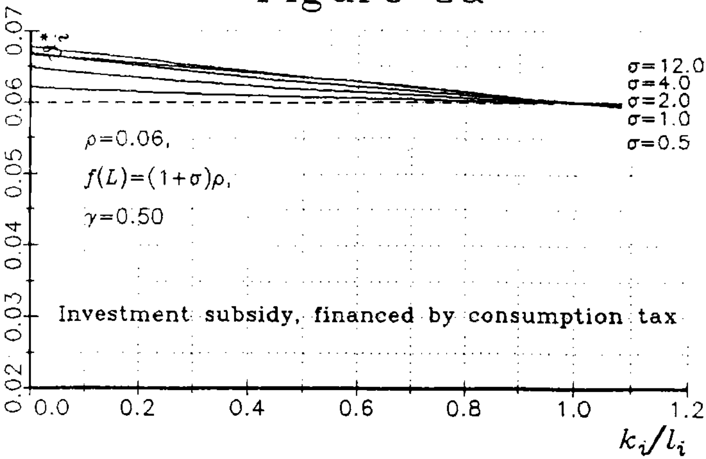


Figure 3b

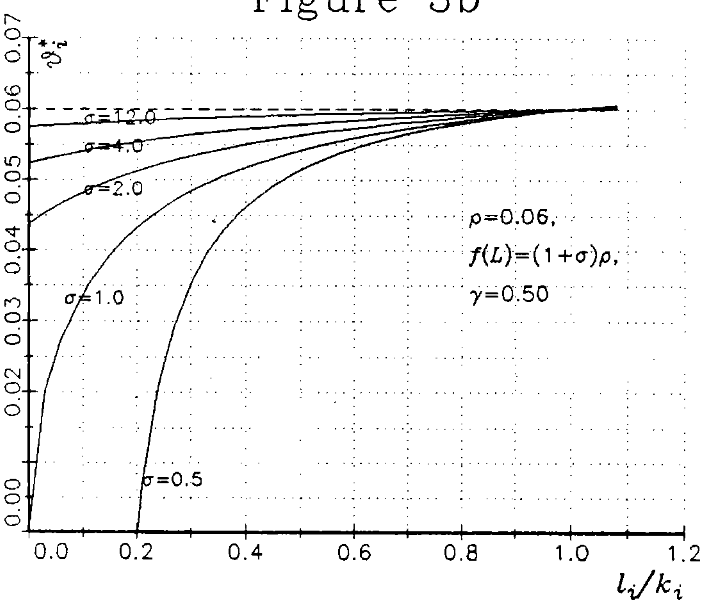
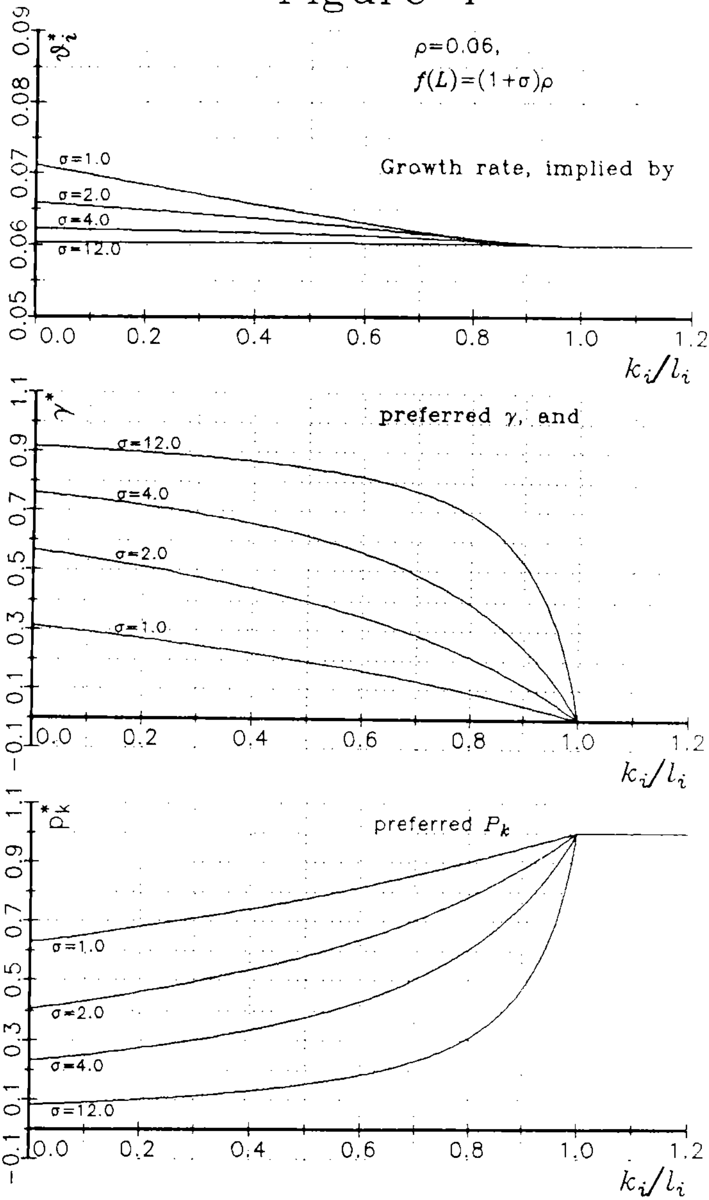


Figure 4



ρ=0.06,
f(L)=(1+σ)ρ
Growth rate, implied by
preferred γ, and
preferred P_k
σ=1.0
σ=2.0
σ=4.0
σ=12.0
k_i/l_i