A Rational Theory of Income Inequality and the Size of Government in A Dynamic Model of Kuznets' Hypothesis

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In his presidential address to the American Economic Association and in subsequent writings, Simon Kuznets (1955, 1966, 1979) suggested that the relation of economic development to income inequality is an inverted U. In the early stages of economic development, inequality increases. As growth proceeds, the spread of the distribution slows, stops and, finally, reverses in the late stages of development.

Kuznets offered the hypothesis tentatively and with many qualifications. Initially, he relied on the scanty empirical evidence available to him from U.S., British and Swedish data. (Kuznets 1955). Later, Kuznets, (1966, Ch. 4) obtained data for other European countries to bring the total number of countries to nine, of which five went back to the 19th century. He summarized the principal findings as showing that the share of upper income groups declined, particularly after World War II.

The main source of growth, Kuznets said, is "exploitation of the transnational stock of useful knowledge" (1966, p. 358) or human capital in current terminology. The accumulation and application of knowledge raises aggregate output. The distribution of the gain over the population depends on family size, age and sex of the family head (1979, p. 280), on the position of the family into which one is born (1966, p. 206), and other factors. Of these other factors, the role of government is of particular interest here. Kuznets suggested that income transfers and progressive taxation widen the before

tax income distribution. His reasoning is that these benefits encourage the acceptance of lower wages by those who work (1966, pp. 196-7).

Empirical studies of the relation of growth to income distribution have produced mixed results. Studies or summaries by Paukert (1973), Ahluwalia (1976) and Campano and Salvatore (1988) generally supported the hypothesis. Studies by Saith (1983), Papanek and Kyn (1986) and by Ram (1988) are less favorable or cast doubt on the hypothesis. Perotti (1990) finds more support in cross-section studies than in time series. Williamson (1985) suggests that the failure of the hypothesis to explain the time series data reflects the omission of other factors affecting the growth and the distribution of income such as immigration and, following Kuznets, we would add taxes and redistribution.

The Meltzer-Richard (1981) hypothesis and its extensions in Meltzer, Cukierman, and Richard (1991) relate some of the principal factors Kuznets mentions – the level of income, tax rates, government spending for redistribution – to the distribution of income. The basic model is static. In this paper, we introduce growth by allowing for investment in education and increases in the stock of knowledge, the factor that Kuznets emphasized and that has been central to recent analyses of growth.

Our study is related to recent work by Perotti (1990), Persson and Tabellini (1991), and Alesina and Rodrick (1990). Each of these papers considers some aspect of the relation between growth, income or wealth, and redistribution. In Perotti's analysis, there are three discrete income classes. Economic growth increases taxes and redistribution, thereby providing an externality that allows the lowest income class to benefit from the investments in human capital by the upper income groups. Tax rates and redistribution are set by majority rule, and tax increases discourage investment in human capital. Kuznets' propositions depend on the size of the differences in income between groups. If the differences between groups are relatively large, the disincentive effects of taxes dominate the positive effects of growth on redistribution.

Persson and Tabellini use an overlapping generations model to study the relation of income distribution to the growth rate of income, rather than the level as in Kuznets' hypothesis. Everyone saves at the same rate; individuals with more skill and income invest more per period. Individual investment in education does not directly change the distribution of income. Majority rule redistributes income and, therefore, lowers the growth rate. The authors' model implies, and their tests suggest, that inequality lowers the growth rate.

We also use an overlapping generations model, but we study the effects of the level of income or productivity on the distribution of income as the level of income changes. Productivity (or human capital) is a continuous variable. As in Perotti (1990) there is an externality, but the externality arises here directly from the effects of education on average productivity; individual

investment in education increases both individual and average productivity. Both the level and distribution of income change. Voters respond to these changes by setting tax rates to provide redistribution in the second period of life. These political decisions affect incentives thereby changing the level of income and the distribution of income before and after taxes. Since both generations pay taxes, voters' decisions cause both intragenerational and intergenerational redistribution.

Section 1 presents the model of an economy with overlapping generations and investment in education. Section 2 considers the effect of government taxes and transfers. In Section 3, we extend the results in Meltzer and Richard (1981) to a growing economy. The median voter determines the tax rate and amount of redistribution that maximizes his utility and sustains the equilibrium. This section also presents some evidence on the relation of income to income distribution and the equilibrium tax rate. A conclusion summarizes our results.

The Model and Its Implications

The model we develop has two periods with equal numbers of people living in each period. Each person inherits an endowment of human capital from his family. Endowments differ across individuals, so productivity differs across individuals in each generation. Human capital is strictly positive for everyone.

Each period consists of a unit of time. In the first period, individuals allocate time between labor and investment in human capital. Investment increases second period productivity. In the second period, allocation of time is between labor and leisure.

A government collects taxes on the earnings of both generations to finance lump sum benefits paid to the old generation. At any time the tax rate is a constant independent of income, so tax collections are proportional to income. The lump sum benefit makes net redistribution progressive; upper income earners make a net payment to government, and lower income earners receive a net transfer. The tax rate and the amount redistributed are set by majority rule one period ahead.

All consumers have the same preference function, represented by a Stone-Geary utility function, shown as equation (1). We use the subscripts $t-1$ and t to denote the two periods that an individual lives, and the symbols c and ℓ for consumption and leisure.

$$u(c_{t-1}^i, c_t^i, \ell_t^i) = ln(c_{t-1}^i + \theta) + \beta[ln(c_t^i + \gamma) + \alpha ln(\ell_t^i + \lambda)] \qquad (1)$$

where $\theta, \gamma, \lambda, \alpha$ and β are positive constants; β, the consumer's time discount factor, is less than one. Both consumption and leisure are assumed to be

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normal goods.

Let h_{t-1}^i be the individual's inherited endowment of human capital. This endowment yields a flow proportional to the stock and is measured in units of productivity or output. n_{t-1}^i is the fraction of time spent at work in the first period, so that $n_{t-1}^i h_{t-1}^i$ is the ith individual's earned income in the first period, and $n_t^i h_t^i$ is his second period earned income. For the community, earned income is the value of output in period t produced by the current young and old generation. It is obtained by aggregating the productivity weighted time spent at work over workers in both generations and summing the two generations.

The consumer's budget constraints are

$$c_{t-1}^i = (1 - \tau_{t-1})n_{t-1}^i h_{t-1}^i \tag{2}$$

$$c_t^i = (1 - \tau_t^{t-1})n_t^i h_t^i + r_t \tag{2a}$$

$$\ell_t^i = 1 - n_t^i \tag{2b}$$

where $1 - n_{t-1}^i$ is the time allocated to schooling, r_t is the amount of income redistributed, and τ_{t-1} and τ_t^{t-1} are the income tax rates. Tax rates are set each period for the next period before allocation decisions are made; τ_{t-1} is the tax rate applicable to income earned by young and old in $t - 1$, and τ_t^{t-1} is the tax rate for period t set in period $t - 1$ by the current young and old generations. τ_{t-1} was set in the previous period, so it is predetermined.[1] Consumers take tax rates and government spending as given when making consumption, investment (or training) and leisure decisions. The tax rate is always less than 100%.

Following Uzawa (1965), Rosen (1976) and Lucas (1988), time devoted to human capital accumulation depends on an individual's inherited human capital and on society's average level of human capital, $\bar{h}_{t-1}$.

$$h_t^i = h_{t-1}^i + \delta(1 - n_{t-1}^i)\bar{h}_{t-1} \tag{3}$$

where δ denotes the effectiveness of human capital accumulation. As in Kuznets (1966), growth depends on the (transnational) stock of human knowledge.

Each person's human capital, and thus his productivity, changes directly with his own investment $(1 - n_{t-1}^i)$ and the general level of human capital or education. An increase in society's average educational attainment helps everyone to learn.

However, the productivity growth rate for the ith individual

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[1]We assume that redistribution to start this system occurred long ago.

$$\frac{h_t^i - h_{t-1}^i}{h_{t-1}^i} = \delta(1 - n_{t-1}^i)\frac{\bar{h}_{t-1}}{h_{t-1}^i}$$

varies inversely with his initial endowment. For the same time spent on education, the productivity growth rate is lower for a person with a relatively large endowment. If individuals in all income groups allocate the same amount of time to education, the distributions of productivity and income narrow; incomes move toward equality.

Actual time spent on education is a personal choice. In general the choice differs across the income distribution and depends on tax rates, transfer payments and the individual's productivity and, thus, on inherited human wealth. Since individual productivity and income differ, the opportunity cost of education differs. The higher one's income, the higher is the value of time devoted to education. The return to education may differ also. If there are diminishing returns to individual investment in education, individual returns decline as income rises. For these reasons, the distribution of income may change, as Kuznets suggested, toward greater equality as the community's income increases.

Returns to individual investment in education may work in the opposite direction, however. The return to time spent increasing skill and knowledge may increase with the size of the initial endowment, h_{t-1}^i. Increasing returns to investment in education work to widen the spread of the distribution of income.

In addition to the private effects there are spillover effects from individual investment, represented by $\bar{h}_{t-1}$, the community's average productivity level, and from the effects of taxes and income redistribution. These government policy decisions modify the changes in income distribution just noted. As Kuznets (1966) suggested, the before tax income distribution will reflect the effects of (distortionary) taxes and transfers. Welfare payments, or in our analysis retirement benefits, encourage leisure. Tax rates also affect labor-leisure choice and decisions to invest in education by altering the return from labor in the second period. The effect of taxes and transfers is not uniform across the income distribution. And taxes and transfers affect the decision to invest in training or education, since the additional income produced by investment in education depends on the decision to remain in the labor force.

A consumer assesses these different effects by maximizing (1) subject to (2), (2a), (2b) and (3). The first order conditions for a maximum are given by

$$n_{t-1}^i = \frac{(1 - \tau_t^{t-1})[(h_{t-1}^i + \delta\bar{h}_{t-1})k_{t-1}^i - \theta\delta\beta]n_t^i + (\gamma + r_t)}{\delta(1 + \beta)(1 - \tau_t^{t-1})k_{t-1}^i\bar{h}_{t-1}n_t^i} \tag{4}$$

and

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$$n_t^i = \frac{(1 + \lambda)(1 - \tau_t^{t-1})h_t^i - \alpha(\gamma + r_t)}{(1 + \alpha)(1 - \tau_t^{t-1})h_t^i} \qquad (4a)$$

where $k_{t-1}^i = (1 - \tau_{t-1})h_{t-1}^i/\bar{h}_{t-1}$.

Let x_t be the productivity level at which an individual chooses full time leisure by retiring from the labor force. Using (4a), we solve for $n_t^i = 0$.

$$x_t = \frac{\alpha(\gamma + r_t)}{(1 + \lambda)(1 - \tau_t^{t-1})} \qquad (5)$$

The retirement choice depends positively on the social decisions represented by r and τ. The larger the retirement benefit and the higher the tax rate on earned income, the higher is the productivity level at which individual's retire.

We rewrite the first order conditions (4) and (4a) using (5).

$$n_{t-1}^i = b_1 + b_2 \frac{x_t}{n_t^i} \qquad (4)'$$

and

$$n_t^i = \frac{1 + \lambda}{1 + \alpha}(1 - \frac{x_t}{h_t^i}), \qquad (4a)'$$

where

$$b_1 = [(h_{t-1}^i + \delta\bar{h}_{t-1})k_{t-1}^i - \theta\delta\beta]/[\delta(1 + \beta)k_{t-1}^i\bar{h}_{t-1}]$$

$$b_2 = (1 + \lambda)/[\delta\alpha(1 + \beta)\bar{h}_{t-1}].$$

An individual's earned income in the two periods is $n_{t-1}^i h_{t-1}^i$ and $n_t^i h_t^i$ respectively. Let Y_t^i be lifetime or permanent income, so the change in permanent income (neglecting the constant discount rate) is

$$dY^i = h_{t-1}^i dn_{t-1}^i + h_t^i dn_t^i + n_t^i dh_t^i.$$

To learn how the distribution of income changes, we study the changes in n_{t-1}^i, n_t^i and h_t^i.

Inspection of (4)/ and (4a)/ shows that n_t^i, n_{t-1}^i, and h_t^i are interdependent; n_{t-1}^i depends inversely on n_t^i, and n_t^i depends on h_t^i. The consumer allocates time to n_t^i and n_{t-1}^i when he sets his plan, but decisions about these allocations depend on h_t^i. Solutions for each of these variables in terms of the given h_{t-1}^i and $\bar{h}_{t-1}$ and the policy variables cannot be expressed in an informative way. We proceed by considering separately the changes in n_{t-1}^i, n_t^i, and h_t^i induced by changes in h_{t-1}^i and $\bar{h}_{t-1}$ for high and low income earners.

From (4a)/ we see that

$$\frac{dn_t^i}{dh_t^i} > 0$$

As h_t^i becomes very large relative to x_t, the fraction of the time worked in the second period approaches a constant, $\frac{1+\lambda}{1+\alpha}$. For an individual with high productivity, we substitute the constant for n_t in (4)/ and differentiate to get the response of high income individuals to private and social productivity.

$$\frac{dn_{t-1}^i}{dh_{t-1}^i} = [\theta\delta\beta\bar{h}_{t-1} + (1 - \tau_t^{t-1})h_{t-1}^{i^2}]/[\delta(1+\beta)(1 - \tau_t^{t-1})\bar{h}_{t-1}h_{t-1}^{i^2}] > 0 \quad (6)$$

$$\frac{dn_{t-1}^i}{d\bar{h}_{t-1}} = -[(1+\alpha)x_t + \alpha h_{t-1}^i][\delta\alpha(1+\beta)\bar{h}_{t-1}^2]^{-1} < 0, \quad (6a)$$

$$\frac{dh_t^i}{d\bar{h}_{t-1}} = [1 + \frac{\theta}{(1 - \tau_{t-1})h_{t-1}^i}]\frac{\delta\beta}{1+\beta} > 0 \quad (6b)$$

From (6a) rising average productivity reduces hours of work, so investment in human capital rises in $t-1$ for everyone. Rising average productivity also raises human capital and productivity directly, (6b). The size of the responses in (6a) and (6b) depend on h_{t-1}^i; the larger is h_{t-1}^i, the larger the response. Hence, rising average productivity reduces hours of work, thereby increasing investment (6a), and directly increases human capital for highest income earners by more than for those with less income. Although everyone invests more in education as income and productivity increase, upper income individuals invest relatively more than individuals with less income. This effect is contrary to Kuznets' conjecture.

Private productivity works in the opposite direction. Equation (6) shows that those with higher productive endowment (h_{t-1}^i) work more in $t-1$ and invest less to increase their productivity. The effect is to narrow the distribution of productivity and income among those with relatively large human capital.

We now consider the other end of the productivity distribution. A worker with low productivity who works in period t has x_t/h_t close to unity; from (4a)/ n_t is close to zero. There is little incentive to invest in productivity improvement, so we assume that

$$h_t \cong h_{t-1}.$$

From (3), this can occur if the worker chooses full time work in $t-1$, to increase consumption in that period. With this assumption

$$n_t^i \cong \frac{1+\lambda}{1+\alpha}(1 - \frac{x_t}{h_{t-1}}),$$

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and

$$n_{t-1}^i = b_1 + b_2 \frac{x_t}{\frac{1+\lambda}{1+\alpha}(1 - \frac{x_t}{h_{t-1}^i})}.$$

Differentiating, we get the responses of first period time allocation to changes in average and private productivity. The change in productivity is small, by assumption, but the expression for $\frac{dh_t^i}{dh_{t-1}}$ is (approximately) the same as for high productivity individuals shown as (6b). The effects on investment and work are:

$$\frac{dn_{t-1}^i}{d\bar{h}_{t-1}} = -\left[\frac{h_{t-1}^i}{\delta(1+\beta)\bar{h}_{t-1}^2} + \frac{(1+\alpha)x_t h_{t-1}^i}{\delta\alpha(1+\beta)\bar{h}_{t-1}(h_{t-1}^i - x_t)}\right] < 0 \qquad (6c)$$

$$\frac{dn_{t-1}^i}{dh_{t-1}^i} = \frac{1}{\delta(1+\beta)\bar{h}_{t-1}} + \frac{\theta\delta\beta}{\delta(1+\beta)(1-\tau_t^{t-1})} - \frac{(1+\alpha)x_t^2}{\delta\alpha(1+\beta)\bar{h}_{t-1}(h_{t-1}^i - x_t)^2} \qquad (6d)$$

As average productivity rises, investment in human capital rises for low as for high income individuals. Again, the size of the response in (6c) rises with h_{t-1}^i; increases in average productivity tend to spread the distribution of income, contrary to the Kuznets hypothesis. The small changes in individual productivity from (6b) again reinforce this effect.

The combined effects of rising average productivity on the income distribution resulting from the decisions by upper and lower income groups is uncertain. Given the lower propensity to invest by those with lowest incomes, the combined effect spreads the distribution of income.

The direction of response to changes in individual productivity in (6d) has positive and negative terms. The first two terms in (6d) are similar to the terms in (6). The last term is negative and, for h_{t-1}^i close to x_t, this term dominates, so private decisions tend to compress the distribution of income. As h_{t-1}^i increases, the sign could turn positive as in equation (6). By assumption, however, investment in education or productivity is relatively small for the members of this group.

The preliminary conclusion from the model is consistent with Kuznets' hypothesis about an inverted U shape if two conditions are met. First, at low levels of income and average productivity, the effect of average productivity on investment in education and training dominates the response to individual productivity. Inequality increases. Second, as income rises, the relative size of the responses reverses; the effect of individual investment decisions dominate, reducing inequality.

Using productivity as a measure of income, inspection of (6a) and (6c) shows that, as the economy grows (average income and productivity increase)

the responses in (6a) and (6c) become smaller. (By inspection, the second derivatives are positive.) Average productivity works to spread the distribution of income but at a slower rate. Equation (6b) is independent of average productivity, so this derivative is the same at high as at low levels of income[2] However, as income rises, the responses to individual productivity in (6) and (6b) fall.[3] This works in the opposite direction, reducing the tendency to compress the distribution of income. The effect of rising h_{t-1}^i on (6c) is unclear, but in the neighborhood of x_t, the response of h_{t-1}^i is small. As h_{t-1}^i moves away from x_t, the response approaches the response of (6); the distribution of income narrows at a slower rate.

We can now bring together the effects of rising productivity on lifetime incomes. Substituting (4a)ı and (3) into the definition of an individual's lifetime permanent income, we have

$$Y_t^i = \frac{1+\lambda}{1+\alpha}[h_{t-1}^i + \delta(1 - n_{t-1}^i)\bar{h}_{t-1} - x_t] + n_{t-1}^i h_{t-1}^i.$$

Productivity change implies that individual and average productivity increase, and lifetime income rises.

$$\frac{dY_t^i}{dh_{t-1}^i} = \frac{1+\lambda}{1+\alpha} + n_{t-1} + [h_{t-1}^i - \delta\frac{1+\lambda}{1+\alpha}\bar{h}_{t-1}]\frac{dn_{t-1}^i}{dh_{t-1}^i}$$

$$\frac{dY_t^i}{d\bar{h}_{t-1}} = \delta\frac{(1+\lambda)}{(1+\alpha)}(1 - n_{t-1}^i) + (h_{t-1}^i - \delta\frac{(1+\lambda)}{(1+\alpha)}\bar{h}_{t-1})\frac{dn_{t-1}^i}{d\bar{h}_{t-1}}$$

The truth or falsity of Kuznets' hypotheses depend on two effects that work in opposite directions. First is the response of dY_t^i/dh_{t-1}^i to changes in productivity at different levels of individual income. This is shown by d^2Y/dh_{t-1}^{i2}. Second is the response of $dY^i/d\bar{h}_{t-1}$ to changes in individual productivity at different levels of individual productivity. This is shown by the cross partial derivative $\frac{d^2Y_t^i}{d\bar{h}_{t-1}dh_{t-1}^i}$. The signs of the relevant derivatives are:

$\frac{d^2Y}{dh_{t-1}^{i2}}$ is positive for upper, and negative for lower, income individuals, and

$\frac{d^2Y}{d\bar{h}_{t-1}dh_{t-1}^i}$ is negative for upper income individuals and positive for lower income individuals if productivity is close to the retirement level, x_t.

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[2]There has been considerable interest in convergence of incomes or productivity. Independence implies that the response of individual productivity to changes in average productivity does not converge as productivity rises.

[3]From (6)

$$\frac{d^2n_{t-1}^i}{dh_{t-1}^i d\bar{h}_{t-1}} = -\frac{1}{\delta(1+\beta)\bar{h}_{t-1}^2} < 0$$

By inspection the cross-partial of (6b) with respect to dh_{t-1}^i is negative also.

Kuznets' proposition requires that the second derivatives are smaller than the cross partials. The former spread the income distribution, while the latter compress the distribution. In the opposite case, data relating income distribution to levels of income would reject the proposition, as some of the papers cited earlier have found.

None of the responses to this point take account of the effects on the income distribution of changes in the size of taxes and transfers. The following section considers these effects. The responses we have discussed also do not consider changes in demand as the economy grows. Demand for professional services increases with growth of income and longevity, which itself increases with income. Satisfying these demands for medical, legal, financial, accounting and educational services requires more of the population to invest in skills and training, thereby compressing the income distribution. Kuznets does not discuss this channel, and we have not introduced this additional complexity. It would have the same effect as a positive response to rising $\bar{h}_{t-1}$ on the derivative in (6). The result would be relatively more investment in human capital by those with income below the mean (or other point of the distribution) than by those above.

The Effect of Taxes and Transfers

Kuznets recognized that the (before tax) distribution of income that we observe reflects individual responses to taxes and transfers. In our model the income distribution may change in response to taxes and transfers as a result of labor and leisure choices and decisions to invest in productivity.

The government's budget is always balanced; tax revenues finance equal lump sum transfers to everyone. The tax rate on income earned by the young and old is the same at any time. Let τ_t be the actual tax rate.

$$\frac{\tau_t(\bar{y}_{t-1} + \bar{y}_t)}{2} = r_t = \tau_t \bar{Y}_t \tag{7}$$

where $\bar{y}_{t-1}$ and $\bar{y}_t$ are the mean income of the young and old generation in period t and $\bar{Y}_t$ is per capita income at time t. The share of disposable income taxed at time t rises as disposable income increases.

τ and r affect the allocation of time to labor and investment in education through their effect on retirement decisions, given by x, as shown in (5). As tax rates increase, the marginal utility of second period consumption declines and, as r increases, more of desired consumption is satisfied by transfers. Individuals choose more leisure, as shown by (4a)/. By raising tax rates and transfer payments, policy raises the level of earned income and productivity at which individual's retire; more people retire. Lower tax rates and transfers reduce retirement.

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Equations (8) to (8b) express n_{t-1}, n_t and h_t as functions of x_t.

$$n_{t-1}^i = n_{t-1}^i(x_t) \qquad (8)$$

$$n_t^i = n_t^i(x_t) \qquad (8a)$$

$$h_t^i = h_t^i(x_t) \qquad (8b)$$

Totally differentiating (3), (4)$\prime$ and (4a)$\prime$ and using (8)–(8b) we obtain the responses of n_{t-1}^i, n_t^i, and h_t^i to the current tax rate and transfer summarized in x_t. The derivatives are shown as equations (9) to (9b).

$$\frac{dn_{t-1}^i}{dx_t} = -\frac{b_2}{\pi_t}\left(\frac{1}{n_t} + \frac{(1+\lambda)x_t}{(1+\alpha)h_t n_t^2}\right) > 0 \qquad (9)$$

$$\frac{dn_t^i}{dx_t} = \frac{(1+\lambda)}{(1+\alpha)\pi_t}\left(\frac{1}{h_t} + \frac{\delta \bar{h}_{t-1} b_2 x_t}{n_t h_t^2}\right) < 0 \qquad (9a)$$

$$\frac{dh_t^i}{dx_t} = \frac{\delta \bar{h}_{t-1} b_2}{\pi_t}\left(\frac{1}{n_t} + \frac{(1+\lambda)x_t}{(1+\alpha)h_t n_t^2}\right) < 0 \qquad (9b)$$

where

$$\pi_t = \frac{(1+\lambda)\delta \bar{h}_{t-1} b_2}{1+\alpha}\left(\frac{x_t}{n_t h_t}\right)^2 - 1. \qquad (9c)$$

For simplicity, the superscript i is omitted on the right side of these equations.

The signs in (9) depend on the sign of π, and the sign of π depends on the response of consumption and leisure to transfer payments. Both goods are normal goods, so the partial derivative are positive. Hence $\frac{\partial \ell}{\partial r} > 0$. Since $\ell_t = 1 - n_t$

$$\frac{\partial \ell}{\partial r} = -\frac{\partial n}{\partial x}\frac{\partial x}{\partial r}.$$

From (5) $\frac{\partial x}{\partial r} < 0$. The sign of (9a) is negative therefore, and $\pi < 0$. The signs of (9) and (9b) follow.

The signs in equations (9) imply that increases in transfer payments increase effort in the first period, thereby reducing investment in education, and reduce second period productivity and effort. More people choose retirement. Reductions in transfer payments have the opposite effect; investment in education and second period productivity increase. From (5) the response of retirement to tax rate changes is in the same direction as for changes in transfers.

In equations (9) to (9b) h_t^i is in the denominator. High income earners respond less than low income earners to taxes and transfers. Increased transfers induce larger reductions in second period effort and second period productivity for low than for high income groups. Low income individuals

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retire and consume the transfer with greater frequency. This tends to spread the distribution of earned income.

The effect on n_t^i is small for large h_t^i. If, as before, we assume that, for high productivity, h_t^i is substantially larger than $x_t, \pi \cong -1$ and $n_t^i \cong \frac{1+\lambda}{1+\alpha}$, a constant. With this assumption, equations (9) and (9b) become

$$\frac{dn_{t-1}^i}{dx_t} \cong b_2 \frac{1+\alpha}{1+\lambda}(1 + \frac{x_t}{h_t^i}) > 0 \qquad (9)'$$

and

$$\frac{dh_t^i}{dx_t} \cong -\frac{(1+\alpha)}{\alpha(1+\beta)}(1 + \frac{x_t}{h_t^i}) < 0. \qquad (9b)'$$

As x_t increases, n_{t-1}^i increases, reducing investment in productivity. The size of the response of productivity is directly related to the level of individual productivity. Those with highest productivity increase work least and invest most. But the size of the response declines as productivity and income increase. The reason is that $\bar{h}_{t-1}$ is in the denominator of b_2, so rising $\bar{h}_{t-1}$ lowers (9)ı for everyone.

Equation (9b)ı expresses the response of human capital and productivity. As h_t^i rises $\frac{x_t}{h_t^i}$ falls and (9b)ı becomes (absolutely) smaller at relatively high levels of income. Hence, rising tax rates and transfer payments widen the spread of the distribution of productivity, and declining tax rates and transfers compress the distribution.

Our conclusion about tax and transfers accords with Kuznets' conjecture, although the mechanism differs. Kuznets believed that increased transfers spread the before tax income distribution by reducing the wages paid to workers with lower skills. In our model, the effects on human capital and retirement (or leisure), not wage rates, are the principal means by which the distribution changes.

Higher taxes and transfers impose a cost on future generations by discouraging investment. This cost falls particularly on the offspring of those with current low incomes. Since the low income groups vote for the transfers, the choice is voluntary. But future generations do not vote in the current election and, because they inherit lower productivity as a result of the current decision, they are likely to vote for increased transfers and retirement in their turn. In this way, benefits paid today can induce behavior which creates a welfare class. The welfare class in our model, however, must work at least one period.

The Equilibrium Tax Rate and Size of Government

The tax rate is set by majority rule voting. All voters, young and old, at time t are eligible to vote. Their votes determine the tax rate applicable to

income earned in period $t+1$. As shown in (7), all tax receipts are paid as transfers to the generation that is old in $t+1$.

The choice of tax rate and redistribution creates both intragenerational and intergenerational transfers. The reason is that three generations are involved. The interests and influence of the three generations differ, however.

The current old are indifferent; they vote randomly and have no effect on the outcome. The tax rate they pay and the transfer payment they receive were set earlier. Since there is no capital and no debt, the only bequest the old leave is the human capital that they passed on to the current young when the young were born.

Since the tax-transfer system is progressive, the current young transfer income within their generation. The tax rate they choose is paid also by the next generation of young on their earnings in $t+1$. This provides an intergenerational transfer to finance part of the redistribution paid next period to the current young, as shown in (7).

The generation that will be young in $t+1$ is not born when the vote is taken. Hence they do not vote on the tax rate they will pay in $t+1$. It might seem that the current young would have an incentive to tax future income heavily, but they are permitted to do so only if they tax themselves at the same rate. Moreover, the current generation recognizes the disincentive imposed by higher taxes on the next generation. There are no bequests, so the model does not directly link the utility of current and future generations. But the income of the next young generation enters through the government budget equation; in this way the current generation is forced to recognize the effects of the taxes they impose on their offspring.

Next period's tax rate is the only issue to be decided. In a single issue election, the voter with median income is the decisive voter. We denote the median or decisive voter by d, and use the decisive voter's first order condition to obtain

$$\frac{dx_t}{d\tau_t^{t-1}} = \frac{1}{1 - \tau_t^{t-1}}(x_t + \frac{\alpha}{1+\lambda}y_t^d) \tag{10}$$

where y_t^d is the decisive voter's income next period. Substituting (7) into (5) and differentiating x_t totally with respect to τ_t,[4] we have

$$0 = (1+\lambda)(1-\tau_t)\frac{dx_t}{d\tau_t} - (1+\lambda)x_t - \alpha[\bar{y}_{t-1} + \bar{y}_t + \tau_t(\frac{d\bar{y}_{t-1}}{d\tau_t} + \frac{d\bar{y}_t}{d\tau_t})] \tag{11}$$

where $\bar{y}_{t-1}$ is the mean income of the next generation of young and $\bar{y}_t$ the mean income of the next generation of old (the current young). These means

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[4]We ignore the superscript $t-1$ on τ_t since the actual and planned tax rates are the same.

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are defined by[5]

$$\bar{y}_{t-1} = \int_0^\infty n_{t-1}^i h_{t-1}^i dF(h_{t-1}^i)$$

and

$$\bar{y}_t = \int_x^\infty n_t^i h_t^i dF(h_t^i),$$

where $F(h)$ is the distribution function of individual productivity. $F(h)$ is continuous and differentiable. Substituting (10) into (11) gives

$$y_t^d - (\bar{y}_{t-1} + \bar{y}_t) - \tau_t\left(\frac{d\bar{y}_{t-1}}{d\tau_t} + \frac{d\bar{y}_t}{d\tau_t}\right) = 0 \qquad (12)$$

Equation (12) resembles the equation derived in Meltzer and Richard (1981, equation 13). The only difference is that the mean income of two generations (and changes in income) replace the single generation they consider. Hence, as in their model, the choice of tax rate depends on the spread of the income distribution, represented by the difference between mean and median, and on the response of mean income to the tax rate. We can, again, use Roberts (1977) lemma to order individual incomes and choose the tax rate.

Differentiating $\bar{y}_{t-1}$ and $\bar{y}_t$ with respect to τ_t and letting $\bar{Y}_t = \bar{y}_{t-1} + \bar{y}_t$, we have

$$y_t^d - \bar{Y}_t + \frac{\alpha\tau_t(1-F)}{(1+\alpha)(1-\tau_t)^2}[\varphi + \tau_t\bar{Y}_t + (1-\tau_t)y_t^d] = 0 \qquad (13)$$

where

$$\varphi = \gamma - \frac{\theta\beta(1+\alpha)}{\alpha(1+\beta)(1-F)}\int_0^\infty \frac{h_t}{\pi_{t+1}}dF(h_t)$$

where π is given in (9c), and $\pi < 0$.

Dividing (13) by y_t^d and letting $m = \bar{Y}_t/y_t^d$ and $e = \varphi/y_t^d$, we have

$$\frac{1+\alpha F}{\alpha(1-F)}(1-\tau_t)^2 + (2m - 1 + e)(1-\tau_t) - (m+e) = 0. \qquad (14)$$

Solving for τ_t gives the following approximation.

$$\tau_t \cong \frac{(1+\alpha)}{\alpha}\frac{(m-1)}{(1-F)}\frac{1}{(1+e)}. \qquad (15)$$

As in Meltzer and Richard (1981), the median voter chooses a tax rate that increases with (1) m, the ratio of mean to median income, (2) F, the proportion of the population that voluntary retires, and (3) the income of the median or decisive voter, y^d. The last effect enters through e. In addition,

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[5]$h_{t-1}^i, n_{t-1}^i, h_t^i$ and n_t^i now refer to the two generations represented by $\bar{y}_{t-1}$ and $\bar{y}_t$.

the tax rate chosen by today's decisive voter depends on the numerator of φ. In the static case, $\varphi = \gamma$. In the dynamic case, φ is positive and larger than in the static case.[6] The tax rate is therefore lower in the dynamic model, ceteris paribus.

In a growing economy with rising income the current generation uses its vote on the tax rate to share in the growth of income. The amount by which the tax rate increases in the dynamic model depends on the response of the next generation's effort to the tax rate. A low response raises the tax rate; a large response lowers the rate.

The current model has neither debt nor capital, so the only way the current generation can share in the higher future income is by taxing future income to increase current consumption. If there were debt and real capital and an unending sequence of future generations, as in Cukierman and Meltzer (1989), the current generation of voters could smooth income by incurring deficits and leaving government debt to their offspring. Unlike taxation, deficit finance would not require the current generation to impose higher taxes on themselves to share in future income.

Equation (15) relates the tax rate to the ratio of mean to median income and to the level of median income. All three are endogenous variables in our model, and the equation relating them is non-linear. Kuznets' hypotheses are difficult to test directly also. The first hypothesis neglects the effects of taxation, which are undoubtedly present in the data. We consider the combined effects of taxation, redistribution and the level of income, as in his second hypothesis.

Table 1 shows a modest effort to consider the relation between the principal variables in countries with relatively high ("rich") income and low and middle income as classified by the World Bank. Data for median income are the mean of the second and third quintiles from World Bank (1991, Table 30) expressed in the standard real dollars used in the table. These data are for different years and are subject to many qualifications. We have interpreted tax rate as equal to the share of government spending on housing, welfare, and retirement from World Bank (1991, Table 11).[7] This measure is most closely related to our model.

The data suggest that inequality declines with per capita income. The ratio of median to mean income in the samples are 0.72 for the "rich" countries and 0.60 for poor to middle income countries. This suggests that the ratio of median to mean income rises as income increases. The regressions

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[6]The expression inside the integral is the response to the tax rate of the labor supply by the current unborn generation when they enter the labor force next period. The integral shows the next generation's aggregate response of work to the tax rate. This response is negative but is multiplied by a minus sign, so φ rises relative to the static analysis.

[7]We also used the share of GDP spent by government separately and in addition to the welfare spending ratio. The principal result is unchanged.

Table 1:

Dependent Variable	Real Per Capita Income	Welfare Spending[a]	Constant	$\bar{R}^2$	N	Comment
median income	0.74 (12.94)		-71.5 (0.1)	.90	19	"rich" countries
median income	0.64 (9.72)		-92.7 (0.4)	.85	18	"poor and middle" income
median income	0.76 (45.35)		-392.4 (2.5)	.98	37	all
median income	0.74 (15.59)	23.19 (2.23)	-1062.1 (1.5)	.94	19	"rich"
median income	0.74 (24.99)	11.17 (1.22)	-490.7 (1.8)	.98	26	all
Median Income						
mean income 0.82	1.22 (12.93)		1225.1 (1.4)	.90	19	"rich"
mean income 0.75	1.33 (9.72)		530.3 (1.9)	.84	18	"poor and middle"
mean income 0.78	1.28 (15.59)	-28.07 (2.00)	1954.5 (2.3)	.94	17	"rich"

t statistics in parentheses.

[a]share of government spending on welfare in 1989.

Source: World Bank (1991).

suggest that each $1000 of additional mean income raises the median by $740 in the rich countries and $640 in the poor and middle countries if median income is used as the dependent variable. When mean income is the dependent variable, the comparable values (the reciprocal of the coefficient of median income) are 0.82 and 0.75. These values are shown below mean income in the last three rows of the table. In all cases, the marginal effect of rising income is above the average effect, so the ratio of median to mean income increases with income.

The change in inequality is relatively small. If per capita income is $12,000 median income is $8640 at the mean value (.72). A $1000 increase in per capita income adds $740 or $820 to the median "rich" income depending on whether median or mean income is the dependent variable. The ratio of median to mean income rises from .72 to .7215 or .7277.

The last two rows of the table introduce "the tax rate", measured here by the share of government spending on welfare and retirement. The coefficient of this variable is positive for median income and negative for mean income given the level of mean (median) income. Increased welfare spending appears to be associated with increased equality, contrary to Kuznets' hypothesis. The World Bank describes the data on income distribution as disposable income, so our estimate is not a direct test of our moel or Kuznets' hypothesis. We do not know of any data on before tax income distribution. We suggest caution, also, about inferring the direction of causality among these interdependent variables.

Conclusion

In the 1950s and 1960s, Simon Kuznets offered two hypotheses about the effects of economic development, taxes and transfers on the distribution of income. First, he suggested that initially economic development increased inequality in income distribution, but continued development reversed the effect, reducing inequality. The relation between the level of income and the distribution of income is an inverted U, on this hypothesis.

Kuznets' second hypothesis states that increased taxes and transfers increased inequality by widening the (before tax) distribution of income. Thus, the effect of higher income may be offset by the effect of higher taxes and transfers if taxes and transfers rise with income.

This paper develops a dynamic version of the Meltzer-Richard (1981) hypothesis that relates the level of income, the distribution of income, the tax rate and income transfers in a growing economy where income changes. As before, individuals differ in productivity and, therefore, in income. Productivity can be increased by investment in education or training. As in recent growth theory, investment in education is the driving force in growth but, in

our model, the effects are not uniform across the income distribution. Everyone benefits from rising average productivity, but individuals can benefit also from investment that changes individual productivity.

The tax rate in our model is proportional to income, but transfers are lump sum, so the tax-transfer system is progressive. This provides for redistribution within the working population. Taxes are paid by young and old workers to finance benefits to the current old. Tax rates and transfers are set each period for the next period ahead, so the current young and old generations vote on the tax rate to be paid by the generation that is not yet born. Hence, redistribution is intergenerational as well as intragenerational. There is no capital and no debt. Budgets are always balanced.

To derive Kuznets' propositions, we first analyze the effects of changes in individual and average productivity on individuals with high and low incomes, neglecting taxes and transfers. We find that changes in average and individual productivity have opposite effects on the distribution of income. Higher individual productivity spreads the distribution, while higher average productivity compresses the distribution. The truth or falsity of Kuznets' first proposition depends on the relative strength of the two effects. This seems consistent with evidence from a number of cross-section and time series studies. Some of these studies support, and others reject, Kuznets' hypothesis. The evidence we present suggests that inequality declines modestly as the level of income rises.

Kuznets' second hypothesis suggests that the observed relation between the level and distribution of before tax income depends on the tax-transfer system. Studies that neglect these fiscal effects do not properly test Kuznets' propositions. Our analysis provides a foundation for Kuznets' second hypothesis, but the data suggest that spending for redistribution increases equality in the distribution of income. However, this is not a direct test, since the available data are for the distribution of disposable income, not before tax income.

Our analysis suggests that the tax-transfer system can produce a "poverty class." The reason is that transfer payments encourage low productivity workers to leave the labor force in the second period of life. Knowing that they will retire, these workers invest less in their own productivity. Since children inherit their productivity level from their parents, the children also choose early retirement and invest relatively little in education. Thus, the progressive tax-transfer system tends to discourage generations of the poorest individuals from investing in education.

To close the model, we determine the tax rate (and the level of spending) by majority rule. As in the static Meltzer and Richard (1981) model, the tax rate increases with the ratio of mean to medium income, the proportion of the population that subsists on transfers in the second period of life, and

the level of (median) income. The dynamic model implies that the tax rate depends, also, on the income of the next (future) generation. With rising income and productivity, the current generation levies taxes on future income. These taxes pay for some of the transfers that the current generation receives. Since the current young generation must pay the same tax rate they levy on their children, there are limits to the amount of intergenerational redistribution.

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