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Income Distribution and Macroeconomics

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This paper analyzes the role of wealth distribution in macroeconomics through investment in human capital. It is shown that in the presence of credit markets' imperfections and indivisibilities in investment in human capital, the initial distribution of wealth affects aggregate output and investment both in the short and in the long run, as there are multiple steady states. This paper therefore provides an additional explanation for the persistent differences in per-capita output across countries. Furthermore, the paper shows that cross-country differences in macroeconomic adjustment to aggregate shocks can be attributed, among other factors, to differences in wealth and income distribution across countries.

1. INTRODUCTION

This paper explores the theoretical linkage between income distribution and macroeconomics, through investment in human capital. Our main interest is how income and wealth distributions are related to long-run macroeconomic issues, like economic growth and sectorial adjustment. It is shown that distribution of wealth can significantly affect aggregate economic activity both in the short and in the long run. Countries which have different historically determined wealth distributions, follow different growth paths and may even converge to different steady states. Hence the paper suggests an explanation for the differences in growth patterns between countries.

One of the major motivations to study the relationship between income distribution and aggregate economic activity is the empirical data, which persistently shows a strong correlation between income distribution and income per-capita. Kravis (1960) and Lydall (1968) have shown that income is more equally distributed within wealthier countries. Recent statistics provided by the World Bank (1988, 1989, 1990, 1991) suggest that this is still the case. Recently Persson and Tabellini (1990) have provided empirical evidence that equity is positively correlated not only with the level of income but with the rate of growth as well. Such observations call for an explanation.

In modern macroeconomic thought the theoretical analysis of the relationships between income distribution and aggregate economic activity has gone through a number of phases. Keynes (1936) stressed the effect of income distribution on aggregate demand. During the 1950s and 1960s attention shifted to the relationship between distribution and economic growth.[1] Most of this literature focused on the effect of income distribution on consumption and saving. During the 1970s and the 1980s macroeconomic theory lost

1. See Kaldor (1956), Kuznets (1955) and a later survey by Cline (1975).

interest in issues of distribution, partly due to the decline of interest in growth, and partly due to increased use of models of representative agents and overlapping generations. The recently renewed interest in growth and development, has led to new interest in distributional issues as well. This paper explores one possible relationship between distribution and growth, through investment in human capital in the presence of imperfect credit markets.[2]

The paper develops an equilibrium model of open economies with overlapping generations and inter-generational altruism. A single good can be produced by either a skill-intensive or an unskilled-intensive process. Individuals live for two periods. In the first they may either invest in human capital and acquire education or else work as unskilled. In the second period they work as skilled or unskilled—according to their education level, consume and leave bequests. Individuals are assumed to be identical with regard to their potential skills and preferences and differ only with respect to their inherited wealth.[3] It is further assumed in the paper that there are enforcement and supervision costs on individual borrowers and hence the borrowing interest rate is higher than the lending rate. Consequently, the inheritance of each individual determines whether she invests in human capital or not. Hence, the distribution of wealth determines the aggregate levels of investment, of skilled and unskilled labour and of output.[4] But the effect of wealth distribution is not only short run, as the different levels of investment in human capital in turn determine the distribution of income, which gradually changes the distribution of wealth through time.[5] It is shown in the paper that the economic dynamics of dynasties depend on initial wealth. There are rich dynasties, in which all generations invest in human capital, work as skilled and leave a large bequest. There are poor dynasties, in which people inherit less, work as unskilled, and leave less to their children. Hence the initial distribution of wealth determines how big these two groups of dynasties are, and therefore what is the long-run equilibrium in the economy. Wealth distribution, therefore, carries long-run as well as short-run implications.

There are two major assumptions in the paper. One is that credit markets are imperfect, as the interest rate for individual borrowers is higher than that for lenders. The second important assumption is that investment in human capital is indivisible, namely that there is a technological non-convexity. The result that wealth distribution affects economic activity in the short run is due to the assumption that credit markets are imperfect. This result is quite intuitive. If borrowing is difficult and costly, those who inherit a large initial wealth and do not need to borrow have better access to investment in human capital, as has already been noticed by Becker (1975) and Atkinson (1975). Hence the distribution of wealth affects the aggregate amounts of investment in human capital and of output. This result was first shown by Loury (1981).[6] In his important contribution Loury also shows, that under credit market imperfection the effect of wealth distribution disappears in the long-run, as all initial wealth distributions in his

2. Other recent papers which examine the relationship between growth and distribution are Greenwood and Jovanovic (1990), Murphy, Shleifer and Vishny (1989), Perroti (1990) and Persson and Tabellini (1990). These papers suggest other channels through which distribution affects growth.

3. According to Becker's (1975) terminology, individuals differ with respect to "opportunities" and not "abilities".

4. Notice that what matters is not only relative wealth, but the size distribution of absolute wealth. In this respect the model is very different from recent papers which emphasize the role of distribution through the political mechanism, as in Alesina and Drazen (1991), Perotti (1990) and Persson and Tabellini (1990).

5. Empirical evidence on the effect of investment in human capital on the distribution of income has been extensively documented in the literature. The central studies in this field are those of Becker (1975) and Mincer (1974).

6. Similar results are reached by Scheinkman and Weiss (1986) and by Banerjee and Newman (1991).

model converge to a unique ergodic distribution. This paper shows that if we add a second assumption, that technology is non-convex, the inherited distribution of wealth affects the economy not only in the short run but in the long run as well. As a result of this assumption there are multiple long-run equilibria and dynamics are no longer ergodic.[7]

From the above description it is clear that this paper is related to the new wave of research on economic growth, pioneered by Romer (1986) and Lucas (1988). Like these, we attempt to examine why differences between economies persist. Contrary to most previous studies, we do not attribute these differences to technology or knowledge, but rather to differences in investment in human capital, due to credit market imperfection.[8] An additional similarity between our model and the new growth models is the existence of non-convexities in production. In our model it is the indivisibility of individual investment in human capital, a non-convexity at the individual level.[9]

The paper also deals, by use of an extension to the basic model, with the issues of the relationship between national income and income distribution and of the adjustment to aggregate shocks. We show that richer economies tend to have smaller wage differentials and a more equal distribution of income. This result is indeed consistent with the stylized facts described above. We also show that income and wealth distributions affect the adjustment of the economy to aggregate shocks, when this adjustment calls for investment in human capital and sectorial shifts.

The paper is organized as follows. Section 2 presents the basic model. Section 3 describes the short-run equilibrium where wealth distribution affects output and investment. Section 4 examines the long-run equilibrium where economic inequality can be persistent. Section 5 contains a discussion of the role of the various assumptions of the model. Section 6 extends the basic model to incorporate variable wages for unskilled workers. Section 7 studies the relationship between income distribution and national income. Section 8 examines the adjustment to exogenous shocks. Section 9 offers some concluding remarks.

2. THE BASIC MODEL

Consider a small open economy in a one-good world. The good can be used for either consumption or investment. The good can be produced by two technologies, one which uses skilled labour and capital and the other using unskilled labour only. Production in the skilled labour sector is described by:

$$Y_t^s = F(K_t, L_t^s), \tag{1}$$

where Y_t^s is output in this sector at time t, K_t is the amount of capital and L_t^s is labour input. F is a concave production function with constant returns to scale. It is assumed that investment in human capital and in physical capital is made one period in advance. For the sake of simplicity it is assumed that there are no adjustment costs to investment and no depreciation of capital. Production in the unskilled labour sector is described by:

$$Y_t^n = w_n \cdot L_t^n, \tag{2}$$

7. The result that there are multiple long-run wealth distributions is important in order to justify the existence of various distributions in the short run as well. Hence this result also gives more content to the former result, that wealth distribution has effect in the short run.

8. For empirical evidence, that points at the importance of investment in human capital in explaining differences in output among countries, see Mankiw, Romer and Weil (1992).

9. The existence of non-convexities in production plays an important role in some other recent models, which display multiple long-run equilibria, as in Azariadis and Drazen (1990) and Tsiddon (1992).

where Y_t^n and L_t^n are output and unskilled labour input respectively, and $w_n > 0$ is marginal productivity in this sector.

Individuals in this economy live two periods each in overlapping generations. They can either work as unskilled in both periods of life or invest in human capital when young and be skilled workers in the second period of life. The amount of investment in human capital is $h > 0$. An individual supplies one unit of labour in each of the working periods. Note that the indivisibility of the amount of investment implies that there is a region of increasing returns to scale.

Each individual has one parent and one child, which creates the connection between generations within dynasties. This assumption also means that there is no population growth. In each generation there is a continuum of individuals of size L. People care about their children and leave them bequests. It is also assumed, for the sake of simplicity, that people consume in the second period of life only. Formally, we assume that an individual derives utility both from consumption in the second period of life and from any bequest to his/her offspring:[10]

$$u = \alpha \log c + (1-\alpha) \log b, \tag{3}$$

where c is consumption in second period, b is bequest, and $0 < \alpha < 1$. Notice that all individuals are born with the same potential abilities and with the same preferences. They differ only in the amounts they inherit from their parents.

Capital is assumed to be perfectly mobile so that both firms and individuals have free access to the international capital markets. The world rate of interest is equal to $r > 0$ and is assumed to be constant over time. Individuals can lend any amount at this rate. As for borrowing, we assume that a borrowing individual can evade debt payments by moving to other places etc., but this activity is costly. Lenders can avoid such defaults by keeping track of borrowers, but such precautionary measures are costly as well. Assume that if lenders spend an amount z at keeping track of a borrower, this borrower can still evade the lenders but only at a cost of βz, where $\beta > 1$. As is later shown in the paper, these costs create a capital market imperfection, where individuals can borrow only at an interest rate higher than r.

Unlike individuals, firms are unable to evade debt payment, due to reasons such as immobility, reputation, etc.[11] Hence, firms can borrow at the lenders' interest rate r. Due to the absence of adjustment costs to investment, and to the fact that the number of skilled workers is known one period in advance, the amount of capital in the skilled labour sector is adjusted each period so that:

$$F_K(K_t, L_t^s) = r. \tag{4}$$

Hence, there is a constant capital-labour ratio in this sector, which determines the wage of skilled labour w_s, which is constant as well. This wage w_s depends on r and on technology only.

We further assume that both labour markets and the good market are perfectly competitive and expectations are fully rational.

10. There are alternative ways to model the bequest motive, but it can be shown that they yield similar results. This issue is discussed in Section 5.

11. This assumption is not critical to any of the results of the paper. Removing it can even strengthen our results. This assumption though reflects, in a somewhat extreme way, the fact that individuals are usually more credit constrained than firms.

3. WEALTH DISTRIBUTION AND SHORT-RUN EQUILIBRIUM

Let us first examine the capital market equilibrium for individual borrowers. It is clear that lenders to individuals must have positive costs of keeping track of each borrower, since otherwise everyone defaults. Hence, the individual must borrow at a rate higher than r, to cover these tracking costs. An individual who borrows an amount d pays an interest rate i_d which covers lenders' interest rate and lenders' costs z, as competitive financial intermediation operates on zero profits:

$$d \cdot i_d = d \cdot r + z. \tag{5}$$

Lenders choose z to be high enough to make evasion disadvantageous:

$$d(1+i_d) = \beta z. \tag{6}$$

This is an incentive compatibility constraint. Equations (5) and (6) determine i_d:

$$i_d = i = \frac{1+\beta r}{\beta - 1} > r. \tag{7}$$

The borrowing interest rate i is, therefore, independent of the amount borrowed d, as tracking costs rise with the amount borrowed d. This result is quite intuitive: as the amount borrowed increases, the incentive to default rises and hence tracking costs rise.

We now turn to describe individual optimal decisions. Consider an individual who inherits an amount x in first period of life. If this individual decides to work as unskilled and not invest in human capital, his (her) lifetime utility is:

$$U_n(x) = \log[(x+w_n)(1+r)+w_n] + \varepsilon, \tag{8}$$

where:

$$\varepsilon = \alpha \log \alpha + (1-\alpha)\log(1-\alpha).$$

This unskilled worker is a lender who leaves a bequest of size:

$$b_n(x) = (1-\alpha)[(1+r)(x+w_n)+w_n]. \tag{9}$$

An individual with inheritance $x \geq h$, who invests in human capital, is a lender with utility:

$$U_s(x) = \log[w_s + (x-h)(1+r)] + \varepsilon, \tag{10}$$

and a bequest of:

$$b_s(x) = (1-\alpha)[w_s + (x-h)(1+r)]. \tag{11}$$

An individual who invests in human capital but has inheritance x smaller than h is a borrower, with lifetime utility:

$$U_s(x) = \log[w_s + (x-h)(1+i)] + \varepsilon, \tag{12}$$

and a bequest of:

$$b_s(x) = (1-\alpha)[w_s + (x-h)(1+i)]. \tag{13}$$

It is clear that if $w_s - h(1+r) < w_n(2+r)$ all individuals prefer to work as unskilled. Since this is a case with limited interest we assume that:[12]

$$w_s - h(1+r) \geqq w_n(2+r). \tag{14}$$

12. If (14) does not hold, individuals all over the world prefer to work as unskilled. Hence, there is no capital and an excess supply of loans prevails. This drives the world rate of interest down until (14) is satisfied. Hence (14) is a reasonable assumption.

Hence, as investment in human capital pays back more than unskilled labour, lenders prefer to invest in human capital, as is seen from equations (8) and (10). Borrowers invest in human capital as long as $U_s(x) \geqq U_n(x)$, that is as long as:

$$x \geqq f = \frac{1}{i-r}[w_n(2+r)+h(1+i)-w_s]. \tag{15}$$

Individuals who inherit an amount smaller than f would prefer not to invest in human capital but work as unskilled. Education is, therefore, limited to individuals with high enough initial wealth, due to a higher interest rate for borrowers.

The amount an individual inherits in first period of life, therefore, fully determines his (her) decisions whether to invest in human capital or work as unskilled, and how much to consume and bequeath. Let D_t be the distribution of inheritances by individuals born in period t. This distribution satisfies:

$$\int_0^\infty dD_t(x_t) = L. \tag{16}$$

The distribution D_t, therefore, fully determines economic performance in period t. It determines the amount of skilled labour:

$$L_t^s = \int_f^\infty dD_t(x_t) \tag{17}$$

and unskilled labour:

$$L_t^n = \int_0^f dD_t(x_t). \tag{18}$$

Hence the distribution of wealth determines aggregate output as well and it therefore has a strong effect on the macroeconomic equilibrium. This result is due to the credit market imperfection. But we can question the relevance of this result in the following way: the effect of wealth distribution is relevant only if this distribution differs substantially from one country to the other. This is not reasonable if the dynamic process is ergodic, namely if all initial distributions converge to the same distribution in the long-run, as in the works of Loury (1981) and Banerjee and Newman (1991). In the next section we show that the second assumption in the paper, of indivisibilities in investment in human capital, leads to non-ergodic dynamics and to multiple long-run wealth distributions. Hence it becomes more meaningful to examine the effect of wealth distribution in the short-run as well.

4. THE DYNAMICS OF WEALTH DISTRIBUTION

The distribution of wealth not only determines equilibrium in period t, but also determines next period distribution of inheritances D_{t+1}:

$$x_{t+1} = \begin{cases} b_n(x_t) = (1-\alpha)[(x_t+w_n)(1+r)+w_n], & \text{if } x_t < f \\ b_s(x_t) = (1-\alpha)[w_s+(x_t-h)(1+i)], & \text{if } f \leqq x_t < h \\ b_s(x_t) = (1-\alpha)[w_s+(x_t-h)(1+r)], & \text{if } h \leqq x_t. \end{cases} \tag{19}$$

In order to illustrate the dynamic evolution of wealth distribution through time we present in Figure 1 the curves b_n and b_s which describe the dynamic relationships between inheritance and bequest for unskilled and skilled workers, respectively. Notice that f is determined by the intersection of b_n and b_s.

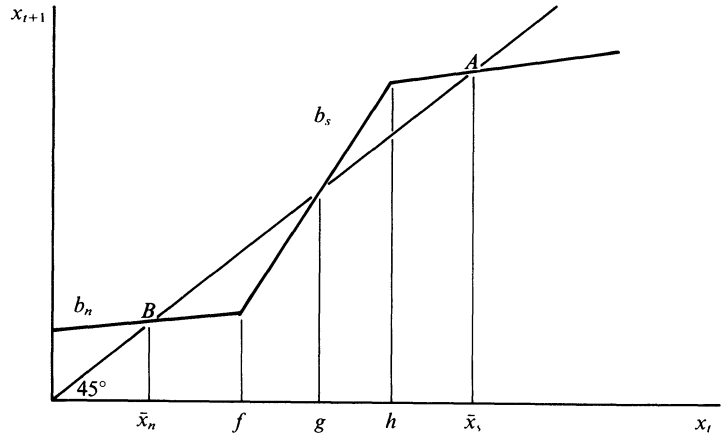

FIGURE 1

Individuals who inherit less than f work as unskilled and so are their descendants in all future generations. Their inheritances converge to a long-run level $\bar{x}_n$:

$$\bar{x}_n = \frac{1-\alpha}{1-(1-\alpha)(1+r)} w_n(2+r). \tag{20}$$

Individuals who inherit more than f invest in human capital but not all their descendants will remain in the skilled labour sector in future generations. The critical point is g in Figure 1:

$$g = \frac{(1-\alpha)[h(1+i)-w_s]}{(1+i)(1-\alpha)-1}. \tag{21}$$

Individuals who inherit less than g in period t may invest in human capital, but after some generations their descendants become unskilled workers and their inheritances converge to $\bar{x}_n$. Individuals who inherit more than g invest in human capital and so do their descendants, generation after generation. Their bequests converge to $\bar{x}_s$:

$$\bar{x}_s = \frac{1-\alpha}{1-(1-\alpha)(1+r)}[w_s - h(1+r)]. \tag{22}$$

Thus, dynasties in this economy are concentrated in the long run in two groups: rich dynasties, where generation after generation invests in human capital, and poor ones, where generation after generation are unskilled workers.

Notice that the slopes of b_n and b_s in Figure 1 are lower than one, at $\bar{x}_n$ and $\bar{x}_s$ respectively, and that means that we assume that α and r satisfy:

$$(1-\alpha)(1+r) < 1. \tag{23}$$

This additional assumption guarantees that the process of bequest from generation to generation is stable and does not explode. Another additional assumption which is implicit in Figure 1 is that enforcement costs are rather high so that the spread between the lending and borrowing interest rates is high too:

$$(1-\alpha)(1+i) = \frac{\beta}{\beta-1}(1+r)(1-\alpha) > 1, \tag{24}$$

so that the b_s curve is drawn in its steep part with a slope higher than one. If (24) does not hold, all long-run distributions of labour are concentrated in either the unskilled labour sector or in the skilled sector. Since this is both unrealistic and uninteresting analytically, we restrict ourselves to the case described by (24).[13] It is also assumed in Figure 1 that g lies between $\bar{x}_s$ and $\bar{x}_n$, for similar reasons.

The dynamic evolution of the aggregate economy can be deduced from individual dynamics, as presented in Figure 1. The economy converges to a long-run equilibrium in which the population is divided into two groups: skilled workers with wealth $\bar{x}_s$ and unskilled workers with wealth $\bar{x}_n$. The relative size of these two groups depends on the initial distrubution of wealth, since the long-run number of unskilled workers L^n_∞ is equal to L^g_t, the number of individuals who inherit less than g in period t:

$$L^g_t = \int_0^g dD_t(x_t). \tag{25}$$

The long-run level of average wealth is:

$$\bar{x}_s - \frac{L^g_t}{L}(\bar{x}_s - \bar{x}_n), \tag{26}$$

which is decreasing with L^g_t/L.

Hence, the long-run levels of income and wealth are positively related to the initial number of individuals who inherit more than g. Thus, an economy which is initially poor, ends up poor in the long run as well. An economy which is initially rich and its wealth is distributed among many, ends up rich. But an economy with a large initial amount of wealth, which is held by few, ends up poor in the long run. If we would like to describe these results in more popular terms, we could say that a country has better growth prospects if it has a relatively larger middle class.

The long-run equilibrium in this model, therefore, depends on the initial distribution of wealth and is as a result historically dependent. There are multiple long-run equilibria and the specific one the economy converges to depends on the initial distribution of wealth.

Note that these results can be applied to a growth model with continuous technological innovations. Assume that productivity in the non-skilled sector w_n grows at a rate α_n, and in the skilled sector w_s and h grow at a higher rate α_s. Then the rate of growth of output per capita is a weighted average of α_s and α_n, where the weights depend on the initial distribution of wealth. Hence, wealth distribution can affect not only the long-run level of output, but the rate of growth as well.[14]

Let us now examine the issue of Pareto-efficiency in equilibrium in our model. It is obvious that wealth redistribution can raise output and income both in the short and in the long-run, but it is not a Pareto-improvement. A Pareto-improvement in our economy is possible, if intertemporal exchange can be facilitated at a lower cost than the costs of monitoring borrowers. Let us consider for example the following policy. The government can subsidize education, which reduces individual costs of investment in human capital h, and finance these costs by a tax on skilled workers in the next period. Such a policy shifts the b_s curve in Figure 1 to the left, lowers both f and g and increases investment

13. The assumption that interest rate for individual borrowers who invest in human capital is much higher than for lenders is also supported by the interesting survey by Tilak (1989) on education. According to studies he cites the estimated yearly social returns to investment in education in developing countries are very high: 26% for primary education, 17% for secondary education and 13% for higher education.

14. Persson and Tabellini (1990) present empirical evidence that supports this result, where they show that a more equal distribution of income tends to increase growth.

and output in the short and in the long-run. This policy can be Pareto-improving if debt collection costs are higher than tax collection costs. This is a plausible assumption for two reasons. The first reason is that the government avoids the need to keep track of each individual borrower, by giving the subsidy to all students and by taxing all those who have a higher income, without even knowing how much each individual borrows. The second reason is that in most cases the tax system already operates for other purposes, and the above policy only raises the taxes already collected.

5. DISCUSSION OF THE BASIC ASSUMPTIONS

Let us now examine more closely the role of various assumptions of the basic model. Examine first the role of the specific form of utility function assumed in equation (3). The logarithmic function greatly simplifies the analysis, but does not affect any of the major results. Even if utility is a general function of consumption and bequest, $u(c, b)$, it is clear that indirect utility depends on the amount the individual has in second period of life and so is his (her) bequest. Hence lifetime utility and bequest are monotonically related and hence the dynamic analysis is basically the same and so are the results.

In the basic model the altruistic intergenerational bequest motive is modelled as utility from the size of bequest. There is an alternative way to model this motive, by assuming that individuals' utility depends not on the size of bequest but on their offspring's utility, as in Barro (1974) and Loury (1981). Is it possible that if poor parents care about the utility of future generations they will save more to enable them in some stage to jump over the hurdle, invest in human capital and become high skilled? The answer is that even under such specification of utility the basic results of the paper hold as well. In an appendix to a former version of this paper (Galor and Zeira (1990)), we show that if the borrowing rate is higher than lenders' interest rate and investment in human capital is indivisible, then even under the Barro specification there are dynasties who remain unskilled workers forever, if their initial wealth is relatively small. We therefore conclude, that the major results of the paper are robust to changes in the specification of utility.

Another specific assumption in the paper is the type of credit market imperfection. We have analyzed the dynamics of the economy under alternative types of credit market imperfections, such as credit constraints due to asymmetric information etc., and the basic results still hold. Under any specification, as long as borrowing is not fully free and costless, those who inherit large amounts have easier access to investment in human capital than those with small bequests.

The results of our model are also robust to the introduction of individual uninsured risk. Even if wages of skilled and non-skilled workers vary randomly, as a result of different skills, the main results of the paper still hold. In order to see that, imagine that w_s and w_n are random but bounded. We can draw the b_s and b_n curves, as in Figure 1, for the upper bounds of w_s and w_n and for the lower bounds. That determines a dynamic band instead of the dynamic curve in Figure 1. If the variability of wages is not too high, the qualitative results are as follows: dynasties with high initial wealth will invest in human capital in every generation and remain rich. Dynasties with low initial wealth will never invest in human capital and remain poor. There is some intermediate domain, in which dynasties may fluctuate between the skilled and non-skilled sector. Hence initial wealth distribution affects the economy in the short and in the long-run, even when skills are heterogenous.

As already mentioned in the paper, imperfection in credit markets is sufficient for wealth distribution to be effective in the short run, but in order to maintain this result in

the long run we add an element of non-convexity to the model, namely indivisibility in investment in human capital. How necessary is this additional assumption? We believe that it is crucial for the major results of the paper. This can be verified by examining carefully the results of Loury (1981). In his model credit markets are imperfect, both due to infinite rate of interest for borrowers and due to lack of insurance, but the production function of human capital is smooth and convex. As a result the distribution of wealth converges to a unique long-run distribution. If we translate this result to our model, then all dynasties invest the same amount in human capital in the long run. This is very different from our results. Hence the results of our model require both assumptions, namely that credit markets are imperfect and that there are non-convexities in human capital.

6. VARIABLE WAGES

In this section we extend the basic model to include variable wages for unskilled workers. This extension has two goals. The first is to make the model more realistic, as it introduces greater mobility between sectors and relaxes the strong segmentation between dynasties in the basic model. The second intention is to enable us to analyze additional issues, such as the correlation between wealth and equality and the adjustment of the economy to aggregate shocks.

Let us, therefore, examine the basic model described in Section 2 with one additional assumption, that production by unskilled labour involves a second factor of production, land. Let production by unskilled labour and land be described by:

$$Y_t^n = G(L_t^n, N), \tag{27}$$

where N is land and G is a standard constant return to scale production function. Let the aggregate amount of land be fixed at $\bar{N}$, so that wages of unskilled workers are:

$$w_t^n = G_L(L_t^n, \bar{N}) = P(L_t^n), \tag{28}$$

where P is a function that describes the diminishing marginal productivity of unskilled labour. We assume that land is traded in a perfectly competitive market, which operates each period after production takes place. Due to lack of uncertainty in this deterministic economy, land is an asset which is equivalent to lending.[15]

We now turn to describe the supply of unskilled workers. Let us slightly change the basic model and assume, for simplification only, that the unskilled work only in first period of life. The supply of unskilled workers is determined by the number of individuals who prefer not to invest in human capital:

$$S_t = \int_0^{f(w_t^n)} dD_t(x_t), \tag{29}$$

where $f(w_t^n)$ is the threshold level for investment in human capital, which has been defined in section 3 in equation (15), and which is equal in this case to:

$$f(w_t^n) = \frac{1}{i-r}[w_t^n(1+r) + h(1+i) - w_s]. \tag{30}$$

15. Hence, if the unit price of land in period t is Q_t, we get: $Q_t(1+r) = Q_{t+1} + G_N(L_{t+1}^n, \bar{N})$ in each period t, where L_{t+1}^n is the expected number of unskilled workers in next period.

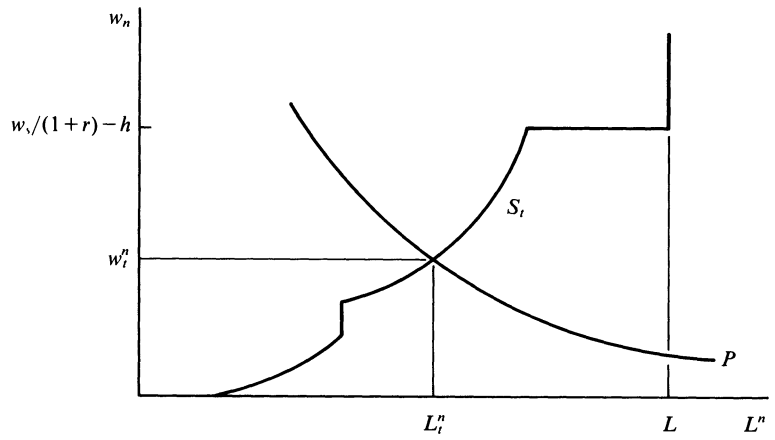

FIGURE 2

Figure 2 presents demand P, supply S_t and the equilibrium in the unskilled labour market. Notice that at $w_t^n = w_s/(1+r)-h$ individuals are indifferent between investing in human capital and working as unskilled, hence the supply curve becomes flat at this wage. The supply curve S_t is upward sloping but can contain horizontal as well as vertical segments. If there is a group of positive measure who inherit the same amount in period t, then there is a horizontal segment in the supply curve. If the distribution D_t is such that there are no inheritances between $f(w_0)$ and $f(w_1)$, then the supply curve is vertical between w_0 and w_1. The equilibrium in the market for unskilled labour, as described in Figure 2, determines the wage of unskilled, the number of unskilled and the number of investors in human capital. It is clear from Figure 2 that this equilibrium depends on the distribution of inheritances D_t. In the next section we show that the historically given distribution of wealth D_t affects the equilibrium not only in the short run, but in the long run as well.

7. WEALTH DISTRIBUTION AND NATIONAL INCOME

In order to examine the dynamics of the economy let us first describe the dynamic evolution of wealth within dynasties:

$$x_{t+1} = \begin{cases} b_n(x_t) = (1-\alpha)[(x_t + w_t^n)(1+r)], & \text{if } x_t < f(w_t^n) \\ b_s(x_t) = (1-\alpha)[w_s + (x_t - h)(1+i)], & \text{if } f(w_t^n) \leqq x_t < h \\ b_s(x_t) = (1-\alpha)[w_s + (x_t - h)(1+r)], & \text{if } h \leqq x_t. \end{cases} \tag{31}$$

These dynamics are similar to those in the basic model with one exception, that w_t^n is no longer fixed, but is endogenous and depends on the distribution of wealth itself. This significantly complicates the dynamic analysis, but as we show later on, our diagrams enable us to describe these dynamics in a fairly simple way.

Figure 3 describes individual bequest dynamics as given in equation (31). As in Figure 1, b_s describes the bequests of investors in human capital while b_n describes bequests of unskilled workers. Figure 3 differs from Figure 1 in one respect: the b_n line is no longer fixed but shifts with w_t^n, which is now endogenous.

Let us define an economy as "developed" if the equilibrium wage of unskilled workers in period t, w_t^n, is high and satisfies: $f(w_t^n) > g$, where g is given by equation (21).

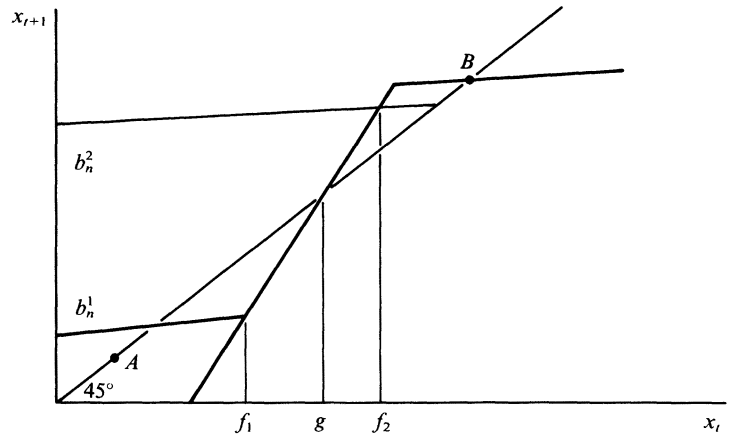

FIGURE 3

Intuitively an economy is developed if the number of individuals who have high inheritances in t is large.[16] Such a case is described by the b_n^2 curve in Figure 3. It can be shown that an economy is developed if and only if $w_t^n > w_g$ where w_g is defined by:

$$w_g = \frac{1}{1+r}\,\frac{\alpha+\alpha r-r}{\alpha+\alpha i-i}[w_s - h(1+i)]. \tag{32}$$

Similarly an economy is defined as "less developed" if $w_t^n \leqq w_g$.

Let us now examine the dynamics of a less developed economy. Individual bequests in this economy in period t are described by the curves b_n^1 and b_s in Figure 3. Notice that individuals who inherit more than g leave a bequest which is larger than what they have inherited, while individuals who inherit less than g leave a bequest which is smaller than what they have inherited.[17] Hence we infer from equation (29) that the supply curve of unskilled labour in period $t+1$, S_{t+1}, is rotated relative to S_t around w_g, as described in Figure 4. Hence, the wage of unskilled workers falls and b_n shifts downward. This process continues and the economy converges to the long-run equilibrium at point A in Figure 4, where the wage is w_∞^n, the number of unskilled workers is L_∞^n and S_∞ is the supply curve. The long-run wealth of the unskilled is $\bar{x}_n$, given by point A in Figure 3. Notice that the long-run number of unskilled workers L_∞^n equals precisely the number of those who inherit less than g in the initial period, L_t^g. Notice that this variable is time independent and remains constant for all t, so that the above results are time-consistent.

Consider now a developed economy where initial unskilled wage is higher than w_g, as described by b_n^2 in Figure 3. In this case every individual (in the relevant domain) bequeaths more than she has inherited. Hence, the supply curve in next period shifts everywhere to the left. As a result wages rise: $w_{t+1}^n > w_t^n$, as is shown in Figure 5. This process continues until equilibrium is reached at B, where the unskilled wage rate is equal to $w_s/(1+r)-h$, and b_n coincides with b_s. This is, therefore, an egalitarian long-run equilibrium, where net life-time incomes of skilled workers and of unskilled workers are equal.

16. It is later shown that the definition of a developed economy is independent of the initial period t (unless there are exogenous shocks or government intervention).

17. This is not true everywhere but in a large neighbourhood of g, but it is sufficient for the analysis which follows.

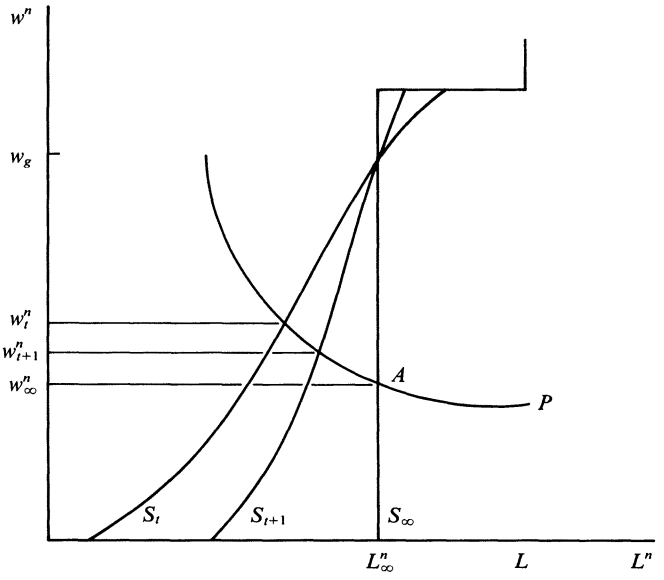

FIGURE 4

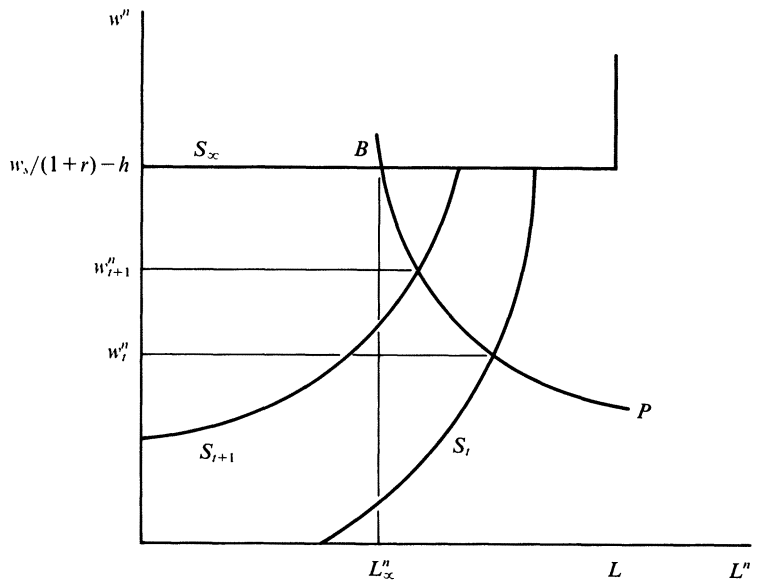

FIGURE 5

The long-run economic dynamics in this model, therefore, crucially depend on the number of individuals who inherit less than g in period t, L_t^g. It can be shown that a country is developed if and only if $P(L_t^g) > w_g$.

We can now summarize the results of this section in the following theorem:

Theorem 1. *If an economy satisfies*: $0 < g < \bar{x}_s$, *its dynamics depend on the number of individuals who inherit less than g in period t*, L_t^g:

(a) A less developed economy, where $P(L_t^g) \leqq w_g$, *converges to an unequal distribution of income, where*:

$$w_\infty^n < w_s/(1+r) - h$$

(b) A rich economy, where $P(L_t^g) > w_g$, *converges toward an equal distribution of lifetime income, where*:

$$w_\infty^n = w_s/(1+r) - h.$$

Theorem 1 assumes that: $0 < g < \bar{x}_s$. If $g \leqq 0$ all countries are developed and converge to an equal distribution of income, while if $\bar{x}_s \leqq g$ all are poor and converge to an unequal distribution. Since we are interested in a situation where income distribution varies across countries we concentrate on the more interesting case and assume that: $0 < g < \bar{x}_s$. It can be shown that $g < \bar{x}_s$ iff $(1-\alpha)w_s > h$ and $g > 0$ iff $h(1+i) > w_s$.

In this section we, therefore, show that wealth and equality are highly correlated and affect one another. On the one hand, countries with greater income per capita have a more equal distribution of income and smaller wage differentials. On the other hand, countries with a more equal initial distribution of wealth grow more rapidly and have a higher income level in the long run. These results shed a new light on the empirical findings on income distribution across countries. It has long been noticed that income tends to be more equally distributed in developed countries than in less-developed countries, as described in the introduction. One of the early explanations for this correlation has been suggested by Kuznets (1955), who claimed that the distribution of income changes along the development path of a country.[18] Thus his theory implied that the changes in observed distributions are due to the fact that countries are at different stages on their growth path. A similar line is adopted in a theoretical study by Greenwood and Jovanovic (1990). Contrary to this approach, which assumes convergence of economies to a unique steady state, our theory presents a very different interpretation of the data. It is claimed that distributions of income differ among countries, since these countries are in different long-run equilibria. Our explanation, of course, does not rule out the existence of a Kuznets curve. It only adds an additional explanation for the correlation between income distribution and aggregate income.[19]

8. EXOGENOUS SHOCKS AND INCOME DISTRIBUTION

In this section we continue to study the extended model, where wages are variable, in order to examine how the economy reacts to exogenous shocks. Let us first consider an adverse supply shock to productivity in the unskilled workers' sector, namely a reduction in P.

Let us assume for simplicity that the shock is unanticipated and that the economy is already in long-run equilibrium at the time of the shock.[20] Consider first the case of a developed economy where wealth is equally distributed. This case is described in Figure 6 by the labour supply curve S_1. The shock reduces the demand for unskilled labour and shift the economy from A_1 to B_1. It has therefore no effect on the wage of unskilled

18. The Kuznets hypothesis had been empirically examined in numerous works. See for examples the surveys of Kravis and Heston (1984) and Lindert and Williamson (1985).

19. According to Cline (1975), the evidence on changes in income distribution in developing countries does not support the Kuznets hypothesis, but rather that of stable distributions.

20. We also assume that the shock is only in this country and not elsewhere in the world. An analysis of world-wide shocks would yield similar results, but would be more cumbersome to analyze, as it would affect world interest rates.

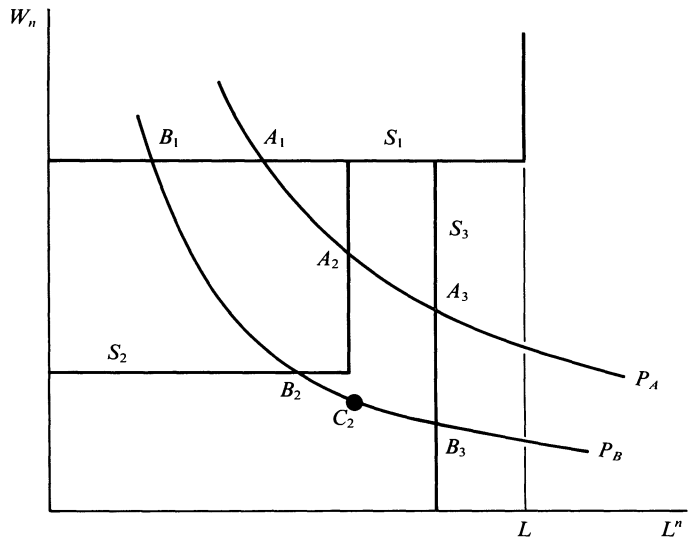

FIGURE 6

workers but only on their number. The economy adjusts immediately through a structural shift, from unskilled to skilled labour, by increased investment in human capital. Notice that income falls on impact, even if wages do not fall, due to an increase in investment in human capital, but this is a temporary fall in income. Net discounted income remains unchanged and there are no utility losses either.

Consider now an economy with unequal distribution of income—a less-developed country. This case is described by the supply curves S_2 and S_3 in Figure 6. The long-run adjustment to the shock is through a decline in unskilled wages and no sectoral shifts, to points like C_2 or B_3. Convergence to the long-run equilibrium can be immediate, as in the case of B_3, when the economy is very poor, or through a temporary rise in skilled labour, as in B_2, but the final result is similar. Hence, economies with unequal income distribution suffer a permanent income and utility loss as a result of the shock, and their distribution of income becomes even more unequal.

Hence, we can conclude that economies with more equal distribution of income adjust better, with smaller income losses, to macroeconomic shocks than economies with highly unequal distribution of income. The intuitive reason for that is that the larger the wealth of an unskilled worker, the easier it is for his/her offspring to shift to the other sector if wages fall.

This analysis can shed some light on the long-run implications of the supply shocks in the seventies. Most studies of these events have concentrated on short-run adjustments to the shocks through wage reduction. Thus, Bruno and Sachs (1985) stress the role of real wage flexibility as an important factor in a country's adjustability to such shocks. In this section we look more into the long-run adjustment to a shock via investment in human capital and structural change in the economy. In the long run it is the initial distribution of income which determines how the economy adjusts to the shock, as described above. It may, therefore, be interesting to examine the patterns of structural adjustments to the supply shocks of the seventies in developed vs. less-developed countries.

Let us now consider another type of exogenous shocks, namely a technological innovation in the skilled labour sector which raises the wage level of skilled workers w_s.

For the sake of simplicity we assume again that the economy is in a long-run equilibrium when the change occurs. The patterns of adjustment to the technological innovation are presented in Figure 7. The technological change raises the bequests of skilled workers and shifts the b_s curve from b_s^1 to b_s^2. Consider first a developed country with an equal distribution of income. In the long run such an economy moves from A to B in Figure 7. Hence unskilled workers' wage rises in order to remain equal to the higher net income of skilled workers, as $w_n = w_s/(1+r) - h$. Investment in human capital in such an economy is increased since the number of unskilled workers is reduced. Both income and wealth increase.

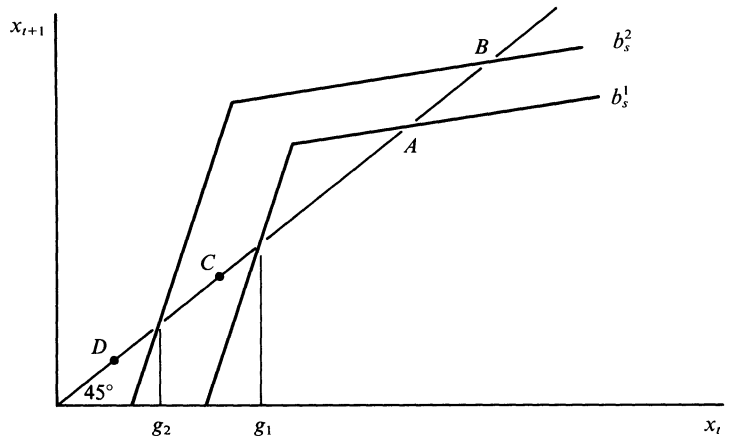

FIGURE 7

Consider now a country with unequal distribution of income. Assume first that the country is not too poor, with unskilled workers concentrated before the change at a point C in Figure 7, where $g_2 < \bar{x}_n \leqq g_1$. In this case, the technological innovation pushes this economy across the threshold to converge to the equal distribution of income, at point B. In such an economy there is a rise in wages in both sectors and a vast investment in human capital. Imagine now that the economy is very poor and unskilled workers are concentrated at a point D, where $\bar{x}_n \leqq g_2$, before the innovation. In this case, the wage and number of unskilled workers remain the same and there is no change in investment in human capital. In fact, the only change in such a poor economy is a rise of income and wealth of skilled workers, while the income gap in society increases.

Thus, the way an economy adjusts to a technological improvement also depends on the initial distribution of income. In countries with fairly equal distribution the rise in skilled labour wage attracts more people to invest in human capital, since they have large enough initial wealth. In poor countries with a very unequal distribution of income there will be no increase in investment in human capital and the economic benefits from the innovation are limited.

9. CONCLUDING REMARKS

This paper analyzes the role of income distribution in macroeconomics through investment in human capital. The study demonstrates, that in the face of capital market imperfections the distribution of wealth significantly affects the aggregate economic activity. Furthermore, in the presence of indivisibilities in investment in human capital, these effects are

carried to the long run as well. Hence, growth is affected by the initial distribution of wealth, or more specifically by the percentage of individuals who inherit a large enough wealth to enable them to invest in human capital. Thus, we can represent our results as describing the importance of having a large middle class for the purpose of economic growth.

In general, this study shows that the distributions of wealth and income are very important from a macroeconomic point of view. They affect output and investment in the short and in the long run and the pattern of adjustment to exogenous shocks. It is, therefore, our belief, that this relationship between income distribution and macroeconomics will attract more studies in the future.

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