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Income Distribution and the Demand Constraint

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This paper argues that the interaction between inequality and the demand patterns for goods is a potential source of persistent inequality. Income distribution, in the presence of non-homothetic preferences, affects the demand for goods and, due to differences in factor intensities across sectors, it alters the return to factors of production and the initial distribution of income. Low inequality leads to high demand for medium skilled intensive goods, providing a bridge over which low skill dynasties may transition to the high-skilled sector in the long run. Under high inequality however, the initial lack of demand for medium skilled labor breaches this bridge from poverty to prosperity and inequality persists.

Keywords: inequality, demand constraint, non-homothetic preferences

JEL classification: O15, J24, and J62

I. Introduction

This paper examines the dynamic interaction between the income distribution in an economy and patterns of demand. It shows that such interaction is a potential source of persistence in initial inequality, that affects (human) capital accumulation and growth. These effects arise because of two factors. First, with non-homothetic preferences, the income distribution affects the pattern of demand for goods and services. Second, due to differences in factor intensities of goods, this demand pattern affects the distribution of factor returns as well. Low initial inequality, through greater demand for less skilled labor, creates a virtuous cycle that carries low income families from poverty to prosperity. Under high initial inequality however, a lack of such demand vitiates this virtuous cycle, resulting in low human capital accumulation and growth.

Links between income inequality and growth have received much attention in the theoretical literature in recent years. Benabou (1996) identifies two broad strands of this literature—one that links inequality and growth through political economy aspects of development and the other, through the role of capital market imperfections (CMI). Our set up here is closer to the latter approach, particularly to the work on inequality and human capital accumulation. Briefly, the CMI approach examines how the lack of easy access to credit can affect aggregate capital investment and economic growth under high inequality. It has been shown that even though poor families could be hindered by credit constraints in the short run, they could still catch up with richer families in the long run by *gradually* accumulating (human) capital over time.[1] Yet, such catch up will not happen if there are indivisibilities in the initial level of investment necessary to acquire any human capital. This is because poor families may never accumulate enough to meet such a threshold.[2]

Distinct from its effect on human capital investment through the cost of funds however, income inequality also has a direct effect on the returns to various skills, through its impact on the composition of demand. The CMI models described above being one good models, cannot capture these demand composition effects or their implications for long run growth. In this paper, we introduce a multiple-good model with non-homothetic preferences in the CMI framework to study these demand effects.

Engel's law implies that an individual's income level must affect his pattern of demand; a poor individual in a developing economy would spend most of his income on essentials such as food. But, as Kindleberger (1989) points out "Engel's law applies to more than food . . . it is a general law of consumption." As an individual's income increases, so would his preference for goods of higher quality and sophistication. In our set up, non-homotheticity takes the form of greater preference for sophisticated goods at higher income levels.

The production of these different types of goods requires various labor skill inputs that are not perfect substitutes. Typically, goods of sophistication and complexity require more skilled labor input than simpler manufactures. As a result, the income based demand pattern described above affects the *derived* demand for various labor skills as well. Richer individuals create a relatively greater demand for more skilled labor than poor or middle income individuals. It follows that a transfer of income from a rich agent to a poor or middle income agent must increase demand for less skilled labor (at the cost of more skilled labor), and affect the returns to these inputs.[3]

In a nutshell then, introducing non-homothetic preferences into the CMI framework creates a distinct new mechanism by which the initial income distribution affects the evolution of inequality and long run growth: Not only does the income distribution in an economy affects its composition of demand, the composition of demand affects the distribution of returns as well. Given such non-homotheticity, we show that high initial inequality can therefore depress human capital accumulation and retard growth in a manner that is self perpetuating.

To understand this interaction, let us classify goods demanded into three broad categories—essentials (like food), simple manufactures (such as bicycles or clothing) and more sophisticated manufactures (such as cars or computers). These goods vary in skill intensity, so consider three corresponding labor skill levels—unskilled, medium-skill and high-skill—one for each category of goods. Acquiring skills requires an initial investment, but in a typical developing economy, capital market imperfections make it hard to obtain loans for education. Hence agents' skill investments are limited by their parents' wealth and bequests. Medium level skills may be affordable to some poor agents, but only the wealthy can afford high level skills. How do demand patterns influence the investment in skills and the growth path of the economy?

Under high income inequality, the absence of a large middle class implies that most people are either too poor to consume anything but essentials, or rich enough to buy sophisticated manufactures. Hence the medium-skilled sector is hit by low demand, which implies low returns to medium-skilled laborers who could not afford high education. But low returns to a poor, medium-skilled laborer today imply that he cannot afford higher education for his children either—hence perpetuating a vicious cycle of high inequality, low demand and low income, low human capital investment and greater inequality.

In contrast, low inequality implies a robust demand for simple manufactures, given the presence of a large middle class—and hence high returns to medium-skilled labor.[4] As a result, an individual who is too poor to invest in high level skills for himself, may still be able to invest in higher education for his children. In this manner, the average skill level, as well as income level in the economy rises over time. The medium-skilled sector thus becomes the bridge over which agents who are poor today make it to the high-skilled sector of the wealthy in the long run; in the process, inequality declines as well.

Under high inequality however, the initial lack of demand for medium skilled labor breaches this bridge from poverty to prosperity. The gap between the poor and the rich widens over time, and the economy stagnates at a low average income level, with a low stock of human capital.

The interaction between demand effects and the income distribution described above also depends on the level of income in the economy. In very poor economies where a large fraction of the population is below subsistence consumption levels, lower inequality may not increase demand for simple manufactures. Hence the virtuous cycle created by low inequality, as described above, may not occur—or even be reversed.[5] However, the focus here is on the more realistic, and hence interesting case.

Thus, the interaction between demand and income inequality can yield (a continuum of) multiple steady states. We find that, at income levels above subsistence consumption, the steady states are such that higher inequality is associated with lower per capita income and lower stocks of human capital. Also, as suggested by our story above, initial conditions affect the dynamic path of the economy, and the steady state it converges to. We find that high initial inequality does result in low per capita income, low average levels of human capital and high inequality in the long run as well. Further, temporary redistribution, through its effects on the demand for, and supply of skills in the short run, is found to have permanent long term effects on the level of per capita income as well as its distribution.

The model adopted here, while highly stylized, is intended to capture the essence of the interaction between income distribution and demand in the most transparent manner. Our goal is not to present a definitive model, but rather an illustrative one. Some of the assumptions made are for expositional simplicity alone, but some others, no doubt, are less innocuous inasmuch as they do away with some potentially important forces. However, these latter forces have been the focus of the CMI literature on inequality and growth. A final perspective must be based on a synthesis of the implications drawn from the entire body of work. The robustness of our assumptions is discussed in a later section of the paper.

Our description of this interaction between demand patterns and income inequality closely resembles various aspects of the growth experience in Brazil during the post-World War II period. According to de-Janvry and Sadoulet (1983), the richest quintile dominated the demand for goods from the high growth sectors in the 1960s; these were all highly skill intensive sectors.[6] Morley and Williamson's (1974) study of the 'Brazilian Miracle' (1948–1962) finds that the growth process led by these very sectors, resulted in lower absorption rates for intermediate skill levels as compared to very high and low level skills.[7] Finally, Langoni (1973) finds that this 'miracle' caused labor demand, and hence the distribution of earnings, to be biased in favor of highly educated workers at the expense of less educated ones. He identifies this as the key source of deterioration in the income distribution in Brazil during this period.[8] It is this kind of *dynamic* feedback effect—from the income distribution to the pattern of demand and then back from demand to the distribution of income that we seek to capture in this paper.

The *static* implications of the effects of non-homotheticity have been studied elsewhere in the literature. Murphy, Shleifer and Vishny (1989) is an early piece of work that highlights how demand patterns under inequality affect the process of industrialization, given increasing returns in production technology. Baland and Ray (1991), Chou and Talmain (1996), de Janvry and Sadoulet (1983), Eswaran and Kotwal (1993) and more recently, Matsuyama (2000) are papers that examine other economic implications of non-homothetic preferences. The dynamic interaction between non-homothetic preferences and human capital accumulation as described here, has not been addressed before.

The paper is organized as follows. Section II describes the basic model and section III, the short run equilibrium. Section IV characterizes the steady states of the model and discusses the nature of the multiple steady states. Section V studies the dynamic path of the economy and demonstrates convergence, starting from any initial conditions. Section VI discusses how differences in initial conditions could lead to different long run outcomes while section VII discusses the robustness of our assumptions and concludes. Proofs of all results are collected in the Appendix.

II. The Model

II.A. The Economy: Basic Description

The economy has an overlapping generations structure, with each generation living for two periods. This structure allows us to depict how wealth is transmitted from one generation to the next.

At birth, each agent i receives a bequest $b(i)$ from his parent. In period 1 of his life, he first decides what amount of his bequest he must invest in education. Having made his desired investment, he then earns income from supplying his labor skills. In period 2, he divides this income between his own consumption and a bequest to his offspring.[9] Agents i are ranked uniformly over the interval [0, 1] in increasing order of the size of their income and wealth.

An agent's choices with respect to education investment and employment are as follows. He can work as an unskilled laborer at a wage w_B, which requires no up front investment in education. Alternatively, he can choose to work as a medium skilled laborer at a wage w_M which requires an initial educational investment of size s_M. Finally, he can work as a high-skilled laborer at a wage w_H after an initial investment of size s_H.

II.B. Production

There are three goods in the economy, denoted by B, M and H. Recall—from our description in the introduction—that good B may be likened to subsistence goods like food, good M to simple manufactures like clothing, toys etc., and good H to more sophisticated items like cars or financial services. These goods are produced with a linear production function, each using labor of a single skill level—B uses unskilled labor as its input, M uses medium-skilled labor, and H uses high-skilled labor.[10,11]

Goods B and H are assumed to be traded in the world market at a fixed international price.[12] We may choose units of these goods so that prices of both goods are equal to one. Given the linear production technology, this implies that the wage levels w_B and w_H may taken to be parameters for the rest of the analysis.

Good M is assumed to be non-traded, so that its price p is determined endogenously by domestic demand patterns.[13] We can choose units of good M such that the output-labor coefficient is one. Given the linear production technology, the wage in sector M, w_M must equal the price p. (Hence w_M is also endogenous.) Henceforth we denote this wage w_M simply by w.

II.C. Preferences and Bequests

Agents gain utility from consuming the three goods B, M and H, and from making bequests to their children. The utility function is defined on the consumption triple $\mathbf{c} \equiv (c_B, c_M, c_H)$ and bequest b as follows.

$$U(\mathbf{c}) = c_B \quad \text{if} \quad c_B \leq \bar{c}_B,$$
$$U(\mathbf{c}, b) = \bar{c}_B + (V(c_M, c_H))^{\alpha} \cdot (b)^{1-\alpha} \quad \text{if} \quad c_B > \bar{c}_B$$

Since B is a basic good such as food, these preferences imply that every individual allocates income only to good B until the required level of good B, $\bar{c}_B$ has been consumed. Any residual income (after consuming good B) is allocated between goods M, H and bequests in the ratio α: $1 - \alpha$.[14]

Here we assume that all agents can afford $\bar{c}_B$. Hence even the poorest agents are able to generate some savings and bequests for their children. This may not be true in very poor economies; we address this case where not all agents can afford $\bar{c}_B$ in a later section of the paper.[15]

If individual income, net of education costs, is denoted by Z and residual income by y, then we have, for all agents i:

$$y(i) = (Z(i) - \bar{c}_B) \geq 0 \tag{1}$$

We can rewrite y as a combination of wage and bequest income. Let $b_t(i)$ denote the total bequest received by individual i at time t, $w_t(i)$ his wage at time t and $s_t(i)$, his educational expenditure at time t. Then we have

$$y_t(i) = b_t(i) + (w_t(i) - s_t(i) - \bar{c}_B) \tag{2}$$

Since a fraction $(1 - \alpha)$ of residual income y is bequeathed to the next generation, we observe the following intertemporal pattern in y.

$$y_t(i) = (1 - \alpha)y_{t-1}(i) + (w_t(i) - s_t(i) - \bar{c}_B) \tag{3}$$

We make some additional assumptions on consumption preferences. First, both M and H are normal goods in the range where they are bought. Second, demand for good M is assumed to be increasing, but *concave* in income. This implies that the *share* of residual income allocated to M is decreasing in (residual) income.[16] (Hence good H is a luxury in the sense that the share of expenditure on this good increases with an increase in residual income, y.)

The above specification of preferences and the allocation of consumption expenditure arising from it allows us to compute an individual's demand for good M, $c_M(p, y)$ at a given date. To obtain the aggregate demand for good M, we then integrate $c_M(p, y)$ over the distribution of y prevailing at that date.

Next, we must address issues relating to the supply of good M. Since labor is the only input, this brings us to the labor supply and education choices of agents. We describe these in the following sub-section.

II.D. Occupational Choices and Education

As mentioned earlier, medium and high-level skills require an initial investment of size s_M and s_H respectively, where $s_M < s_H$. These costs are expressed in units of good B. Since the price of good B is fixed, the costs of investing in medium and high level skills also remain fixed over time.

It is assumed that there are no capital markets that fund such initial investment in skills. Hence agents must finance education solely out of their inheritance.

Of course, this would imply that they would differ in the levels of education they afford; some may afford none at all, some others up to the medium level, and a few up to the highest level, depending on the bequest distribution. However, we make the simplifying assumption that *all* agents can afford medium level education, though not all agents can afford high education.[17]

To express this assumption formally, observe that the poorest (assetless) agent can earn a wage of at least w_B since sector B requires no up-front investment in education. At this wage, an agent i will bequeath $(1-\alpha)[w_B - \bar{c}_B + b(i)]$.[18] If several generations of this family earn the low wage w_B, then, in the long run, an agent belonging to this family will enjoy an inheritance of $\frac{1-\alpha}{\alpha}(w_B - \bar{c}_B)$.[19] This amount is enough to purchase medium-level skills required for sector M. Thus, the assumption implies that

$$\frac{1-\alpha}{\alpha}(w_B - \bar{c}_B) \geq s_M \tag{4}$$

Of course, not all agents can afford high-level education. Specifically, bequests made out of income earned in sector B are never sufficient to cover the cost of high education whereas bequests made out of incomes earned in sector H are large enough to cover this cost. This assumption may be expressed as follows:

$$\frac{1-\alpha}{\alpha}(w_B - \bar{c}_B) < s_H < \frac{1-\alpha}{\alpha}(w_H - s_H - \bar{c}_B) \tag{5}$$

The last expression in equation (5) represents the long-run income in sector H. Since $s_H < \frac{1-\alpha}{\alpha}(w_H - s_H - \bar{c}_B)$ (in (5)), it follows that $s_H < (1-\alpha)(w_H - \bar{c}_B)$. In other words, any agent, once employed in sector H, can *always* make a bequest large enough to afford high education for his offspring.

Equation (5) also implies that the net returns in sector H are strictly higher than those in the sector B. Recall that w_H and w_B are specified as parameters. In other words,

$$w_H - s_H > w_B \tag{6}$$

Of course, we cannot make any similar assumption regarding the wage in sector M, as it is endogenous.

The above description of occupational choices allows us to determine the supply of medium-skilled labor in sector M at any date. We do so in the following section. We also trace out the demand curve for medium-skilled labor in the short run and describe the intertemporal equilibrium in this economy.

III. The Short Run

In describing the equilibrium in this economy at any date, we focus on sector M alone. Since the two other goods, B and H, are traded internationally at fixed prices, no independent equilibrium conditions need be imposed on those sectors.

We describe the equilibrium in terms of the market for medium skilled labor. Since the production function is linear, this is equivalent to discussing the equilibrium in the output market for good M.

As a first step, let us trace out the supply curve for medium-skilled labor, using the description of occupational and educational choices from the previous section.

Since an individual's bequest constrains his educational choice, and hence skill level he supplies to the market, we first define the fraction of the population that can afford high education. To do so, recall that individuals i are ranked uniformly over the [0, 1] continuum in increasing order of their income. Given a distribution $\mathbf{y}$ of residual income at any date, let $i^*(\mathbf{y}) \in [0, 1]$ be the poorest individual who can afford high education.[20] Thus, a population of size $(1 - i^*)$ can afford high education. We can use this to trace out the labor supply curve.

The Labor Supply Curve

A wage of w_B in sector B is always attainable for any agent, with no up-front investment in education. For there to be a positive supply of labor to sector M, the wage in this sector, net of the cost of education, must be at least as high as w_B. Also, agents $i \in [0, i^*)$ can afford only up to medium level education, so they must supply their labor to sectors B or M, but not H. Using this information, the labor-supply curve in sector M may be traced out as follows (refer to Figure 1). Letting $w_B + s_B \equiv \underline{w}$ and $w_H - (s_H - s_M) \equiv \bar{w}$, it must be the case that

$$\begin{aligned} L_S &= 0 \qquad \text{for } w < \underline{w} \\ &\in (0, i^*] \qquad \text{for } w = \underline{w} \end{aligned}$$

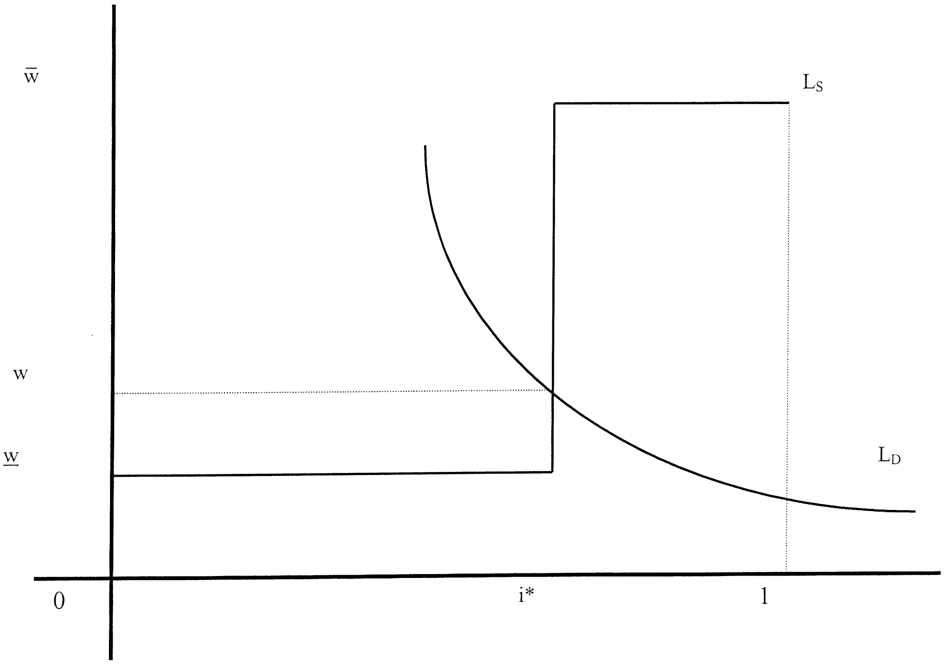

Figure I. Single period equilibrium.

$$
\begin{aligned}
&= i^* \qquad \text{for } \underline{w} < w < \bar{w} \\
&\in [i^*, 1] \qquad \text{for } w = \bar{w} \\
&= 1 \qquad \text{for } w > \bar{w}
\end{aligned} \tag{7}
$$

At $\underline{w}$, an agent who cannot afford high education is indifferent between working in sectors B and M. Hence, as seen in the diagram, the L^S curve is horizontal at this wage, over the range $[0, i^*]$. Similarly, at $\bar{w}$, an agent is indifferent between working in sectors M and H. This gives rise to another horizontal segment of the supply curve at $\bar{w}$. For any wage between $\underline{w}$ and $\bar{w}$, an agent who can only afford medium-level education strictly prefers to work in sector M rather than in sector B. For any wage below $\bar{w}$, an agent who can afford high education strictly prefers to work in sector H over other sectors. This gives us the vertical segment of the labor supply curve. Next, we trace out the demand curve for medium-skilled labor, based on agents' preferences.

The Labor Demand Curve

Let $l^D(w, y(i))$ be the representative consumer's demand function for medium-skilled labor (or equivalently, for good M).

At any date t, only the old agents in the economy consume. The residual income which they allocate towards good M is carried over from the previous period $t-1$. However, the wage of medium-skilled labor that they must pay is the current period wage. Hence the ith family's demand for medium-skilled labor at date t is given by $l^D(w_t, y(i)_{t-1})$.[21] The market demand for medium-skilled labor at any time t, L_t^D can be obtained by simply integrating the individual labor demand over all i. Thus we have

$$L_t^D(w_t, \mathbf{y_{t-1}}) = \int_0^1 l^D(w_t, y_{t-1}(i))\, di \tag{8}$$

At any period t, market-clearing requires that the total demand for medium-skilled labor, L_t^D, equal the total supply of medium-skilled labor, L_t^S. Let L_t denote the market-clearing amount of labor in sector M at date t. Given our description of labor demand and supply earlier, *market-clearing* at any date t is achieved provided:

$$L_t^D(w_t, \mathbf{y_t}) \leq i^*(\mathbf{y_t}) \tag{9}$$

with equality holding if $w_t > \underline{w}$.[22]

We can now define an intertemporal equilibrium as a sequence of wages $\{w_t\}_{t=1}^{\infty}$ that leads to market-clearing at every date, given an initial distribution of residual income $\mathbf{y_0}$.

Note that, given $\mathbf{y_0}$, any sequence of wages $\{w_t\}_{t=0}^{\infty}$ defines a sequence of residual incomes $\{\mathbf{y_t}\}_{t=0}^{\infty}$, bequests $\{\mathbf{b_t}\}_{t=1}^{\infty}$ and fractions of agents who can afford high education, $\{(1-i_t^*)\}_{t=1}^{\infty}$. Hence, given any sequence of wages, the market-clearing condition can be checked for at every date.

The market clearing wage at any period t determines the distribution of residual incomes, $\mathbf{y_t}$ and the bequest distribution at period $t+1$, $\mathbf{b_{t+1}}$. The distribution $\mathbf{y_t}$ determines the aggregate labor demand, L_{t+1}^D and the distribution $\mathbf{b_{t+1}}$ determines the labor supply, L_{t+1}^S. The intersection of the demand and the supply curve ensures market clearing at any date.[23] Also, note that the labor supply curve is non-decreasing in the wage and the labor demand curve is strictly decreasing in the wage. This gives us a unique market clearing wage at date $t+1$, w_{t+1}, and this process repeats itself in all subsequent periods.

Thus, starting from date 0, the equilibrium sequence $\{w_t\}_1^{\infty}$ can be determined recursively. Since the market-clearing wage in any period is unique, the equilbrium path $\{w_t\}_1^{\infty}$ must also be unique, given a distribution of residual incomes, $\mathbf{y_0}$ at the initial date.

One special case of such an equilibrium sequence $\{w_t\}_{t=0}^{\infty}$ is when $w_t = w_{t+1}$, such that the distributions $\mathbf{y_t}$ and $\mathbf{y_{t+1}}$ are identical—what we conventionally describe as a steady state. We begin our analysis of this economy by studying such intertemporal equilibria that are steady states.

IV. Steady States

A distribution of income $\mathbf{y}$ constitutes a steady state if, given consumption and bequest preferences, it is self-perpetuating from one period to the next. We choose to describe a steady state in terms of the collection $\{\mathbf{y}, w, i^*\}$, where w is the (stationary) market clearing wage and $(1-i^*)$ is the fraction of agents employed in sector H.[24] We explicitly add the wage and employment levels here, simply to bring out interesting differences in the features across steady states.

A steady state distribution **y** is closely associated with w and i^*, and it can easily be recovered from these latter variables. It is easy to see that **y** is at most a two point distribution given by:

$$\mathbf{y} = \frac{w - s_M - \bar{c}_B}{\alpha} \quad \text{for fraction } i^*$$
$$= \frac{w_H - s_H - \bar{c}_B}{\alpha} \quad \text{for fraction } (1 - i^*) \tag{10}$$

Note that, since the wages w_B and w_H are exogenously specified, the steady state value $\frac{w_H - s_H - \bar{c}_B}{\alpha}$ is exogenous. On the other hand, the steady state value of $\frac{w - s_M - \bar{c}_B}{\alpha}$ is *endogenous* since the wage in sector M, w is endogenously determined.

Given income and bequests in steady state, we can derive the labor supply curve, as before. As for labor demand in the steady state, let us denote it by L^D. Since by equation (10) above, agents are distributed over at most two income levels in steady state, we can write labor demand as: $L^D \equiv i^*.l^D(w, \frac{w - s_M - \bar{c}_B}{\alpha}) + (1 - i^*).l^D(w, \frac{w_H - s_H - \bar{c}_B}{\alpha})$. Note that this expression does not characterize labor demand in the standard sense. Here, the wage variable affects not only the price of labor but also the income earned by labor. For our analysis in this section, we assume that $L^{D\prime}(w) < 0$.[25]

We are now ready to describe the necessary and sufficient conditions on labor supply and labor demand for a collection $\{\mathbf{y}, w, i^*\}$ to form a steady state.

Proposition 1 *A collection $\{\mathbf{y}, w, i^*\}$ is a steady state if and only if one of the following three conditions holds:*

(I) $w = \underline{w}$ *and* $i^*.l^D\left(\underline{w}, \frac{\underline{w} - s_M - \bar{c}_B}{\alpha}\right) + (1 - i^*)l^D\left(\underline{w}, \frac{w_H - s_H - \bar{c}_B}{\alpha}\right) \le i^*$

(II) $\frac{1-\alpha}{\alpha}[w - s_M - \bar{c}_B] < s_H$ *and* $i^*.l^D\left(w, \frac{w - s_M - \bar{c}_B}{\alpha}\right) + (1 - i^*)l^D\left(w, \frac{w_H - s_H - \bar{c}_B}{\alpha}\right) = i^*$

(III) $w - s_M \ge w_H - s_H$ *and* $i^*.l^D\left(w, \frac{w - s_M - \bar{c}_B}{\alpha}\right) + (1 - i^*).l^D\left(w, \frac{w_H - s_H - \bar{c}_B}{\alpha}\right) = i^*$

(I)–(III) are market clearing conditions that correspond to the three points marked by arrows in Figure 2. Under Condition (I), the market clearing wage, $\underline{w}$ is the lowest possible. Given this low income level, demand for the middle good is low. Again, since the wage is low, fewer agents can afford high education, hence labor supply to the middle sector is very high. Thus a low demand for, and a large supply of labor, reinforces the low wage, $\underline{w}$ as a steady state.

In contrast, under Condition (III), the wage is at the highest possible level $\bar{w}$. Hence demand for the middle good is high. All agents have access to the high sector at this wage, so labor supply to the middle sector is forthcoming only at a wage of $\bar{w}$, equivalent to w_H (or greater). This justifies high wage $\bar{w}$ as a steady state.

Condition (II) represents the 'intermediate' case where the wage lies between the two extremes. Herein wages are not as low as $\underline{w}$, so agents can demand more of good M, and more of them can afford high education than in (I). Since the wage is higher than that in sector B, all agents without access to sector H choose employment in sector M.[26]

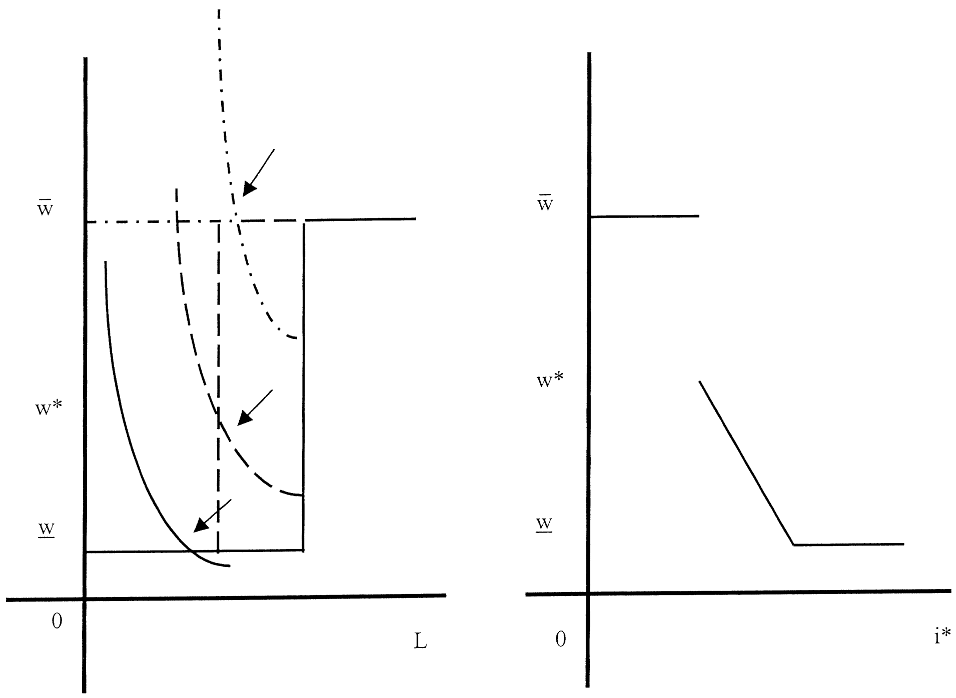

Figure 2. Characteristics of steady states.

Figure 2 suggests then, that there are three possible 'types' of steady states, with different wage levels. But, apart from wages, how are they qualitatively different from each other? Is it possible to rank them by some criterion? Proposition 2 below addresses these questions. We see that these steady states differ not only with respect to wage levels, but also with respect to the level of per capita incomes, the stocks of human capital, patterns of employment as well as the degree of inequality in the economy.

To help interpret Proposition 2, we define w^* to be the minimum steady state wage in sector M at which agents in this sector can afford high education. Hence $\frac{1-\alpha}{\alpha}.(w^* - s_M - \bar{c}_B) = s_H$.

Proposition 2 *(i) The set of steady state wages consists of the interval* $[\underline{w}, w^*)$ *and* $\{\bar{w}\}$.

(ii) In this range, for $w > \underline{w}$, w *and* i^* *are negatively related over steady states: a lower proportion of people employed in the* H *sector is associated with a lower* M *sector wage.*

The second graph in Figure 2 maps the relationship between wage and employment levels in sector M across different steady states, based on the graph to its left.

As we saw earlier, when the wage is at its lowest, i.e. $\underline{w}$, there is a large fraction of poor agents, i^* who are denied access to high education and employment in sector H. This implies that the total stock of human capital in the economy must be very low.

Not surprisingly, this low stock of human capital is associated with low per capita income as well. As is typical of low income economies, a significant number of the poor agents are employed in the subsistence sector B, for want of sufficient demand for good M.[27] At the same time, a small fraction $(1 - i^*)$ of agents are employed in sector H at the high wage $\bar{w}$. Hence there is a yawning gap in the incomes of rich and poor agents.

When the wage is somewhat higher (above $\underline{w}$), more agents have access to high education, and have been able to move over to sector H. Hence the stock of human capital, and with it, per capita income, is higher as well. Given greater demand for good M, poorer agents left out of sector H are now all employed in sector M. Though these agents still receive a much lower wage than those in sector H, wage inequality between rich and poor agents is not as high as in the earlier case. In fact, for this intermediate range of steady state wages, the higher wage rate in sector M goes hand in hand with a higher employment in sector H (and lower employment in sector M).[28] It follows that higher the wage in this range, higher the per capita income and stock of human capital, as well as lower the wage inequality between rich and poor.

Of course, if the wage were high enough that even all poor agents could afford high education for their children, then all agents could potentially move over to sector H. In the picture w^* depicts the minimum wage level where this becomes feasible.

Beyond this level, wages in sector M must 'jump' to a level as high as in sector H—that is, $\bar{w}$—to attract any labor. Hence the gap in the set of steady states wages between w^* and $\bar{w}$. In this 'happy' steady state where $w = \bar{w}$, per capita incomes and stocks of human capital are at their highest, and there is no inequality whatsoever.

In a nutshell, our analysis of steady states reveals that richer economies would have higher stocks of human capital and lower inequality in steady state—which is pretty consistent with the features of developed, as opposed to developing economies.[29]

It would be useful to understand the role that inequality plays in a market economy to yield such different outcomes. Consider a case where the fraction of agents with access to sector H is parametrically reduced, even as wages in sector M are kept fixed. How does the market respond to this change?

Clearly, there is a drop in total income, as a result of this change—hence demand for good M and medium-skilled labor must fall. Since fewer agents now have access to sector H, the labor supply to sector M has increased as well. Hence the wage in sector M must fall. Effectively, *the response of the market to this change in the distribution is to accentuate wage inequality*.[30] Hence steady states with a larger fraction of agents without access to sector H are associated with lower M sector wages.

We would now like to delve deeper into this link between the income level in steady state and its distribution. Towards this goal, our next step is to understand the *dynamic process* which may cause the economy to end up at any one of these scenarios described above, in the long run. This analysis is our focus in the next section.

V. Transitional Dynamics

We examine the dynamic path of the economy, starting at any initial date.

Earlier, in section 3, we described how individual incomes, and hence distributions evolve in this economy from one period to the next. Such distributional changes, through effects on labor demand and labor supply, affect future wages. Of course, across any two periods, changes in the income distribution involve rising incomes for some agents and falling incomes for others. But this makes it hard to predict what the aggregate effect on labor demand and supply may be. Therefore, wages may fluctuate up or down, quite haphazardly, from one period to the next.

However, a closer look tells us that, even with individual incomes within a distribution moving in opposing directions, there is in fact a certain pattern to wage movements. Interestingly enough, these patterns are such that, no matter what the initial distribution in the economy, it always converges to one of the steady states described in the previous section in the long run. This is the subject of our next proposition.

Proposition 3 *Starting at any initial conditions, the wage in sector M converges to $w \in [\underline{w}, w^*)$ or $\{\bar{w}\}$. Hence, the corresponding distributions* **y** *and* **b** *also converge.*

How does such convergence occur? It comes about through an interesting interplay of two factors. First, the evolution of the income distribution over time displays a particular pattern, described below. Second, the demand for good M is concave in income.

From our description of the intertemporal movement in income in equation (3), we can see that there must be *a gradual reduction in the spread of incomes of agents within any particular sector*, between any two periods.[31]

To understand the convergence result, let us focus on what happens to the *average residual income* during this process. Suppose there is an increase in this average income at any period, over the previous period: $\bar{y}_t > \bar{y}_{t-1}$. This implies that the rise in the incomes of the poorer agents in the economy is larger than the fall in the incomes of the richer agents. How does this affect the demand for, and supply of labor, to sector M?

Given that L^D is concave in income, this increase in average income at period t over period $t-1$ must cause the demand for good M to increase in period $t+1$ over the level prevalent in period t.[32] Supply of labor to sector M is non-increasing over time, since a family from which an agent graduates to sector H, can always afford high education in future. These changes in L^D and L^S cause wages at time $t+1$ to increase.

Income in period $t+1$ is a combination of bequest out of income from period t and wage, w_{t+1}. Since, both the average income in period t and the wage w_{t+1} are higher, the average income in period $t+1$ must be higher than in period t as well. This causes another round of increase in labor demand and possibly, decrease in labor supply in period $t+2$, and henceforth in all future periods. Thus, *an increase in average residual income in any single period implies that the average residual income must increase in every subsequent period.* In the absence of such a one period increase, it follows that the wage must either remain constant or decrease over time. Since the wage in sector M must always lie between $\underline{w}$ and $\bar{w}$, it must always converge.

So we have learned that the wage must always converge to some steady state level—but the more interesting question is, can we tell what this wage level will be, or what determines it? Do initial conditions influence it in any way? Our analysis in this section does provide some clues. That a *one-time* increase in average residual income is crucial in creating an upward moving spiral of wages and bequests does suggest that initial conditions matter. We elaborate on this in the next section.

VI. How Initial Conditions Matter

Here we address what are really the central questions of the paper: How does the degree of income inequality at some initial date, through the demand patterns that emerge, affect the future growth path of an economy? How do such initial demand patterns affect the long run income level and its distribution? Do they have a tendency to perpetuate inequality, or do they reduce inequality over time?

To answer these questions, we examine how a redistribution program at some initial date would affect the growth path of the economy. Under such a program, rank-preserving Dalton transfers are made from the richest to the poorest agents in the economy. Thus, our implicit definition of lower inequality here is in terms of a narrower *range* of the income distribution.[33] Further, transfers by rich agents do not end up denying their offspring access to high education.[34] We compare the dynamic paths of the economy and its long run equilibrium with and without such redistribution.

We find that, given an income level where all agents are able to meet their basic needs (i.e. $\bar{c}_B < \underline{w}$), economies with lower initial inequality end up with a *strictly* higher long-run income levels (and stocks of human capital), which are also more equally distributed.[35] To see why, let us first examine how lower initial inequality affects the wage path in sector M.

Lemma 1 *Let $\{w_t\}$ and $\{w'_t\}$ be the equilibrium wage paths before and after redistribution respectively. If $w'_T > \underline{w}$ at some $T \geq 0$, then $w'_t \geq w_t$ for all $t > T$.*

Consider the short run effects of redistribution on labor demand and supply in sector M. It transfers income from those at the higher end of the income range to those at the lower end. Since, for $\bar{c}_B < \underline{w}$, labor demand is increasing and concave in income, the L^D curve in period 1 must shift out. Also, since no agents are drawn out of sector H as a result of redistribution, the L^S curve is as before.[36] If the labor demand curve shifts out beyond the horizontal part of the labor supply curve, the wage must rise. Suppose this is true in period 1.

Such a rise in the wage benefits those at the lower end of the income distribution. Demand for good M being concave in income, period 2 demand for M must be higher as well. With rise in period 1 incomes, labor supply to sector M is possibly lower too. Thus a *one-period* redistribution, by creating greater equality in initial incomes, triggers off wage and income increases in every subsequent period, through its effects on labor demand and supply. Therefore, the new wage path is higher than the original one.

If the L^D curve shifts out beyond the horizontal part of the L^S curve, not at period 1, but at some later date T, then the above analysis holds for any period after T. However, if the L^D curve never shifts out beyond the horizontal part of the L^S curve, then the wage path after redistribution is the same as that without it.

What does all this imply for the long run wage? Does such redistribution result in a long run income level that is *strictly* higher than what would otherwise have prevailed? This is the subject of our next proposition.

Proposition 4 *Lowering initial income inequality (through redistribution) always results in a long run wage that is strictly higher than the original long-run wage if*

(i) the long run wage along the original path, $w \in (\underline{w}, \bar{w})$ *and*

(ii) the initial distribution $\mathbf{y_0}$ *is continuous at the value of* $i^*(\mathbf{y})$ *associated with the original long run distribution of* $\mathbf{y}$.

Proof: See Appendix. ■

As described above, redistribution pulls up the incomes of the poor because the changes in demand that it produces raises wages in the short run. In general, this ensures that the long run wages are higher with lower initial inequality. However, the two conditions stated in the proposition caution us as to when this may not be true.

The first condition accounts for the possibility that even if labor demand does rise, it may not be sufficient to pull up the wages in sector M beyone $\underline{w}$. (This is a possible outcome when condition (i) does not hold.) The wage is more likely to remain permanently low at $\underline{w}$ if a large fraction of the initial distribution is poor, so that the labor supply pool is large enough to absorb any increase in labor demand. (If the original long run wage is already at the highest possible wage $\bar{w}$, then the long run wage after redistribution will be $\bar{w}$ as well.)

Also, it is possible that the wages do increase over the short run, but never enough to pull more agents over to sector H in the long run, with redistribution. (Again, this is a possible outcome when condition (ii) does not hold.) This may occur, for instance, if the economy is very polarized, with high initial income inequality. If so, small transfers made to poor agents may fall far short of helping them afford high education. Hence the size of the lesser skilled labor force is not lower in the long run and the medium-skill sector wage remains low, as before.[37] Note however that (i) and (ii) are only *sufficient* conditions. The long run wage may still be higher after redistribution, in spite of them.

There is an important aspect of difference in the dynamic demand effects described here, as compared to those described in the CMI literature on lumpy schooling investments, started by Galor and Zeira (1993). In the basic Galor-Zeira model, redistribution increases the human capital stock of the economy only to the extent that it relaxes the funding constraint of recipients in a direct and immediate way. There is no true macro-economic interaction, or pecuniary externalities. One implication is that redistribution from the rich to the very poor may not be effective at all. A later section in Galor-Zeira (1993), as well as Owen and Weil (1998), generate pecuniary externalities through supply-side effects: redistribution reduces the size of the less skilled labor force, and in the presence of diminishing marginal product, exerts upward pressure on their wages. Such externalities allow for "trickle-down" or multiplier-type effects of a redistribution scheme—even those who do not directly receive transfers may benefit in the long run, through the resultant movement of market prices and wages.

In this paper, we identify a new pecuniary externality working from the demand side. Regardless of who receives transfer payments, redistribution generates additional demand for middle level skills, increasing the returns to such skills, with its consequent long-run implications as discussed above. In the presence of strongly non-homothetic preferences, this effect could be fairly large in magnitude, and hence it is an important aspect of the role played by the income distribution in long-run growth.

Robustness Issues

The model presented above illustrates how initial conditions with respect to the income distribution can affect long run outcomes in an economy. In particular, it emphasizes that higher initial income and wealth inequality can result in greater long run (wage) inequality and lower per capita income. To make this point in a transparent manner, we have adopted some simplifying assumptions. In this sub-section, we discuss the extent to which our basic conclusions are sensitive to them.

Unskilled wages are high enough to cover basic needs ($w > \bar{c}_B$) Under this assumption, all agents are consumers of the non-basic items (i.e. M and H). This may not be true in extremely poor developing economies. If so, redistribution may in fact lower long run wages and the stock of human capital in such an economy. If several agents in an economy are so poor, income transferred to them from richer agents would be spent entirely on B. Also, redistribution would lower the demand for M from richer agents whose incomes are taxed. As a result, the overall demand for good M could in fact fall in the short run, and hence so would wages in this sector. The impact on future demand and hence incomes levels, would be adverse as well.[38]

All agents can afford medium level education. ($\frac{1-\alpha}{\alpha}(w_B - \bar{c}_B) \geq s_M$) Under the original model, redistribution results in an increase in demand for medium skilled labor, as well as a decrease in its supply. However, if some agents cannot afford medium level education to begin with, and if they are the main beneficiaries of a redistribution scheme, then such a redistribution may end up increasing the labor supply to the medium skilled sector. The demand and supply effects of redistrubtion would then be in opposing directions and hence the overall effect of it would be ambiguous.

At the other end, if income levels in an economy are high enough that all agents can afford high education, then the income distribution does not affect the long run income level. Thus, whether inequality is beneficial or harmful for growth depends upon the existing income level in the economy as well as its distribution.

Absence of physical capital While the model describes how inequality can hinder human capital accumulation, it does not consider the issue of physical capital, and the savings required for its accumulation. Given the threshold $\bar{c}_B$, lower inequality could lower aggregate savings in economies where consumption is below subsistence level, and therefore reduce the amount of physical capital accumulation. An older literature (Kaldor (1956), Keynes (1920)) emphasizes this opposite kind of impact of inequality on physical capital accumulation. This effect arises through a higher marginal propensity to save among the rich. In a model where both kinds of capital are used in the production technology, the effect of the income distribution on growth would be more ambiguous. If production requires both physical and human capital, lower inequality could lower the returns to human capital, and adversely affect its accumulation as well. Thus, inequality could have different effects, depending upon a country's stage of development.[39]

Linear production function The model assumes that each good uses only one kind of labor with fixed coefficients. This may easily be relaxed to allow for multiple labor skill inputs for each good, with fixed coefficients. The results of the model would not be affected by such a modification, as long as the relative requirement of medium-skilled labor decreases going from M to H. There are more complications, however, if the assumption of linear technology is dropped.

The qualitative properties of our results are maintained in the case of decreasing returns in sector M, but things are more ambiguous in the case of increasing returns. The linear production technology allows us to focus on the demand effects of inequality, while ignoring certain other effects. In particular, it guarantees that every increase in demand for M results in higher wages. To see how, use the fact that $w = p.MPL$. Every increase in the previous period income causes the demand curve this period to shift out (and the supply curve of labor to sector M to shift in, provided the initial income distribution is continuous). Since the supply of good M is non-increasing, the price p must rise. With a linear production function, the constant MPL (marginal product of labor) ensures that the wage this period must rise too. With a decreasing returns to scale production function, MPL is non-decreasing, hence wages would be higher in that case as well. With increasing returns to scale, MPL need not be higher, hence the impact on wages is not clear. Further, in either of the latter two cases, the issue of how profits should be dealt would remain. Thus, non-linear production technologies would create effects other than the demand effects highlighted here, which would be important to examine. These 'supply side' effects have in fact been captured in other papers in the CMI literature.[40]

VII. Conclusion

This paper examines how the *two-way* interaction between income inequality and the pattern of demand affects human capital accumulation and growth in a developing economy. While the effects of the income distribution in an economy on demand patterns have been widely studied so far, much less has been said about how demand patterns affect the distribution of income.

We explore this link in a model with three categories of goods—essentials, simple manufactures and sophisticated manufactures—and three corresponding skill levels. Our main result is that in developing economies (except possibly in those below subsistence levels) demand patterns under high inequality reduce long run growth and perpetuate inequality. This hinges on the demand for simple manufactures that are produced with medium level skills. Under high inequality, the absence of a middle class keeps this demand low, and hence depresses incomes of poor, medium-skilled workers. Furthermore, since this hinders their ability to provide a better education to their children as well, it lowers the long run average income level, and perpetuates inequality. Under low inequality, however, the presence of a large middle class at the initial date ensures robust demand for simple manufactures, and high returns to medium-skilled labor. The medium-skill sector hence becomes a bridge from poverty to prosperity. Thus, multiple steady states emerge, where inequality and per capita income are inversely associated; long run outcomes depend crucially on the initial distribution of income.

Our analysis thus highlights a new aspect of the link between inequality, human capital accumulation and growth, namely, demand patterns; existing theoretical work on inequality has focused mostly on the impact of credit constraints on this process. We believe that this paper presents a richer interaction between demand and supply side factors that link income inequality and growth in a developing market economy. In this sense, it is a step in the direction of gaining a wider understanding of inequality in the process of development.

Appendix

Proof of Proposition 1: Suppose a collection $\{\mathbf{y}, w, i^*\}$ is a steady state.

Since $\bar{c}_B < 1$, by assumption, employment in sector M must always be positive in equilibrium. Hence $w \geq \underline{w}$.

Let w^*, where $\underline{w} < w^* < \bar{w}$ be the minimum wage such that an agent's bequest is eventually just sufficient to cover the cost of high education.

Hence $b = \frac{1-\alpha}{\alpha}[w^* - s_M] = s_H$.

Note that $w^* \in (\underline{w}, \bar{w})$ since we have assumed that the bequest at a wage of $\underline{w}$ is never sufficient to cover the cost of high education whereas the bequest at a wage of $\bar{w}$ is more than sufficient to do so.

In order to prove Proposition 1, let us make use of the following lemma.

Lemma 2 $w \in [w^*, \bar{w})$ *and* $w > \bar{w}$ *cannot prevail in any steady state.*

Proof: Suppose $w \in [w^*, \bar{w})$ is a steady state wage. Then, we know from equation (10), that $y_t(i) = \frac{w - s_M - \bar{c}_B}{\alpha}$ for a fraction i_t^* of the population, at some time $t \geq 0$, where $i_t^* \equiv i^*(\mathbf{y_t})$. Hence, $b_{t+1}(i) \geq s_H \forall i$. If so, then all agents have access to sector H at period $t+1$ and they can earn $y_{t+1} = \frac{w_H - s_H - \bar{c}_B}{\alpha} > y_t$. This contradicts the definition of a steady state. Hence $w \in [w^*, \bar{w})$ cannot prevail in any steady state.

From the labor supply curve, $w > \bar{w}$ implies that $L = 1$. The total income earned in sector M in steady state is w. The total expenditure on M and H, however, is $\alpha . \frac{w - s_M - \bar{c}_B}{\alpha} = (w - s_M - \bar{c}_B)$. Thus the total income from sector M is greater than the total expenditure on good M, which is a contradiction. Hence $w \leq \bar{w}$.

Thus $w \in [w^*, \bar{w})$ and $w > \bar{w}$ cannot prevail in any steady state. ■

Let us now examine the necessary and sufficient conditions for a steady state, as stated in the above proposition.

Since only one of the above three conditions need hold to guarantee a steady state, let us suppose, without loss of generality, that conditions (II) and (III) do not hold. From Lemma 1, we have already ruled out $w \in [w^*, \bar{w})$ and $w\bar{w}$ as steady state wages.

If (II) *and* (III) do not hold, this implies that the market clearing condition such that $L^D = i^*$ is not compatible with *any* steady state wage. Then it must be true that $L^D \leq i^*$ in any steady state. This implies that agents not employed in sector H are employed *both* in sectors B and M. In order that agents outside sector H are indifferent between sectors B and M, given that they have access to sector M, the equilibrium wage in sectors B and M must be equivalent. Hence $w = \underline{w}$.

Thus, if conditions (II) and (III) do not hold, condition (I) must be true in a steady state.

To prove the converse, consider any period t in which any of the above conditions hold. So, given the wage w_t for which this is true, we know that the distribution of income coming from the previous period, $\mathbf{y_{t-1}}$ is as follows:

$$\begin{aligned}\mathbf{y_{t-1}} &= \frac{w - s_M - \bar{c}_B}{\alpha} \quad \text{for fraction } i^*_{t-1} \\ &= \frac{w_H - s_H - \bar{c}_B}{\alpha} \quad \text{for fraction } (1 - i^*_{t-1})\end{aligned}$$

and $w_t = w$ as well. Since $y_t = (1-\alpha)y_{t-1} + w$, using the distribution $\mathbf{y_{t-1}}$ from above, we see that $\mathbf{y_t} = \mathbf{y_{t-1}}$. If so, then $\mathbf{b_{t+1}} = \mathbf{b_t}$ as well.

From this, we see that the L^D curve and L^S curve in period $t+1$ are the same as in period t. Since the L^D curve is strictly decreasing in w and the L^S curve is non-decreasing in w, the *unique* equilibrium in sector M at period $t+1$ is such that $w_{t+1} = w_t = w$ and $i^*_{t+1} = i^*_t$.

Hence, if *any* one of Conditions (I)–(III) are satisfied, we have a steady state. ■

Proof of Proposition 2: (Refer to Figure 2) We propose to examine the set of feasible steady states along the vertical and horizontal segments of the L^S curve since this covers all the possible cases of long-run outcomes.

From Lemma 2, we know that $w \in [w^*, \bar{w})$ cannot be a steady state wage. Now we shall see that, for the rest of the feasible range, if w' is a steady state wage, then $w > w'$, $w \notin [w^*, \bar{w})$ is also a steady state wage.

Along the vertical segment, a wage w can prevail in steady state if Condition (II) holds for some $i^* < 1$.[41]

Note that the left-hand side of (II) can be expressed as $L_D(w, i^*)$ since $\frac{w_H - s_H}{\alpha} - \bar{c}_B$ is exogenous. Hence, for $\underline{w} < w < w^*$, Condition (II) can be rewritten as:

$$L^D(w; i^*) = i^* < 1$$

Similarly, we can rewrite (I) as:

$$L^D(\underline{w}, i^*)i^* < 1$$

Suppose $\underline{w}$ is a feasible steady state wage. Then Condition (I), as expressed above, holds. However, if so, $\underline{w}$ also satisfies Condition (II) (as expressed above):

Since $L^{D\prime}(w) < 0$, we know that $L^D(\underline{w}) \leq 1 \Rightarrow L^D(w) \leq 1, \forall w > \underline{w}, w \notin [w^*, \bar{w})$.

Also, in general, if w' is a steady state wage, then $w > w'$, $w \notin [w^*, \bar{w})$ is also a steady state wage.

Thus the set of steady state wages is *continuous* except for the interval $[w^*, \bar{w})$.
(ii) Next, let us examine the link between w and i^* in steady states for which $w > \underline{w}$.
For $w > \underline{w}$, we know that $L^D(w; i^*) = i^*$. Now if we increase i^*, the right hand side of this equality increases. At a higher i^*, the left-hand side, L^D, is lower, for a fixed w. In order to restore equality, we need to *decrease* w, since $L^{D\prime}(w) < 0$. Thus w and i^* are negatively correlated over steady states for $w > \underline{w}$. ■

Proof of Proposition 3: As we know, the residual income allocated to consumption of good M and H is denoted by y. In equation (3),

$$y_t(i) = (1-\alpha)y_{t-1}(i) + \alpha(w_t - s_t(i) - \bar{c}_B)$$

Integrating over all i we have

$$\int_0^1 y_t(i)di = \int_0^1 (1-\alpha)y_{t-1}(i)di + \alpha[i_t^*(w_t - s_M - \bar{c}_B) + (1-i_t^*)(w_H - s_H - \bar{c}_B)]$$

Since $\int_0^1 y(i)di = \bar{y}$ where $\bar{y}$ is the average residual consumption expenditure, we can rewrite the above equation in terms of $\bar{y}$ as follows:

$$\bar{y}_t = (1-\alpha)\bar{y}_{t-1} + \alpha[i_t^*(w_t - s_M - \bar{c}_B)) + (1-i_t^*)(w_H - s_H - \bar{c}_B))] \tag{11}$$

Comparing $\bar{y}_t$ and $\bar{y}_{t-1}$, one of the following must be true.

(i) $\bar{y}_t \geq \bar{y}_{t-1}$ or

(ii) $\bar{y}_t < \bar{y}_{t-1}$

Case (i): $\bar{y}_t \geq \bar{y}_{t-1}$
From equation (11), note that $\bar{y}_t \geq \bar{y}_{t-1} \Rightarrow$

$$i^*(w_t - s_M) + (1-i^*)(w_H - s_H - c_B) \geq \bar{y}_{t-1} \tag{12}$$

We compute the total demand for good M at period t as follows:

$$\int_0^1 l^D(y_t(i))di = \int_0^1 l^D[(1-\alpha)y_{t-1}(i) + \alpha(i_t^*(w_t - s_M) + (1-i_t^*)(w_H - s_H) - \bar{c}_B)]di$$

Given that l^D is concave in y, it follows, using Jensens's Inequality that:

$$\begin{aligned}&\int_0^1 l^D(y_t(i))di(1-\alpha)\\ &\qquad > \int_0^1 l^D(y_{t-1}(i)di + \alpha.l^D[i_t^*(w_t - s_M) + (1-i_t^*)(w_H - s_H) - \bar{c}_B)\end{aligned}$$

Rewriting the above, we have:

$$L_{t+1}^D > (1-\alpha).L_t^D + \alpha.l^D[i_t^*(w_t - s_M) + (1-i_t^*)(w_H - s_H) - \bar{c}_B] \tag{13}$$

Suppose $L_{t+1}^D < L_t^D$. In equation (13), this implies that $L_t^D > l^D[i_t^*(w_t - s_M) + (1 - i_t^*)(w_H - s_H) - \bar{c}_B]$. Once again, applying Jensen's inequality we have

$$\begin{aligned} L_t^D &= \int_0^1 l^D(y_{t-1}(i))di \\ &< l^D\left(\int_0^1 y_{t-1}(i)\right)di \\ &= l^D(\bar{y}_{t-1}) \end{aligned}$$

The above inequality implies that

$$[l^D(\bar{y}_{t-1})] > l^D[i_t^*(w_t - s_M) + (1 - i_t^*)(w_H - s_H) - \bar{c}_B]$$

Since l^D is increasing in y, this implies that

$$\bar{y}_{t-1} > [i_t^*(w_t - s_M) + (1 - i_t^*)(w_H - s_H) - \bar{c}_B]$$

This contradicts equation (12), since we are in the case where $\bar{y}t > \bar{y}_{t-1}$. Hence

$$L_{t+1}^D > L_t^D \tag{14}$$

As for the supply of labor, L^S, an agent who makes it to sector H can always afford s_H for his offspring, i.e. $(1 - \alpha)(w_H - \bar{c}_B) > s_H$. Hence

$$L_{t+1}^S \leq L_t^S \tag{15}$$

From equations (14) and (15), we have $w_{t+1} \geq w_t$.

Hence we have $\bar{y}_{T+1} \geq \bar{y}_T$ for all $T > t$. Since w is bounded away from infinity, w converges. Given that y and b are defined in terms of w in the steady state, **y** and **b** converge as well.

Case (ii): $\bar{y}_t < \bar{y}_{t-1}$

In this case, two possiblities arise. One is that $\bar{y}_s > \bar{y}_{s-1}$ for some $s > t$. Then we can apply Case (i) above. The other possiblity is that $\bar{y}_s < \bar{y}_{s-1} \forall s \geq t$. If this is so, then $\bar{y}_s$ converges to $\bar{y}^*$ as $s \to \infty$.

From equation (11), we can express w_s as

$$w_s = \frac{1}{\alpha.i_s^*}[\bar{y}_s - (1 - \alpha)\bar{y}_{s-1} - \alpha.(1 - i_s^*).(w_H - s_H - \bar{c}_B)] + s_M + \bar{c}_B \tag{16}$$

Using the above equation, we have,

$$\begin{aligned} w_s - w_{s+1} &= \frac{1}{\alpha.i_s^*}[\bar{y}_s - (1 - \alpha)\bar{y}_{s-1} - \alpha.(1 - i_s^*)(w_H - s_H - \bar{c}_B)] + s_M + \bar{c}_B \\ &\quad - \frac{1}{\alpha.i_s^*}[(\bar{y}_{s+1} - (1 - \alpha)\bar{y}_s) - \alpha(1 - i_{s+1}^*).(w_H - s_H - \bar{c}_B)] - s_M - \bar{c}_B \\ &\leq \frac{1}{\alpha.i_s^*}[(\bar{y}_s - \bar{y}_{s+1}) + (1 - \alpha)(\bar{y}_s - \bar{y}_{s-1}) + \alpha.(i_s^* - i_{s+1}^*)(w_H - s_H - \bar{c}_B)] \end{aligned}$$

$$
\begin{aligned}
&< \frac{1}{\alpha.i_s^*}[(\bar{y}_s - \bar{y}_{s+1}) + (1-\alpha)(\bar{y}_s - \bar{y}_{s+1}) + \alpha.(i_s^* - i_{s+1}^*)(w_H - s_H - \bar{c}_B)] \\
&= \frac{1}{\alpha.i^s}[(2-\alpha)(\bar{y}_s - \bar{y}_{s+1}) + \alpha.(i_s^* - i_{s+1}^*)(w_H - s_H - \bar{c}_B)] \\
&< \left[\frac{(2-\alpha)}{\alpha.\underline{i}^*}(\bar{y}_s - \bar{y}_{s+1})\right] + (w_H - s_H - \bar{c}_B) \\
&\equiv \lambda(\bar{y}_s - \bar{y}_{s+1})
\end{aligned}
$$

Having expressed the wage difference, $(w_s - w_{s+1})$ as a function $\lambda(\bar{y}_s - \bar{y}_{s+1})$, we now want to prove that $\bar{y}_{s+1} < \bar{y}_s$ for all $s \geq t \Rightarrow w_{s+1}$ converges to one of the steady state wage levels described earlier.

Suppose not. Then there exist at least two limit points w_1 and w_2 such that $(w_2 - w_1) \geq 2\epsilon$, for some $\epsilon > 0$.

Pick $t = T$ large enough such that $\lambda(\bar{y}_t - \bar{y}_s) < \epsilon, \forall t, s \geq T, t < s$. There exist t such that $w_2 - w_t < \frac{\epsilon}{2}$ and s such that $w_s - w_1 < \frac{\epsilon}{2}$.

This implies that $w_t - w_s > \epsilon$. But $w_t - w_s < \lambda(\bar{y}_t - \bar{y}_s)$ and $\lambda(\bar{y}_t - \bar{y}_s) < \epsilon$ by construction. Since this generates a contradiction, w must converge for the case when $\bar{y}_t < \bar{y}_{t-1}$ for all t.

Hence w converges. Given that **y** and **b** are expressed in terms of the w in steady state, these distributions converge as well. ■

Proof of Lemma 1: Let $\mathbf{y_0}$, $w_0(i_0^*)$, and i_0^* denote the original income distribution at date 0, the associated wage and the fraction of agents outside sector H respectively. Let us denote the new distribution after redistribution by $\mathbf{y_0'}$, and the variables along the new path by attaching primes to the original variables. Note that, under $\mathbf{y_0'}$, $y'(i)_0 \geq y(i)_0$ for $i < i_0^*$ and $y'(i)_0 \leq y(i)_0$ for $i \geq i_0^*$. Also the average income $\bar{y}_0'(i) = \bar{y}_0(i)$ since the redistribution does not change the aggregate level of income. Hence $\mathbf{y_0}$ is a mean-preserving spread of $\mathbf{y_0'}$

How does this affect labor demand, $L^D(\mathbf{y})$ and labor supply, $L^S(\mathbf{y})$? Individual demand $l^D(y(i)$ is concave in $y(i)$, hence, from theorems on mean-preserving spreads applied to concave functions,

$$L_1^D(\mathbf{y_0'}) > L_1^D(\mathbf{y_0})$$

Also, since the redistribution does not expand the supply of labor supply to sector M, we know that $L^S(\mathbf{y_0'}) \leq L^S(\mathbf{y_0})$. Therefore, $w_1' \geq w_1$.

We compare income distributions $\mathbf{y_1'}$ and $\mathbf{y_1}$. For this, first consider the average income.

$$
\begin{aligned}
\bar{y}_1'(i) &= (1-\alpha)\bar{y}_0'(i) + w_1' - s_M - \bar{c}_B \\
&\geq (1-\alpha)\bar{y}_0(i) + w_1 - s_M - \bar{c}_B \\
&= \bar{y}_1(i)
\end{aligned}
$$

(i) Thus, a higher wage w_1' in period 1, along the new path implies a higher average income along the new path.

(ii) Also, distributions $\mathbf{y_1}$ and $\mathbf{y'_1}$ cross only once. This is true because, given the redistribution at $t = 0$, $y'_1(i) \geq y_1(i)$ for all $i < i^*_0$ and $y'_1(i) \leq y_1(i)$ for all $i \geq i^*_0$.

(i) and (ii), taken together, imply that $\mathbf{y'_1}$ dominates $\mathbf{y_1}$ in a seond-order stochastic sense.

As in period 1, we have $L^D_2(\mathbf{y'_1}) L^D_2(\mathbf{y_1})$ in period 2. since there has been an increase in incomes at the lower end of the distribution, we also have $L^S_2(\mathbf{y'_1}) \leq L^S_2(\mathbf{y_1})$. Therefore, once again, $w'_2 \geq w_2$.

Recursively, this argument holds in every subsequent period as well so that the *entire wage path* after redistribution lies above the original wage path, for any finite time period.[42] ■

Proof of Proposition 4: We denote the original and the new long run distributions by $\mathbf{y}$ and $\mathbf{y}'$ respectively.

Condition (i) says that in the long run, L^D intersects L^S along the latter's vertical segment. From Lemma 1, the long run demand $L^{'D} \geq L^D$ and $w' \geq w$. Let us see how conditions (i) and (ii) together guarantee *strict* inequality with respect to long run wages.

$i^*(\mathbf{y})$ is the marginal agent in the orginal long run distribution $\mathbf{y}$ who makes it to sector H. It must be true that he crosses over to sector H in *finite* time. This because, at some $t = \tau$ sufficiently large, the bequest of the last infra-marginal agent is arbitrarily close to the steady state bequest level—and hence *strictly* below s_H.

Let agent $i^*(\mathbf{y})$ cross over to sector H at date T, along the original path. (Hence no agents move to sector H after T.) Then his bequest at date T, $b_T(i^*(\mathbf{y})) = s_H$. That he crosses over at time T implies that wages must have increased (for his parent) in period $T - 1$. Therefore, $w_{T-1}\underline{w}$, i.e. L^D_{T-1} intersects L^S_{T-1} along the latter's *vertical* segment.

Since $L^{'D}_{T-1} > L^D_{T-1}$ from Lemma 1, we know that $w'_{T-1} > w_{T-1}$. Suppose the marginal agent $i^*(\mathbf{y})$ moves over to sector H only at period T along the new path (and not earlier). $w'_{T-1} > w_{T-1}$ implies that the bequest he receives at date T along the new path, $b'_T > s_H$. When Condition (ii) holds, continuity around $i^*(\mathbf{y})$ implies that $b'_T(\hat{i}) \geq s_H$, for $i \in [\hat{i}, i^*)$, for some $\hat{i} < i^*(\mathbf{y})$ as well. Hence $i \in [\hat{i}, i^*)$ too must move to sector H at period T, along the new path.

Hence, in the long run $i^*(\mathbf{y}') < i^*(\mathbf{y})$. From Proposition 2, it follows that $w'w$ in the long run. ■

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Notes

1. This point is demonstrated by Loury (1981).
2. This point is demonstrated in Galor and Zeira (1993). Piketty (1997) and Banerjee and Newman (1993) show that, even with *gradual* capital accumulation being feasible, initial income inequality can have long run effects. In these models, this results through general equilibrium effects of inequality on the interest rate and the wage rate respectively.
3. In previous work based on household level consumption data from South Africa, I have examined both how demand patterns vary with the level of income as well as how this affects the returns to different skills. One finding, not surprisingly, is that richer households spend a larger share of their total expenditure on more skill intensive items such as automobiles or financial services, and a lower share on less skilled items such as clothing and furniture, than poorer ones. Similar spending share patterns are reported in some other studies, for instance, Hunter (1991) and Lluch, Powell and Williamson (1977). In addition, richer households are found to create relatively much lower demand for medium and low level skills than medium or low income households. See Mani (1998) for details.
4. This is true provided the income levels in the economy are high enough so that subsistence needs are taken care of.
5. Such an adverse effect of lower inequality at very low levels of income would also be true in CMI models that emphasize supply-side effects.
6. The high growth sector goods included electrical goods, automobiles, plastics, publishing and communication services. Teitel's (1976) survey of 17 manufacturing industries in developed and developing countries by skill intensity consistently ranks these sectors as high skill sectors.
7. Their labor skill classification is based on wage data.
8. According to estimates computed by Carnoy et al. (1979) from Langoni's data, rates of return on upper secondary and college education rose by 27 percent and 230 percent respectively over the period 1960–69. Over this same period, the rates of return on elementary and lower secondary education fell by 39 percent and 22 percent respectively, even though the supply of graduates from the two higher levels of education rose much faster.
9. Each agents is assumed to have exactly one offspring. Note that agents earn and consume in different periods of their lifetime.
10. The linear production function assumption (and hence constant marginal product of labor) is a simplification that allows us to clearly highlight the demand side effects of the income distribution. In a later section we discuss the effects of alternative production technologies. For an income-distribution and growth model with endogenous supply-side effects on wages, see Owen and Weil (1998).
11. Agents may choose to work in sectors which use a lower skill level than their own, provided the returns, net of their education cost, make it worthwhile for them to do so. Production is taken to be decentralized—each agent individually produces output using his labor skill and, upon selling his output in the market, receives his marginal revenue product.
12. A typical developing economy may export goods of type B—say food, and import goods of type H—say cars or computers.
13. The focus of our analysis being on sector M, the assumption of endogenous prices in sector M alone helps us get across our basic point with greater clarity and simplicity. However, prices of simple manufactures may in fact depend largely on domestic demand patterns for very plausible reasons. It is often the case that the quality of simple manufactures made in a developing country is so poor that the quality conscious consumers in the international market do not want to buy these goods. Copeland-Kotwal (1996) and Shleifer-Vishny (1997) discuss how quality-conscious consumers in rich 'North' countries may prefer not to buy low-grade manufactures of poor 'South' countries, even if they are much cheaper. In our story, such effects would render the medium-skilled good *effectively* non-traded in an otherwise open economy, even it if were potentially tradable—hence making prices in this sector endogenous.
14. The 'warm-glow' (Andreoni, 1989) is more tractable than other bequest motives.
15. Note that our assumptions imply that the share of expenditure on good B is *decreasing* in income. In order to rule out the uninteresting case where all agents are employed in sector B, we assume that $\bar{c}_B < 1$, the total population. We may add that the results of the model are unaffected even when the share of expenditure on good B is non-decreasing in income.

16. This is consistent with a fall in the share of expenditure on good M, with a rise in total income, Z. Consumption studies document such a decline in the share of expenditure on certain simple manufactures, at higher levels of income.

    Clothing is the category of simple manufactures that is most commonly covered in all Engel curve studies. For instance, in a time series studies of several developing countries, Lluch, Powell and Williams (1997) find that the budget share allocated to clothing is highest at middle income levels.

    In a cross section study of 34 countries, Hunter (1991) (Table 1) finds that the share of income spent on the items clothing and footwear tend to decrease at higher levels of income. At the same time, there is an increase in the share of expenditure allocated to transport and communication, a category of goods which is relatively more skill intensive in production, according to Teitel (1976).
17. This assumption on medium level skills merely allows us to make our point about demand composition effects with sharper focus. The results do not depend on this modification in any way whatsoever. Also, some credit constraints on higher education are necessary to rule out the unrealistic case where all agents, poor or rich, simply invest in higher education and earn the high-skill wage.
18. Use equation (2).
19. We obtain this expression by setting $y_{t+1}(i) = y(i)_t$ in the long run, in equation (3) and using the fact that $b(i) = (1 - \alpha).y(i)$.
20. In other words, the bequest he receives is large enough to cover the cost s_H; i.e. $i^*(\mathbf{y}) \equiv min\{i\colon (1-\alpha)y(i) = b(i) \geq s_H\}$.
21. Thus, the assumption that agents only consume when they are old ensures that the current wage w only has a 'price effect' on current labor demand—making demand a decreasing function of w. If agents consumed in both periods, a higher wage w would also affect demand through increase in income y. See footnote 25 for a discussion of these effects in steady state.
22. We should pause to clarify some issues related to market clearing in this economy. Since the wage in sectors B and H is determined *exogenously*, it is possible that there is a surplus of domestic output in *both* these sectors at the wages w_B and w_H respectively, at any given date. This surplus output would have to be sold in the international market, but the question would remain: in exchange for what? Since agents who produce this output (in period 1 of their lives) consume only in period 2, they could exchange their output for a non-interest bearing asset today. If this asset is denominated in the international price of say, good B, which is fixed over time, it should be re-exchangeable for goods in the period in which these agents consume. There would thus be no changes in the agents' income level between periods 1 and 2.
23. Intersection of the two curves is guaranteed provided the labor demand function, L^D_{t+1} satisfies Inada conditions.
24. In section 2 earlier, we had defined $(1 - i^*)$ as the fraction of the population that can *afford high education*. The definition given here is quivalent to the earlier definition, except for the case when *all* agents are able to afford high education. To keep the amount of notation to the minimum level necessary, we do not add an extra variable here.
25. In the steady state, an increase in w has two effects: one, an increase in the incomes of those employed in sector M and two, an increase in the price of good M (or wage of medium-skilled labor). With $L^{D\prime}(w) < 0$, the negative effect of the price increase on demand dominates the positive effect of the income increase on demand. Such a feature is ensured provided the weight attached to the consumption of M in $V(c_M, c_H)$ is sufficiently concave in income. Note that this assumption would not hold if $V(c_M, c_H)$ is a Cobb-Douglas function—an instance of homothetic preferences. In this latter case, the positive effect of the income increase on demand always dominates. Therefore the demand curve need not be downward sloping in w, and hence the existence of a steady state cannot be guaranteed.
26. Since good B is traded, it would be imported in this case.
27. At a wage $\underline{w}$, they are indifferent between sectors B and M.
28. Recall that $(1 - i^*)$ is the poopulation employed in sector H, hence a lower i^* implies larger employment in that sector.
29. It is not possible to 'Pareto-rank' these different steady states, even though some of them may seem more 'desirable' than others. This is because agents who are in the H sector *across* different steady states are worse off at higher wages in sector M, given that good M is costlier.

30. We use the expression 'wage inequality,' as opposed to income inequality because the effect on the latter is ambiguous in this context, given that the Lorenz curves for any two steady states can cross. Fields (1976) points out that standard measures of inequality do not capture the idea of inequality satisfactorily in 'dual' economy models with two levels of income in steady state. It argues that the notion of wage inequality is more satisfactory in such a context.
31. Intuitively speaking, the gap in the bequests of the poorest and the richest agents within a sector is shrinking over time. Hence incomes of the poorest agents within a sector is converging *upwards* from a level below the limiting income level and incomes of the richest agents is simultaneously converging *downwards* towards this same level.
32. To remind the reader, incomes at period t are used for consumption in period $t+1$.
33. This is consistent with the definition adopted in section III.
34. Effectively, all we impose is that the number of agents in sector H does not *decrease* because of redistribution, so that there is no net expansion in the supply of labor to sector M.
35. In our approach here, lower initial inequality arises through the redistribution program.
36. If some poor agents can afford high education because of a transfer, the L^S curve may shift in as well.
37. Recall from our discussion of steady states that the fraction of agents employed in sector M, i^* is decreasing in the wage for the range between the two extremes, $\underline{w}$ and $\bar{w}$.
38. However, if such Dalton transfers are made from the rich to the middle income households that can afford $\bar{c}_B$, then there will still be an overall increase in the demand for M, as described in the model. Hence our results still hold in a qualified sense.
39. Galor-Moav (1999) show that inequality can be growth promoting in early stages of development, where physical capital has a more prominent role.
40. See, for instance, Owen and Weil (1998).
41. The last inequality is *strict* because $L << 1$ from Lemma 2.
42. If $w'_T > w_T$ for the first time at some $T > 1$, then the above analysis holds from T onwards.

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