Chapter 10

Human Capital and Income Distribution

I.

Improvements in the health and education of people are central to the development process. Clearly, people place a high value on the health and education of themselves and their family members, and thus their improvement must be a goal of development. At the same time, the health and education of an individual have an important effect on that individual’s capability to produce. A healthier, better educated person is capable of producing more, and this improved productivity is rewarded in the labor market. The commitment of current resources to improving an individual’s health or education, therefore, increases that person’s future productivity and income.

The use of the term “human capital” as shorthand for the cluster of factors like nutrition, health, formal education and on-the-job training, which are embodied in an individual and which provide future advantages focuses attention on the role of expenditures on these factors as investments. This focus is a powerful analytical device, and will prove particularly useful in exploring the links between the distribution of expenditures on human capital and the distributions of income and wealth. At the same time, however, this focus should not detract from the recognition of the value that people place on good health and education in themselves, apart from their instrumental role in generating future income.

The population of a poor country, of course, is not uniformly poor. There is persistent poverty in every poor country, and in many cases there is a high degree of income inequality. One of the most visible manifestations of this inequality is the wide dispersion in the health and
education attained by people living in any poor country. In this chapter, we will explore the idea that there is joint causation between income and human capital, and that this combined with increasing returns to investments in human capital and imperfect credit markets generates a \textit{poverty trap}. Relatively wealthy individuals are able to invest in human capital, this enables them to earn enough income to remain wealthy. Conversely, the poor are unable to invest in human capital, and thus earn low incomes and remain poor. The joint causation of human capital investment and income, therefore, can provide a theory of the distribution of income. An example of such a theory is provided in section III of this chapter.

Economists hypothesize that the educational attainment, health, and nutrition of an individual affect that person’s labor power. An improvement in health, nutrition or education increases that a person’s productivity and thus income. There is in fact a very strong association between household income (or wealth) and these aspects of well-being. Any empirical investigation of the influence of human capital on income, however, is made difficult by the fact that people value the health and education of themselves and their family members. Richer people can afford to acquire more of these valued goods. The positive association between income, health and education might reflect the positive elasticity of demand for the components of human capital rather than a direct link between human capital and productivity. Some of the challenges of investigating the empirical relationships between human capital and income are briefly discussed in section II of this chapter.

The level and distribution of human capital within an economy also have important effects on the rate of technological innovation in that society. These links are explored in some detail in Chapter 12.
II

That there is two-way causality between income and human capital can hardly be disputed. There is clearly a demand-side effect of income on each of the components of human capital. The very phrase “human capital” reminds us of the reverse causation, from an individual’s health and education to her productivity, wage, and income. The strength of each of these relationships, however, is an empirical matter and is subject to ongoing debate.

To illustrate the difficulty of measuring the strength of these relationships, consider what might be the simplest of the relationships: the income elasticity of demand for calories. Conventional estimates of this elasticity in poor countries range from around .5 to about 1. Behrman and Deolalikar (1987), Bouis and Haddad (1992) and Bouis (1994), however, all argue the actual elasticity is near zero. It can be argued that the standard estimates are biased upwards for four important reasons. First is the likelihood that income is not exogenous due to the feedback from nutrition to productivity. Second, many estimates of the calorie demand are calculated from reports of expenditure on broad groups of food, converted to calories via standard nutrition tables. As incomes rise, people may be consuming more expensive foods within these groups, biasing up the calculated income elasticity of demand for calories. Third, much of the food consumed in poor countries is produced on people’s own farms and thus is also a component of income. Thus any measurement error in the production of food on one’s own farm is common to both income and calories, biasing up the calculated elasticity. Finally, unrecorded gifts of food probably flow mostly from richer to poorer households, so calorie consumption is understated for the poor, and overstated for the rich, again biasing the estimated elasticity up.
Most importantly, it is possible to construct any number of arguments that rationalize the fact that the wealthy are relatively well-educated without a causal relationship between education and productivity, Spence’s (1973) screening model being the most familiar. Schultz (1988) provides a good review of the statistical problems associated with estimating the effect of education on productivity. The most important of these is the fact that an individual’s level of education is not randomly allocated across any population, but rather is chosen. Therefore, statistical evidence regarding the relationship between education and earnings can be misleading due to correlations between education and omitted factors (like ability, or class background) which themselves affect earnings.

These comments nicely illustrate some of the difficulties of measuring the relationships between income and human capital outcomes, but the conclusion of these authors is probably overstated. Instrumental variable procedures have been used to address both the endogeneity of income and to correct the bias induced by measurement error, and attention has been drawn to the strong non-linearities that appear to exist in the relationship between income and calorie consumption (see Thomas and Strauss (1997)). The weight of the evidence is that the elasticity of demand for calories is relatively high (but less than 1) for poor households, declining to around zero as household income rises.

Despite the cavils regarding the specifics, the general point that the demand for the components of human capital increases with income is well-established. There is also strong evidence regarding the strength of the reverse relationship, from aspects of human capital to productivity and income. Consider first the effect of education on productivity. There is clear-cut evidence of a strong positive relationship between the schooling of a child and that child’s future earnings. There are a variety of conceptual and statistical difficulties which complicate the interpretation of this regularity. However, it is most convincingly explained with reference to the role of education as an investment in human capital which increases the future productivity of the individual. Moreover, it appears to be the case that the increase in earnings associated with

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additional education is much higher in poor countries than in rich countries, on the order as twice as high (see Psacharopoulos (1985) and Schultz (1988)).

The possibility that a worker’s health and nutritional status affects his or her productivity underlies the notion of the efficiency wage discussed in chapter 4. Although the initial theoretical work on the implications of a direct link from health and nutrition to productivity rested on quite weak empirical grounds, evidence regarding the importance of this relationship has grown rapidly in the past decade. The work reviewed by Strauss and Thomas (1994) now clearly establishes that health and nutritional status is an important determinant of productivity and earnings in poor countries.

III

This section examines the implications of the interdependence between income and human capital using a model due to Ljungqvist (1993). The model serves to illustrate three important theoretical points. First, the feedback between income and human capital investments can serve as the basis of a theory of the distribution of income. Richer families are able to invest more in human capital, and thereby earn more in the future. This reasoning applies both to the distribution of income within a nation, and can serve as part of the explanation for international differences in average income. Second, this reasoning depends on a form of increasing returns in human capital investment. If the returns to investing in human capital are smoothly diminishing, then (at least in the long-run) everyone will wind up with a similar level of human capital. Finally, the persistence of inequalities in incomes and human capital depends on imperfections in the capital market. If everyone has access to the same investment opportunities, then (again, at least in the long run)
incomes and levels of human capital will converge. To illustrate these points, the model makes
dramatic simplifications. Perhaps most importantly, we make the now-standard assumption in the
literature on human capital that education serves only to increase future income; it is not valued
itself.

We begin by assuming that all agents have the same preferences and basic abilities. The
agents live forever and maximize a standard, additively separable utility function:

$$
\int_0^\infty e^{-\rho t} U(c_t) \, dt,
$$

(1)

where $c_t$ is the consumption at time $t$ of the single good that is produced. The good is
internationally traded, and each country’s output is determined by a constant returns to scale
production function using physical capital ($K_t$), unskilled labor ($U_t$) and skilled labor ($S_t$),
$F(K_t, U_t, S_t)$. An unskilled laborer can be (instantaneously) transformed into a skilled laborer
using $\gamma (< 1)$ skilled laborers. This education enables the worker to remain skilled for one period,
after which she must be retrained. The natural interpretation is that each period represents a
generation, and that the agents represent a type of family dynasty.

We will consider only steady-state equilibria, therefore, we drop the time subscript $t$ from
all notation. There are three types of employment: working as a skilled laborer (S), working as an
educator (E), and working as an unskilled laborer (U). Normalizing the population to 1, we have
$S+E+U = 1$. Let $H$ be the number of educated workers. Thus $S+E = H$. If we recall that educated
workers have to be retrained after one period, then it can be seen that in a steady state the number
of teachers required to maintain the stock $H$ of educated workers is $E = \gamma H$. Thus the number of
skilled workers engaged in production is \( S = (1-\gamma)H \), and the number of unskilled workers is \( U = 1 - H \). We assume that workers cannot borrow to finance their education. Therefore, the cost of education (the wages of the teacher) must be accumulated as savings before a worker can be educated.

It can now be seen that the state of the country’s economy (in steady state) is determined fully by the number educated workers \( H \). Physical capital is internationally traded at a discount rate equal to \( \rho \). Thus, for any number of educated workers, the equilibrium stock of capital in the country is determined implicitly by

\[
\rho = F_3((1-\gamma)H, 1-H, K(H)),
\]

where the subscript \( i \) indicates the partial derivative with respect to the \( i^{th} \) argument. In turn, the wages of educated workers (skilled laborers and educators) and uneducated workers are determined by

\[
\begin{align*}
    w_S(H) &= F_1((1-\gamma)H, 1-H, K(H)) \\
    w_U(H) &= F_2((1-\gamma)H, 1-H, K(H))
\end{align*}
\]

The rate of return on human capital investments \( r(H) \) is determined implicitly by

\[
\gamma w_S(H) = \int_0^1 e^{-\tau r(H)} (w_S(H) - w_U(H)) \, d\tau
\]

The left-hand side is the cost of education, while the right-hand side is the discounted value of the increase in wages consequent upon being educated.

A number of educated workers \( H \) will characterize a steady state equilibrium if at the
factor prices determined by that number, educated workers choose to maintain their training (by paying for renewed education in each period), and uneducated workers choose not to invest in education. Educated workers will choose to maintain their educations if the rate of return on human capital as defined in (4) is at least as high as \( \rho \), the return on investing in physical capital. This will be the case as long as the wage differential between trained and untrained workers is large enough. If we assume that the technology is such that the marginal rate of substitution between skilled and unskilled workers is diminishing for any positive \( K \), then the wage differential is decreasing in \( H \). Therefore, if there is an \( H^* \) such that \( r(H^*) = \rho \), then \( r(H) > \rho \) for all \( H < H^* \).

That is, if there is some number of trained workers such that the wage differential in a steady state is large enough that the return to being trained is as high as the return on physical capital, then the return to training will be greater than the return to physical capital for any steady state with a smaller number of trained workers.

The existence of some \( H^* > 0 \) is guaranteed if the education technology is sufficiently productive relative to the return on physical capital;\(^2\) and

\[
\lim_{H \to 0} w_U = 0 \text{ and } \lim_{H \to 0} w_S > 0. \tag{5}
\]

The assumptions in (5) guarantee that as the number of skilled workers declines, the ratio of the skilled to the unskilled wage gets arbitrarily large. Thus there is a number of educated workers \( H^* > 0 \) at which the return to investing in education is at least as high as the return to holding physical capital. In steady states with this or any lower number of educated workers, dynasties of

\(^2\)Specifically, \( 1 - \rho \gamma > e^\rho \) guarantees that education is sufficiently productive to be profitable as \( H \) approaches zero.
educated workers will choose to invest in the education of each successive generation of workers.\(^3\)

It now remains to be seen if there exists a number of educated workers \(H \in (0, H')\) such that uneducated workers do not invest in education, and thus remain employed as unskilled labor. If so, then this number of educated workers characterizes an equilibrium of this economy.

Since for any number of educated workers \(H \in (0, H')\), the return to investing in education is at least as high as that to investing in physical capital, uneducated workers would choose to invest in education if it had sufficient capital, or if it could borrow to finance the training. Our assumption of an imperfect capital market, such that future labor earnings cannot serve as collateral for a loan for education, therefore, is essential. Were there to be a perfect capital market, there could be no steady state with \(H<H'\), and people would be indifferent between investing in education and investing in physical capital.

Consider an uneducated individual with no assets. The rate of time preference is equal to the interest rate, so she prefers a constant stream of consumption. If she chooses to remain uneducated, her constant flow of consumption is

\[ c_u = w_u. \]  

(6)

Once she has been trained, she can consume at the constant rate of

\[ c_s = w_s. \]  

(7)

\(^3\)We have simplified a bit here. It is possible that \(r(1)>\rho\), in which case there is no \(H'\). In this case, in any steady state all educated workers choose to reinvest in education each period.
She can be educated worker by paying the cost of $\gamma w_s$. In order to accumulate the savings required to pay for training, she will have to reduce her consumption below $c_a$ for some period. During this accumulation phase, it will be optimal to choose a constant consumption stream, say $c_a < c_u$. Given $c_a$, the length of time $T(c_a)$ it will take to accumulate $\gamma w_s$ is determined by

$$\int_0^{T(c_a)} e^{pt} (w_u - c_a) \, dt = \gamma w_s. \quad (8)$$

She can choose low current consumption with rapid accumulation and thus early training, or higher current consumption with slower accumulation and a longer delay until she achieves the higher consumption level of $c_u$. She thus chooses $c_a$ to

$$\max_{c_a} \int_0^{T(c_a)} e^{-pt} U(c_a) \, dt + \int_{T(c_a)}^\infty e^{-pt} U(c_s) \, dt,$$  

subject to $c_a < w_u$. Suppose $c^*$ solves (9). She will decide not to invest in education if

$$\int_0^{T(c^*)} e^{-pt} U(c^*) \, dt + \int_{T(c^*)}^\infty e^{-pt} U(c_s) \, dt < \int_0^\infty e^{-pt} U(c_u) \, dt. \quad (10)$$

Consider the inequality (10) as $H \to 0$. Given the assumptions in (5), as the number of educated workers gets small, the unskilled wage approaches zero, while the skilled wage remains bounded away from zero. $c^*$, which is strictly less than the unskilled wage, approaches zero faster than the unskilled wage. At the same time, the cost of education ($\gamma w_s$) gets large relative to the unskilled wage. The time it takes to accumulate the savings required for training increases. If we make the usual Inada assumption that the marginal utility of consumption approaches infinity as consumption approaches zero, then the loss of utility for giving up consumption to accumulate savings for education outweighs the delayed gain from higher consumption in the future. For any
small enough $H$, inequality (10) holds and an uneducated worker with no assets has to remain uneducated. Any $H \leq H^*$ for which (10) holds, therefore, can be an equilibrium. Educated workers choose to remain skilled ($H$ is less than or equal to $H^*$, so the return to investment in education is at least as great as the return to physical capital). Uneducated workers with no assets remain unskilled and assetless, because the cost of foregoing enough consumption for long enough to accumulate the savings needed to finance training is too high.

This model provides a simple theory of persistent income inequality generated by inequalities in human capital. The rich can afford to invest in human capital, and as a consequence earn high incomes and remain rich. The poor cannot afford training, and thus earn low incomes and remain poor. There are two features of the model which are essential for generating this persistent inequality. First, there is a crucial imperfection in credit markets. Workers cannot borrow to finance their educations, presumably because the future increased earnings from training cannot be pledged as collateral for a loan. If education loans were to be available, then as long as education is a valuable investment (that is, the return to education is at least as large as the return to physical capital), then uneducated workers would simply borrow enough to fund training, repaying the loan from the consequent increased earnings. Income inequality would not persist without a failure of the credit market.

Second, there is a strong form of increasing returns to human capital investment. In this model, a worker is either educated or uneducated - education is not divisible. A small expenditure on training (less than that required to fully train a worker), therefore, earns no return at all. It is the difficulty of reducing consumption by enough, and for long enough, to save up the lump sum required to finance education that prevents uneducated workers from become trained. If
investment in human capital instead displayed “normal” diminishing returns, currently uneducated workers would gradually accumulate education until all workers were equally well-trained. It will be recalled from chapter 4 that a similar assumption regarding increasing returns to nutrition generated an efficiency wage in the labor market.

Finally, it should be noted that the twin assumptions of an imperfect capital market and increasing returns to human capital investment (along with the variety of more specific technical assumptions that we have made) generate not only a theory of the distribution of income, but also a continuum of equilibria. We have seen that it is possible to have steady state equilibria with an entire range of trained workers. Steady state equilibria exist with large numbers of trained workers, a relatively low differential between skilled and unskilled wages, and a rate of return to education which just equals the return to investment in physical capital. Equilibria also exist with small numbers of trained workers, very large differences in the wages earned by skilled and unskilled workers, a very high return to education, and a pool of untrained workers who cannot afford to reduce their consumption by enough to save up the funds required for training.

In this chapter, we have discussed only one of several possible mechanisms through which the interaction between human capital and income can generate poverty traps and persistent income inequality. It is important to recall other possible mechanisms, two of which have been discussed in less detail earlier in this book. Nutrition is one such potential mechanism, which has been discussed briefly in chapter 4. Dasgupa (1993) provides a full model in which the interconnections between nutrition and income result in a particularly virulent poverty trap. In our discussion of migration in chapter 5, we have had occasion to discuss a model in which the externalities associated with neighborhoods, particularly through the local externalities associated
with education, can cause persistent poverty.

References


