UNIT 10 HUMAN CAPITAL

Structure

10.0 OBJECTIVES

After reading this unit, you will be able to:

- define the term 'human capital';
- present an overview of the early contributors to the concept of 'human capital;
- differentiate between the concepts of 'human capital' and 'human capital formation';
- state the sources of 'human capital formation';
- distinguish between physical capital and human capital;
- indicate the linkage between health and education;
- prove that growth of capital per unit of labour, in the long run, is exogeneous;
- interpret the essence of 'Solow residual';
- discuss the importance of AK model in explaining the growth process accounted for 'technological change and human capital';

- show that in the production function framework, growth in per capita output is positively correlated with increase in 'human capital investment' (HCI);
- explain the relationship between HCI, Fertility (F) and Poverty (P); and
- estimate the expenditure 'per school aged child' for educational services.

10.1 INTRODUCTION

Human capital is the stock of knowledge embodied in human beings. It refers to the ability to perform a job, producing something of economic value. In broad terms it comprises of skills, training, experience, education, knowledge, know-how and competencies acquired by humans. The earliest idea of human capital can be traced back at least to Adam Smith in the 18th century. The modern theory of human capital was popularised by Gary Becker, Theodore Schultz, Robert Lucas and Paul Romer. Initially, only education was considered as human capital. But later, Becker pointed out that accumulation of knowledge capital depends also on the health status of the society. Thus, not only education, health status indicated by life expectancy, mortality and morbidity pattern and nutritional status of the children are also included in measuring human capital. According to Becker and Schultz, good health and nutrition enhance workers' productivity and healthier people who live longer have stronger incentives to invest in developing their skills as they expect to reap the benefits of such investments over longer periods. Better health increases workforce productivity by reducing incapacity, debility and number of days lost due to sick leave. Further, good health helps to forge improved levels of education by increasing the levels of schooling and scholastic performance. Health affects economic growth through its impact on demographic factors. Shorter life expectancies inhibit investment in education (and other forms of human capital) since there is greater risk that the individual may not survive long enough to benefit from investment. Additionally, larger proportion of dependent population, a consequence of lack of policy attention to increase human capital, has a detrimental effect on the rates of savings and capital and thereby on economic growth.

While Lucas gave emphasis on mass education as driving force of economic growth, Romer stressed on ideas (or research and development) as the key factor of economic growth. Lucas's interpretation of human capital is closer to population wide education – a social activity not directly related to the frontier knowledge (e.g. science and technology) as argued by Romer. Romer specifies three factors to make the distinction between physical capital and human capital. These are: (a) development of new knowledge has positive external effects on the production possibilities of other firms as knowledge cannot be perfectly patented and it is non-rival in nature; (b) creation of new knowledge does not exhibit diminishing returns; and (c) new knowledge is more profitable when it leads to more efficient production. Thus, while education is important for an individual, the social importance of

education has multiplier effects. This is because education: (i) raises peoples' productivity and creativity; and (ii) promotes entrepreneurship and technological advances.

While the concept of human capital refers to the abilities and skills of human resources of a country, 'human capital formation' refers to the process of acquiring and increasing the number of people with skills, good health, education and experience that are critical for economic growth. Sources of human capital formation may be listed as follows:

- increasing per capita public expenditure in education at primary, secondary and higher level with provision of education at primary, secondary and tertiary levels;
- providing health facilities which increases the life expectancy of the people;
- on the job training;
- allowing migration to individuals for change of jobs; and
- organising vocational training programmes for students and working class.

10.2 ECONOMICS OF EDUCATION

Economics of education is an applied field of study that allows for the systematic examination of the problems faced in promoting education for all. By applying the economic theories of consumer, producer and social choice, 'economics of education' aims at understanding the behaviour of individuals, education providers, public and private organisations and governments in decision-making in the context of overall development of a society.

Education is classified as a 'merit good'. This is because its consumption provides benefit to others besides the individual consumer. For instance, a well educated person is aware about the health benefits of immunisation compared to a person who is illiterate. Thus, education or knowledge accumulation generates both a private benefit as well as an external benefit. A merit good is thus a product that society values and judges that people should have regardless of their ability to pay. Education thus creates public and not purely private benefits. In this sense, the government acts paternally while providing merit goods and services. Individuals may not act in their own interest because of imperfect information. While it is a fact that education produce private benefits (e.g. skills that can be used to get a good job), it also produces significant public benefits (e.g. gains in public health, robust democratic participation, responsible citizenry, etc.). The reason that education is a quasi-public good or merit good is because education is supposed to advance goals like ensuring equal opportunity and giving every student access to good schooling which helps society in general.

10.2.1 Physical Capital and Human Capital

Both the physical and human capital are durable but there are some basic distinctions between the two. Physical capital implies non-human assets such as: (i) plant and machinery, (ii) tools and equipment, (iii) office supplies, etc. that help in the process of production. Human capital refers to: (i) stock of knowledge (measured by literacy rate and years of schooling), (ii) talent, skills and abilities (brought in by the employee to the organisation) and (iii) general health status of the masses (of the society) like life expectancy and morbidity pattern, etc.

Physical capital is tangible whereas human capital is intangible. Physical capital can be traded in the market but the services of human capital can only be hired. Physical capital is formed through technological progress and economic development whereas human capital is generated through society. Human capital originates and gathers momentum through societal culture, customs, mobility and interactions. Accumulation of physical capital does not necessarily imply accumulation of human capital. Human capital can generate positive externality to the society whereas physical capital does not possess such property. Physical capital can be separated from its owner but human capital cannot be so separated. The creation of physical capital is an economic process and does not take too much time whereas accumulation of human capital requires much time and patience. Physical capital can be transferred from one individual (say, A) to another (say, B). As a result, B's endowment of physical capital increases and A's endowment reduces. Such type of exchange can not be made in case of human capital.

Mobility of physical capital from one country to another is restricted by trade barriers whereas nationality and culture makes obstacles to move human capital from one country to another. Both the physical and human capital depreciates but physical capital depreciates at a constant rate as compared to human capital. It is the natural ageing which leads to the depreciation of human capital which can be minimised by proper medical intervention.

10.2.2 Linkage between Health and Education

Education of the poor helps improve their food intake not only by raising their incomes and spending on food but also by inducing them to make better and healthier choices. Educated persons tend to consume a healthier diet even when the total amount spent on food is held constant. The relationship between the three [(i) education, (ii) better health and (iii) life expectancy] involves causation in both directions. This is because greater health and lower mortality induce larger investments in education because the rate of return on investment in education is greater when the expected span of working life is also greater. Education has therefore been recognised as the primary determinant of human capital, although over time, health and nutritional expenditure too are recognised as major contributors to 'human capital investment'. In sum, therefore, education, health, nutrition, water and

sanitation all complement each other, with investments in any one contributing to better outcomes in the others.

Check Your Progress 1 [answer within the given space in about 50-100 words]

1) Define the term 'human capital'.

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2) Differentiate between 'human capital' and 'human capital formation'.

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3) Distinguish between 'physical capital' and 'human capital'.

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4) How is the relationship between education and health bi-directional?

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10.3 ENDOGENOUS GROWTH MODELS

Traditionally, economic theory has given emphasis on physical capital accumulation to explain the source of economic growth in the short-run. In the long run, it has considered the exogenous technical progress as the determinant of growth. In the neoclassical growth models, the exogeneity of

technological progress is considered restrictive to explain the analytical capacity of the models.

10.3.1 Neoclassical Growth Model

The standard Solow growth model (1956) assumes that: (i) population growth in the long run is exogenously given (i.e. it grows at a constant rate but exponentially), (ii) the growth of capital per unit of labour depends on propensity to save and (iii) average productivity of output per unit of labour (per capita output) will increase if population growth declines. With these assumptions, the standard Solow-Swan growth model is derived by assuming the per capita output ($k = \frac{K}{L}$ where K is capital and L is labour) as given. Differentiating k with respect to time 't', we get:

$$k = \frac{d}{dt}(k) = \frac{d}{dt}\left(\frac{K}{L}\right) = \frac{L.\frac{dK}{dt} - K.\frac{dL}{dt}}{L^2} = \frac{1}{L}.\dot{K} - \frac{K}{L}.\frac{\dot{L}}{L} \qquad (10.1)$$

Net investment is both the addition to the stock of capital (K) over time (i.e. $\dot{K}$) and also the difference between gross investment (I) and depreciation of capital (K). We can therefore write: $\dot{K} = I - \sigma K$ where σ denotes the rate of depreciation of capital. Since population (labour force) grows at a constant rate (n) and follows an exponential function we have: $L_t = L_0.e^{nt}$ or $\frac{\dot{L}}{L} = n$. From Equation (10.1), we can write:

$$k = \frac{1}{L}.\dot{K} - \frac{K}{L}.\frac{\dot{L}}{L} = \frac{(I - \sigma K)}{L} - k.n = \frac{(S - \sigma K)}{L} - k.n$$

$$= \frac{(sY - \sigma K)}{L} - k.n = s\frac{Y}{L} - \sigma.\frac{K}{L} - k.n = s.y - k(\sigma + n) \qquad (10.2)$$

[since $I = S$ (savings) in equilibrium, $S = sY$ with 's' as propensity to save] where Y is income so that $y = \frac{Y}{L} = f(k)$. Dividing both sides of Equation (10.2) by k, we get:

$$\gamma = \frac{\dot{k}}{k} = s\frac{y}{k} - (\sigma + n) = s.\frac{f(k)}{k} - (\sigma + n) \qquad (10.3)$$

where, γ denotes rate of growth of physical capital per unit of labour, k stands for physical capital per unit of labour, s is the average (= marginal) propensity to save and σ is the rate of depreciation of physical capital. Thus, if ρ is the population growth rate, then as ρ increases, γ falls and vice-versa. In a steady state situation, capital per unit of labour depends on the propensity to save (s), technology and population growth rate. Further, as population growth decreases, steady state capital per worker will increase. This means, in steady state γ = 0, equilibrium capital per worker

$k^* = \left(\frac{sA}{\rho+\sigma}\right)^{\frac{1}{1-\alpha}}$ and steady state output $Y_t^* = A^{\frac{1}{1-\alpha}}.\left(\frac{s}{\rho+\sigma}\right)^{\frac{\alpha}{1-\alpha}}.L_t$ If the production function is of Cobb-Douglas type giving constant returns to scale as: $Y_t = AK_t^{\alpha}L_t^{1-\alpha}$ [where, α is share of capital in total output and $(1-\alpha)$ is the share of worker in total output, $0< \alpha <1$, a model which has been used widely to study the conditional convergence in growth empirics across countries], in the long-run growth being exogenous, in the absence of continuing improvements in technology, per capita income growth eventually ceases. This is known as convergence theory.

10.3.2 Solow Residual

Empirical evidence of neoclassical growth model explains about half the variation in growth. The remainder, called the Solow Residual (SR), is a measure of our ignorance of the determinants of economic growth. The Solow residual is a number describing productivity growth in an economy (from year to year and decade to decade). Solow defined the rising productivity as 'rising output with constant capital and labour input'. It is a 'residual' because it is the part of growth not accounted for by measures of capital accumulation or increased labour input. The Solow Residual is pro-cyclic (i.e. it generates a cycle) and its measure (called multifactor productivity or total factor productivity) is derived by considering a production function like Cobb-Douglas exhibiting constant returns to scale as specified below:

$$Y(t) = [K(t)]^{\alpha}[A(t).L(t)]^{1-\alpha} \qquad (10.4)$$

where *Y(t)* represents the total output in an economy (the GDP) in some year *t, K*(*t*) is capital in the productive economy (measured as the combined value of all companies in a capitalist economy) and *L*(*t*) is labour i.e. the number of working people or the labour force. Growth models being long-run models they ignore cyclical unemployment effects, assuming instead that the labour force is a fraction of an expanding population. *A*(*t*) represents multifactor productivity (often generalised as 'technology' including soft skills like good communication with labour). Equation (10.4) can be alternatively written as: $Y(t) = [K(t)]^{\alpha}[A(t)]^{l-\alpha}.[L(t)]^{l-\alpha}$. Differentiating this with respect to time (t), we get:

$$\frac{\delta Y}{\delta t} = [A(t)]^{1-\alpha}.[L(t)]^{1-\alpha}.\alpha.[K(t)]^{\alpha-1}.\frac{\delta K}{\delta t} + [A(t)]^{l-\alpha}.[K(t)]^{\alpha}.(1-\alpha).[L(t)]^{-\alpha}.\frac{\delta L}{\delta t} +$$
$$[K(t)]^{\alpha}.[L(t)]^{l-\alpha}.(1-\alpha).[A(t)]^{-\alpha}.\frac{\delta A}{\delta t}$$

Dividing both sides by *Y*(*t*), and subsuming observed values into the two respective coefficients, we get:

$\frac{\dot{Y}}{Y} = \alpha.\frac{\dot{K}}{K} + (1-\alpha).\frac{\dot{L}}{L} + (1-\alpha).\frac{\dot{A}}{A}$. Thus, the SR is defined as:

$$SR = \frac{\dot{Y}}{Y} - \left[\alpha.\frac{\dot{K}}{K} + (1-\alpha).\frac{\dot{L}}{L}\right] \quad (10.5)$$

Solow's theory helps to clarify the role of accumulation of physical capital and emphasise the importance of technological progress as the ultimate driving force behind sustained economic growth. Human capital in the Solow model is not linked to the dissemination of technological change [as it is in Romer (1986) and Lucas (1988)] but is strictly exogenously determined. The human capital or endogenous growth can be derived from Solow's version (of exogenous growth) by incorporating the human capital into the production function. Any activity including innovation and technical improvement is pursued continuously only if people are rewarded for it. A production process would not be continuously improved if the innovators were outside the economy. Hence, only the producers of goods are motivated to introduce new products or find ways to improve their productivity to increase profitability. The new growth economists were therefore of the view that technological change is generated by the day to day economic activity and hence is endogenous to the model of growth.

According to the endogenous growth theory, a firm that accumulates physical capital to produce goods will also gather knowledge specific to that production process. Since the technological knowledge comes from learning by doing, it is the capital that initiates this change. Thus, technological knowledge is itself a kind of capital that yields increasing returns (or at least constant returns) but never diminishing returns owing to its spillover effects. Further, knowledge once created can be re-used with zero cost and almost no depreciation as old knowledge builds new knowledge.

10.3.3 AK Model

The AK model is the basic version of an endogenous growth model. This model uses the term Technology to include both technological change and human capital. The AK model assumes constant exogenous savings rate and a fixed level of technology. The rationale for this assumption is that the 'production function does not accommodate for diminishing returns to capital'. This means, if we invest one unit of capital, return from that capital will be higher than one unit. Consider the AK model for a closed economy as:

$$Y = AK \quad (10.6)$$

where the production function is explicitly dependent only on capital with A as a positive constant reflecting the level of the technology. Output per worker can be written as:

$$y = Ak \quad (10.7)$$

where A > 0. From Equation (10.3), we have the equation for steady state as:

$$\gamma = s.\frac{f(k)}{k} - (n+\sigma) \Rightarrow \gamma = sA - (n+\sigma) \qquad (10.8)$$

If the technology is *AK*, then the saving curve $s.f(k)/k$ is a horizontal line at the level of $s.A$ (Figure 10.1). If $s.A > (n+\sigma)$, then perpetual growth occurs even without technical change. From Figure 10.1 it follows that γ_k is the vertical difference between $s.A$ and $(n+\sigma)$. If $s.A > (n+\sigma)$, it implies $\gamma_k > 0$. Since the two lines are parallel, γ_k is constant and is independent of k. Thus, since, $y = Ak$ implies $\gamma_y = \gamma_k^*$ at every point in time, the steady state growth path is: $\gamma = \gamma^* = sA - (n+\sigma)$

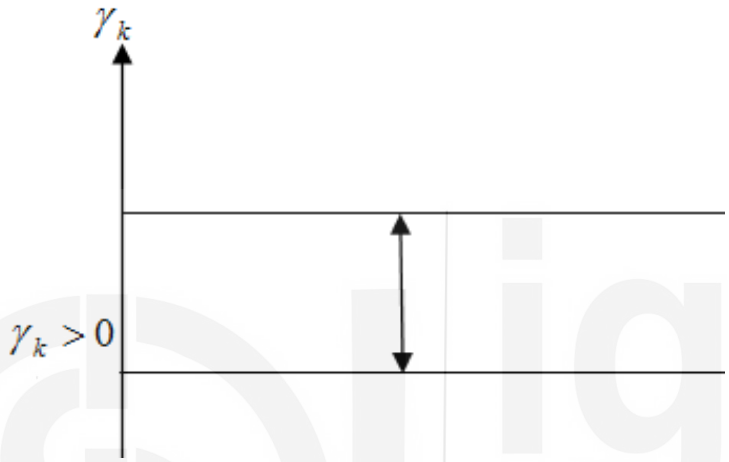

Fig. 10.1: Steady State Growth Path in AK Model

The economy described by the AK technology can display positive long run per capita growth without any technological progress. The per capita growth rate depends on the behavioural parameters of the model such as the savings rate and the rate of population growth. Thus, unlike in the neoclassical model, if the savings rate is high then the long run per capita growth will also be high. If the level of the technology (*A*) improves then also the long run growth will be high.

The AK model is an endogenous growth model used in a sub-field of modern macroeconomics. In the 1980s, it became progressively clearer that the standard neoclassical exogenous growth models were theoretically unsatisfactory as tools to explore long run growth. This is because these models predicted economic growth without accounting for technological change and thus would eventually converge to a steady state with zero per capita growth. A fundamental reason for this is the diminishing return of capital whereas the main property of AK endogenous-growth model is the absence of diminishing returns to capital.

Check Your Progress 2 [answer within the space given in about 50-100 words]

1) Under the neo classical growth model, is 'human capital' directly or otherwise accounted?

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2) Does Solow in paying attention to the residual growth rate accord exclusively any weight to human capital element?

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3) Indicate the expression of SR and state how it is useful?

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4) Is the AK model an improvement over its predecessors? How?

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10.4 EDUCATION AND ECONOMIC GROWTH

In models of neoclassical economic growth, physical capital in the form of machines, land, assets, buildings, infrastructure, etc. have been given a central place while the role of labour has remained peripheral. In explaining Solow Residual (SR), educational attainment like schooling or enrolment has been given a central place. Given these, in this section, we shall first take a look at the production function approach to human capital formation and then examine the linkage between human capital formation, fertility and poverty.

10.4.1 Production Function Approach

Following the endogenous growth model, we consider here an implicit production function like:

$$Y_t = Y(K_t, H_t, L_t) \qquad (10.9)$$

where Y = aggregate output, K is physical capital, H is human capital (like mean years of schooling, enrolment ratio, life expectancy, etc.) and L is the labour force. We have deliberately separated human capital from labour in order to distinguish unskilled labour from skilled labour.

Differentiating Equation (10.9) with respect to time t, we get:

$\dot{Y} = \frac{\partial Y}{\partial L}\dot{L} + \frac{\partial Y}{\partial K}\dot{K} + \frac{\partial Y}{\partial H}\dot{H}$ Dividing throughout by Y and subtracting $r = \frac{\dot{P}}{P}$ (viz. rate of growth of population) from both sides, we get:

$$\frac{\dot{Y}}{Y} - \frac{\dot{P}}{P} = \left(\frac{\partial Y}{\partial L}\right).\frac{L}{Y}.\frac{\dot{L}}{L} + \left(\frac{\partial Y}{\partial K}\right).\frac{I_K}{Y} + \left(\frac{\partial Y}{\partial H}\right).\frac{I_H}{Y} - \frac{\dot{P}}{P}$$

$$\Rightarrow \frac{\dot{y}}{y} = \frac{MP_L}{AP_L}.n + MP_K.\frac{I_K}{Y} + MP_H.\frac{I_H}{Y} - r$$

where 'n' = L/L'rate of growth of labour force'. The left-hand side of the above equation represents the growth in per capita output. We assume that: (a) gross investment is equal to net investment (i.e. rate of depreciation of physical and human capital is zero) and (b) $AP_L = MP_L$ in the long-run. Therefore, the above expression becomes:

$$\frac{\dot{y}}{y} = (n - r) + MP_K.\frac{I_K}{Y} + MP_H.\frac{I_H}{Y} \qquad (10.10)$$

In the standard Solow-Swan growth model, it is assumed that n = r but in reality n ≠ r. Moreover, in less developed economies, r > n because of slow demographic transition. In fact, in the 3rd or last stage of demographic

transition, most of the developed economies have witnessed n > r which results in demographic dividend (i.e. rising share of working population). An increase in 'n' or a decrease in 'r' results in an increase in per capita growth of output. Since marginal productivity of physical and human capital is positive, an increase in share of investment in physical and human capital of total output results in higher growth in 'per capita output'.

Equation (10.10) shows that the share of human capital investment (comprising educational and healthcare spending) in total output bears a positive effect on the growth of 'per capita income'. The same is also found to be the case for physical capital. Further, the marginal productivity of human capital (MP_H) being positive and MP_H can be interpreted either by considering education or health as human capital, MP_H can be considered as 'marginal increase in output/income (Y) due to one unit increase in years of schooling'. In the same way, if we consider health as human capital, incremental increase in output per capita can be considered as due to one unit increase in life expectancy (i.e. MH_{H}).

10.4.2 Human Capital Investment, Fertility and Poverty: Linkage

The population of a poor country is not uniformly poor. This means, there is persistent poverty relative to degree of income inequality. One of the most visible manifestations of this inequality is the wide spread dispersion in educational attainment and health outcomes. Given that there is a two way causality between income and human capital (vide Sub-section 10.2.2), there is a demand side effect of income on human capital. Household choices with regard to fertility being strongly conditioned by the social environment, with the potential to affecting the demographic structure of the society, we need a theoretical model to describe fertility (F), human capital (H) and poverty (P).

If an economy is characterised by small families, labour is relatively scarce and consequently adult wages are high. An alternative situation could be one in which adult wages are low, families are so poor that all children must work and family decides to have many children. In such a situation, poor families will not send their children to school due to loss in opportunity cost. Secondly, technology is such that adult and child labour could be substitutes. Thus, in poor families, children become capable of providing net economic benefits to the family. This factor becomes an incentive to the poor parents to prefer more children indirectly affecting the health of the mothers. The demographic structure generated by such fertility choices yields low wages. In such an environment, it is individually optimal to have many children in order to avoid situation of destitution. To break such low level trap of human capital accumulation, government intervention is needed. In order to attract children in schools especially from the poor families, the government needs

to initiate special programmes (like mid-day meals, free books, free school dress, free cycles etc.) to increase human capital formation.

An exogenous increase in expenditure on education and healthcare directly benefits the poor people. Since private schooling and healthcare are expensive, in less developed economies with wide spread incidence of poverty, public expenditure in 'social sector' (i.e. education and healthcare) gives higher returns both in the short as well as the long run to the society. In this, returns from primary education is found to be higher compared to secondary and higher education. Just as poor people cannot afford to send their children to privately run schools, they cannot purchase private healthcare. Therefore, in the long run, at the aggregate level, the health stock of the poor people can be increased by increased public expenditure on health by way of immunisation of children, post and pre-natal care for mothers, etc. As the survival probability of each child increases, parents would not find the need to insure themselves by having more children. Conversely, decline in child mortality increases the probability of survival to adulthood thereby reducing the need to have a large family. In other words, both the adult and child mortality declines induce a quality-quantity trade-off. In the case of a decline in adult mortality, increases in educational investments, driven by expected higher future return, will result in a reduction in fertility. With decline in child mortality and fall in fertility, parents would be motivated to increase educational investments on their children. Though accumulation of human capital stock through schooling is a long-run phenomenon, as a result of accumulation of human capital the productivity of the labour force goes up. This, in turn, increases the 'growth in output' of the economy. Since human capital at the aggregate level is non-decreasing, the growth in output will be sustained by multiplier effect. With sustained growth, the migration of people from primary to secondary and secondary to tertiary sectors would be facilitated over time. This would, in turn, lead to demand for fewer children and increase in per child investment in education. The mechanism through which falling fertility is observed to contribute to the multiplier effect are: (i) female education (which raises the opportunity cost of time of the mothers) and (ii) negative income elasticity for the number of children. Reduction in poverty and fertility, as a result of exogenous influence of human capital investment, can be more clearly gathered with the help of a flow chart as shown in Fig. 10.2.

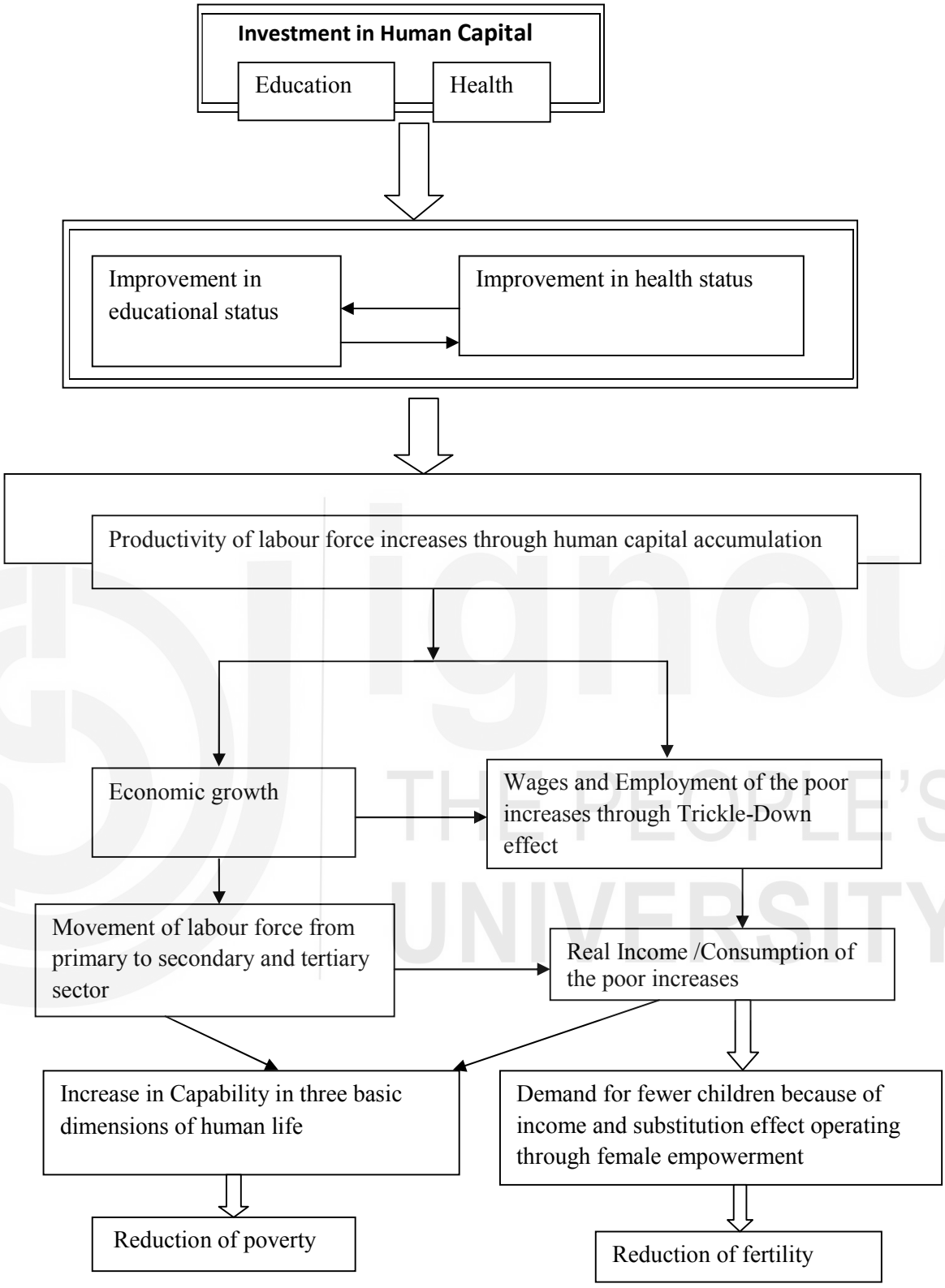

Fig. 10.2: Flowchart Depicting Links between Human Capital Investment, Poverty and Fertility

10.5 EXPENDITURE FOR EDUCATIONAL SERVICES

In this section, assuming that the technological possibilities for producing educational services are identical across countries, we try to formulate/model the mechanism for determining the 'price of educational services' in a democratic set up. The production function for educational services is assumed to exhibit constant returns to scale in the long-run. This assumption is realistic at least for primary and secondary school education. Thus, assuming the elasticity of substitution between labour and capital to be one, the production function in the standard Cobb-Douglas form is:

$$X = ZL^{\alpha}K^{1-\alpha} \tag{10.11}$$

where X is output of educational services, L is labour input, K is physical capital, α is the share of wages in output, $(1 - \alpha)$ is the share of capital in output and Z is a set of exogenous factors accounting for technological shifter that affects the unit cost of producing educational services (including many other factors neutral to labour and capital productivity in use). One such technological factor, for instance, could be the distribution of the population. This is in the sense that differently dispersed population groups would incur differing private and public costs in providing quality schooling services to their children. It is assumed that rapid population growth, which strains the capacity of the government to provide desired school services is subsumed (i.e. included) in Z. The political process is assumed to be democratic in the sense that services and its associated tax burden have the majority support of voting population. The essential idea here is that public as well as private institutions tend to optimise their input allocation and production decisions subject to constrains of consumers income and perceived benefits from output. It also includes the effect of technological possibilities and relative input prices to factors of production.

The educational sector minimises its unit cost of producing educational services by focusing on bringing down its 'marginal cost or price of schooling services' (P_x). P_x can therefore be expressed as a multiplicative function of wage (W) paid to labour (teacher) and the interest rate (r) paid on capital. Under a perfectly competitive equilibrium, where price is equal to AC (=MC), the unit price of educational services based on Equation (10.11) can be expressed as:

$$P_X = \frac{1}{Z}\cdot\left(\frac{W}{\alpha}\right)^{\alpha}\cdot\left(\frac{r}{(1-\alpha)}\right)^{1-\alpha} \tag{10.12}$$

We consider an international perspective where the capital markets are better integrated for yielding efficient returns. In such a context, the rate of return on capital (K) over time depends mainly on the real wage (W) and the exogenous factors (Z). Thus, the estimates of elasticity of Z and W could be obtained from:

$$P_X = e^{\beta_0}.Z^{\beta_1}.W^{\alpha}.e^{u_1} \tag{10.13}$$

where β_0 is constant, $\beta_1 = -1$ and u_1 is a multiplicative error term affecting unit cost or price. We can estimate Equation (10.13) by using the labour's share of educational expenditure α. Assuming that the quantity of schooling demand (by the median voter q) is log-linear in the tax (t) of tax-payers' income (y), we can estimate:

$$q = D.t^{\eta}.y^{\delta}.Z^{\varepsilon}.e^{u_2} \tag{10.14}$$

where u_2 is the multiplicative error term in the demand function. Therefore, the expenditure 'per school aged child' (E/P) can be obtained by multiplying quantity demanded (q) by price (P_X) where the general tax rate is assumed equal to the marginal cost or price (P_X) of schooling services. Therefore, expenditure per child (E/P) can be estimated as:

$$E / P = D.y^{\delta}.P_X^{\eta+1}.Z^{\varepsilon}.e^{u_2} \tag{10.15}$$

Substituting the price relating to production technology from Equation (10.13) in Equation (10.15) and taking log on both sides, the partial effects of income, relative prices and technological shifter, the 'public expenditure on education per child' (expressed as a combination of underlying household demand and production technological parameters), we have:

$$\ln(E / P) = b_0 + b_1 \ln y + b_2 \ln W + b_3 \ln Z + \upsilon \tag{10.16}$$

where, $b_0 = (\eta + 1).\beta_0 + \ln D$, $b_1 = \delta$, $b_2 = \alpha(\eta + 1)$, $b_3 = (\eta + 1).\beta + \varepsilon$

In Equation (10.16), the error term (υ) combines the effect of variations in production technology and household demand relationship. 'v' is assumed to be independent of y and Z. Knowledge of labour share, α, is to be used in the identification of price elasticity η. The net effect of income δ and the Z factors (determined by cohort of school going children, fertility, urbanisation and density of population) on educational inputs and outputs needs to be inferred from the estimates of reduced form of Equation (10.16).

Check Your Progress 3 [answer within the space given in about 50-100 words]

1) In the standard endogeneous growth models, what is the assumption made on human capital? What improvement is made in the formulation

of analytical framework to accommodate the contribution of 'human capital' here?

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2) Why is governmental intervention necessary in developing economies to break the low human capital trap?

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3) State the two factors which contribute in the mechanism through which falling fertility results in higher investment in 'per child investment in education'?

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4) State the expression for estimating the unit price of educational services in an economy under conditions of perfectly competitive equilibrium. State also the expression for estimating the 'expenditure per child'.

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10.6 LET US SUM UP

Indicating the linkage between health and education, the significance of endogeneous growth models in enhancing the share of 'human capital formation' is highlighted in the unit. The potential of production function approach in disentangling the contribution of human capital is explained. The linkage between 'human capital investment', fertility and poverty is delineated. Stressing the importance of increased public expenditure on education and health, particularly in developing countries, an analytical framework for estimating the 'price function' to obtain the 'expenditure per school aged child' is discussed.

10.7 KEY WORDS

Human Capital : Refers to (i) stock of knowledge measured by literacy rate and years of schooling, (ii) health status of the population measured by life expectancy and quality of life index and (iii) talent, skills and abilities brought in by the employee to the organisation.

Marginal Productivity of Human Capital (MP_H) : If we consider, human capital as literacy rate or years of schooling, MP_H can be interpreted as the incremental change in total output (viz. Y) due to one percent increase in literacy rate or years of schooling.

Merit Good : Consumption of a good, which generates positive externality to the society at large, is defined as merit good. In such cases, social benefits exceed private benefit and such a good either can be produced by the private as well as public sector.

Solow Residual : Refers to an empirical expression developed by Solow to explain the contribution to growth besides that by explicit accounts of two factors of production viz. labour and capital.

10.8 SOME USEFUL BOOKS AND REFERENCES

1) Basu K and P H Van (1988). 'The Economics of Child Labour', American Economic Review, Vol. 88, No. 3 (Jun.), pp. 412-27.

2) Lucas R E (1988). 'On the Mechanics of Economic Development', Journal of Monetary Economics, 22, 3-42.

3) Romer P (1986). 'Increasing Returns and Long-Run Growth', *Journal of Political Economy*', 94 (5):1002-1037.

4) Schultz, T P (1988). 'Education Investments and Returns', Chapter-13, Handbook of Development Economics, Volume-1, 543-630.

10.9 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) It is defined as the stock of knowledge embodied in human beings. Such knowledge is acquired by formal education, practical training, etc. Persons with human capital skill are thus identifiable as 'trained or skilled persons' as opposed to those who are not i.e. unskilled persons.

2) Human capital refers to abilities and skills; human capital formation refers to the processes through which higher competencies are acquired (e.g. increasing public per capita expenditure on school education).

3) Physical capital is tangible (i.e. felt like machines, equipments) whereas human capital is intangible (not felt physically but experienced in terms of better behaviour, knowledge, culture, etc.). Human capital generates positive externality to society whereas physical capital does not do so.

4) Better health induces larger investments in education and 'rate of return' on education is greater when life expectancy and thereby working life span is greater.

Check Your Progress 2

1) Population is assumed to grow at a constant rate (n) and capital per unit of labour (i.e. capital-labour ratio) is assumed to depend on 'n'. No exclusive factoring of knowledge or skill component is made.

2) The human capital (HC) can be derived from Solow's version by incorporating the human capital into the production function. But once again no direct infusion or consideration is made even here just like in the neoclassical models.

3) $SR = \frac{\dot{Y}}{Y} - \left[\alpha.\frac{\dot{K}}{K} + (1-\alpha).\frac{\dot{L}}{L}\right]$. By exogeneously determining HC it emphasises the importance of technological progress as the driving force behind sustained growth.

4) In the AK model, the per capita growth in output depends on the behavioural parameters viz. savings and rate of population growth. This is an improvement over the neoclassical models which predicted economic growth without accounting for technological change. By assuming the absence of diminishing returns to capital, the emphasis is brought on technological improvement. Thus, for long run prediction, this model is an improvement over its predecessors.

Check Your Progress 3

1) That the rate of depreciation in human capital (as well as physical capital) is zero. Human capital and labour force are given exclusive exogeneous places. By doing this, unskilled labour is distinguished from skilled labour.

2) The opportunity cost of having more children and using them to enhance household income by sending them to work rather than to school, sets a low level of human capital accumulation in developing countries. This needs governmental intervention by special schemes to promote and motivate sending children from poor families to school.

3) Female education and negative income elasticity for the number of children.

4) Equations (10.12) and (10.15).