Chapter Three
Theoretical Model and Empirical Background

This chapter discusses the theoretical and empirical issues relevant to the study. The chapter consists of 8 parts. Section 3.1 provides the theoretical background for educational investments. Section 3.2 discusses the benefits of education. Section 3.3 discusses the costs of education. Section 3.4 discusses the concepts of net present value and internal rate of return. Section 3.5 outlines the basic model of educational investments. Section 3.6 provides the rationale for public investments in education. Section 3.7 discusses the earnings function approach for measuring educational benefits. Finally, Section 3.8 provides the empirical background of the study.

3.1 Background

The importance of education in economic development has been emphasized by several economists, starting from Adam Smith, who considered the skills of the laborforce to be a crucial component of economic progress. Early economists like Von Thunen and Alfred Marshall recognized the importance of education in their works. However, it was not until the 1960's that the theory of human capital was formally developed. The seminal works of three great economists – Theodore W Schultz, Gary Becker and Jacob Mincer – formally linked educational investments to human capital formation and economic development. Two types of findings were particularly significant for the development of human capital theory. First, it was observed that the growth of conventionally measured inputs of labor and capital was far smaller than the growth of output in the US and some other countries, and second, data on personal income distribution showed that the variance of labor incomes, rather than the differences between returns to labor and capital, represented the major component of personal income inequality. The development of human capital theory broadened the concept of capital to human capital, and made invalid the assumption of homogeneous labor. It was recognized that human skills were like any other physical capital that could be augmented through purposeful investment. The concept of human capital has been applied both at macro and micro levels in the economics literature. At the macro level the stock of human capital and its growth are considered important factors determining economic growth. At the micro

level differences in individual human capital stocks and their growth have been used to explain variation in wages and the distribution of income.

Mincer (1984) states that "human capital analysis deals with acquired capacities which are developed through formal and informal education at school and at home, and through training, experience and mobility in the labor market. The central idea of human capital theory is that, whether deliberate or not, these activities involve costs and benefits and can, therefore, be analyzed as economic decisions, private or public". Numerous studies have been undertaken since the 1960's to estimate the profitability of educational investments. Investments in education can be analyzed using the same framework as that of investments in physical capital. The benefits and costs of educational investments extend over the lifetime of individuals. Since the benefits and costs accrue over long periods of time, it is important to discount these benefits and costs to a common time period. The net present value (NPV) method compares the benefits and costs of educational investments after discounting them to a common time period. A discussion of the benefits and costs of education is presented below.

3.2 The Benefits of Education

The benefits of education have been broadly classified into two types – monetary and non-monetary. Education equips individuals with skills that lead to higher productivity and earnings at the workplace. For example, the higher earnings of college graduates, relative to high school graduates are the monetary benefits of a college education. Several studies have estimated the incremental earnings of individuals that could be attributed to a higher education. For example, McMahon (1998) reported that the lifetime earnings of University of Illinois-Urbana Champaign (UIUC) graduates were considerably higher than the earnings of high school graduates for the nation as a whole. However, the incremental earnings varied across majors. Commerce graduates had the highest incremental earnings (Table 3.1) followed by engineering graduates, indicating the higher market returns to graduates with these skills.

Table 3.1: Incremental lifetime earnings (undiscounted) of bachelors degree-holders of the University of Illinois at Urbana-Champaign

College	Male ($)	Female ($)
Agriculture	1,032,135	655,276
Applied & Life Studies	1,210,742	625,593
Art & Architecture	671,753	542,072
Commerce	1,861,879	1,297,697
Communications	927,657	752,851
Education	740,345	696,143
Engineering	1,598,370	1,278,681
Labor Studies	1,223,044	812,524

Source: McMahon (1998)

Further, the author found that the private rates of return at the bachelors level were 22 percent for males and 21 percent for females, compared to a high school degree. After accounting for the effects of ability, prior schooling, family factors and productivity changes in the economy (the author used estimates from other studies for making the adjustments), the private rates of return were 20.9 percent for males and 23 percent for females.

Grosskopf and Sloboda (2000) in their cost-benefit analysis of a Southern Illinois University undergraduate degree found that the present discounted value (PDV) of income increments (Table 3.2) due to the degree were $223,954 and $187,192, for males and females, respectively. In addition, they reported that the present discounted value of increments in Illinois State income and sales tax revenue due to a college education were $14,813 and $12,381, for males and females, respectively.

Education also leads to several non-monetary benefits. These include better health (own and family), the ability to make more-informed decisions regarding fertility, consumption and investment, higher participation in political processes, lower crime rates and so forth.

Table 3.2: Present discounted values of income increments due to a Southern Illinois University undergraduate degree ($)

	College Vs High school	1-3 years college vs High school	College Vs 1-3 years college	Graduate school Vs College
Male	223,954	90,054	133,900	335,841
Female	187,192	9,234	177,948	84,204

Source: Grosskopf and Sloboda (2000)

Recent studies have attempted to measure and value the non-monetary benefits of education. Grossman and Kaestner (1997) reported that an additional year of schooling lowers the probability of death of adults by 0.4 percentage points per year. The authors conclude that the purely non-monetary effects on better own health, better spouse health and better child health can be valued at 40 percent of the value of the direct effect of education on earnings.

This study primarily focuses on the monetary benefits of education. However, in the final chapter of the thesis a detailed review of the non-monetary benefits of education is presented.

3.3 The Costs of Education

The costs of education include the earnings foregone by the graduates while in school/college, and tuition and fees paid. The foregone earnings constitute the major portion of the costs of education. For an undergraduate, for example, the foregone earnings are equivalent to the earnings they could have obtained with a high school degree during the time they are enrolled in college. Tuition and fees are the other costs of education. Since tuition rates receive considerable focus in the public policy arena, the relationship between tuition rates and college enrollments assumes significance. Students

appear to be responsive to the cost, particularly tuition, of college enrollment. Leslie and Brinkman (1988) in their study on the impact of higher tuition rates on student enrollments in community colleges, found that the demand elasticities with respect to college tuition rates were quite high. They reported that a $100 increase in tuition was associated with a 0.7 percentage point decline in enrollments among 18-24 year-olds. According to Kane and Rouse (1999), while the payoff to college was rising dramatically during the 1980's, the proportion of high school graduates entering college with a high school degree rose by only 7 percentage points, from 65 to 72. Using the tuition sensitive estimates reported by Leslie and Brinkman, the authors calculated that a tuition increase of $1500 would be enough to wipe out that rise in college enrollments.

3.4 Net Present Value (NPV) / Internal rate of return

The net present value (NPV) of an investment is the difference between the discounted benefits and discounted costs of an investment. In case of college education the benefits (monetary) are the higher earnings of a college graduate relative to a high school graduate over the individual's lifetime. The NPV of a VT undergraduate education can be found by discounting the benefits and costs of obtaining a VT degree. The benefits are the incremental earnings of VT graduates relative to their earnings without the VT degree, over their lifetime employment. The costs are the foregone earnings (which are obtained from the earnings profiles without the VT degree), and tuition and fees. Thus, the NPV of a VT education is given by,

$$NPV = \sum \frac{(Y_{VT} - Y_{HS})}{(1+r)^t} - \sum \frac{Y_{CS}}{(1+r)^t} \qquad (3.1)$$

where, Y_{VT} are the earnings of a VT graduate, Y_{HS} are the earnings of the graduate without the VT degree, Y_{CS} is the cost (sum of foregone earnings and tuition) of getting the VT degree, r is the discount rate and t the time period in question.

A related concept that is often used in the analysis of investments is the internal rate of return. The internal rate of return is the discount rate that equalizes the discounted benefits and discounted costs. The internal rate of return indicates the desirability of investments. The higher the internal rate of return, the better the investment. The internal rate of return for a college education often exceeds the rates of return on many other investments. Estimates of the rate of return to post-secondary education in the US vary between 8.4 percent and 17.9 percent depending on major, occupation, sex and other characteristics like ability and motivation. However, university-specific rates of return could easily exceed this range. For example, McMahon (1998) reported that the rates of return for a University of Illinois – Urbana Champaign undergraduate education were 22 percent and 21 percent, for males and females respectively. The internal rate of return of a college education further indicates the demand for college-educated workers. A higher rate of return reflects a strong demand for college–educated workers. The rates of return to schooling in the US have remained relatively stable despite the continuous growth of educational attainment, suggesting that there have been continuous growth in the demand for educated labor in the US economy (Mincer, 1984).

The internal rate of return of an educational investment can be estimated from either the private or the social point of view. The private rate of return is calculated after adjusting the earnings of individuals for taxes, while the social rate of return is calculated without adjusting the earnings for tax payments. On the cost side, the private rate of return is calculated using the costs (of education) borne by individuals and their families, while in the calculation of the social rate of return, the full resource cost of education is considered, that is, society's spending on education. "The private rate of return is used to explain the demand for education. It can also be used to assess the equity or poverty alleviation effects of public education expenditures, or the incidence of the benefits of such expenditure. The social rate of return summarizes the costs and benefits of the educational investment from the state's point of view. Since the costs are higher in a social rate of return calculation, social rates of return are typically lower than private rates of return" (Psacharopoulos, 1995). The social rates of return are typically lower relative to private rates of return because society's spending on education outweighs the

benefits of that education. For the purpose of this thesis the focus will be on the private rate of return.

3.5 The Basic Theoretical Model of Educational Investment

Economic theory provides a framework for analyzing educational investments. Let C_i denote the marginal cost of education in period 'i', R_i the return to that education, and 'r' the interest rate. If education lasts 't' years and the individual expects to work subsequently until year 'T', then the individual will invest in human capital up to the point at which C_i equals R_i, after adjusting for the effect of time.

This basic model has a number of implications –

1. Investment in education will occur as long as the marginal (discounted) benefits (R_i) exceed or equal the marginal (discounted) costs (C_i). The net present value of the total benefits must therefore exceed the total costs.
2. The greater the time gap between T and t, the greater the returns. The time horizon T is fixed by the retirement age or death, but t is a choice variable, that is, the individual decides how many years he invests in education. The returns are greatest when the educational investment is made early in life. Since the earnings of individuals depend on the amount of human capital possessed by them, individuals invest early in their lives on education to increase their lifetime earnings.
3. The lower the C, the greater will be the investment. Foregone earnings are a major component of the costs of education. This is the reason why older people (with higher remuneration) invest less in education. Since older people are likely to have higher earnings, their costs of going to college (and stop earning) are much higher relative to younger individuals.
4. The greater the returns to education, the more the investment. Since a college education significantly increases earnings, individuals are willing to invest in a college degree. Returns to a college education have considerably increased in the

nation. This is the reason for the dramatic increase in college enrollments over time in the nation.

5. The higher the rate of interest ‘r’, the lower will be the investment in education. This is because a higher ‘r’ will reduce more severely the net present value of future earnings, when compared to a smaller ‘r’.

The basic model thus explains why individuals invest in education early in their lives and what determines their investment decision.

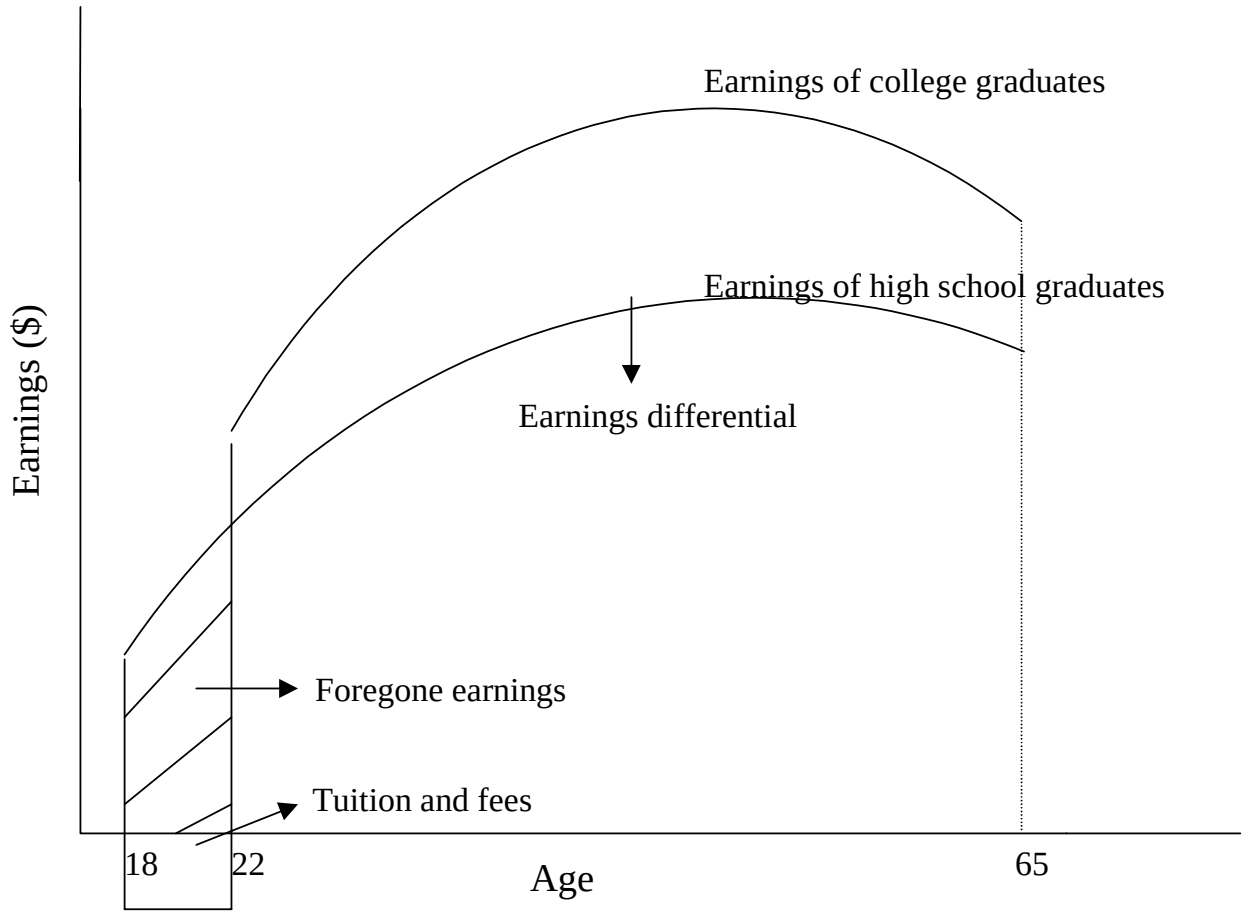
3.6 The Rationale for Public Investments in Education

The costs of education are not fully borne by the individuals being educated, in most cases. Public financing of education is prevalent all over the world. “The arguments in favor of state provision of education rely on the widespread belief that the market for educational services fails when left to its own devices” (Johnes, 1993). The reasons for market failure are due to the presence of externalities, non-rival consumption and imperfect capital markets. Externalities exist because education benefits not only the individual being educated but other individuals in society. For example, if a more-educated individual is less prone to criminal activities relative to a less-educated individual, then the benefits of a less crime-prone society are enjoyed by everyone in society, and not only by the more-educated individual. The existence of externalities imply that individuals are likely to underinvest in education. State financing of education thus assumes importance. Another important reason for state intervention is the existence of imperfect capital markets. Since the acquisition of education is not like the acquisition of a physical asset that can serve as collateral, financial institutions are less likely to finance education. The state may take an important role in subsidizing student investments in education or in guaranteeing private loans.

3.7 The Measurement of the Monetary Benefits of Education

While the theory of investments in education is straightforward, the actual measurement of benefits and costs is difficult for a number of reasons. Becker (1964) argues that earnings vary over an individual's life cycle according to a typical age-earnings profile. The earnings are low while the individual is young and inexperienced, increases up to a peak around mid-life, and thereafter falls. The economic interpretation of lifetime earnings growth is as follows – wages of individuals are proportionate to the size of human capital stock possessed by them. Wage differentials among workers are primarily due to differences in their human capital stocks. An individual's human capital stock grows by means of investment, which is initially in schooling and later in job training, and in health. " At any stage the level of earnings depends on the size and utilization of the human capital which accumulated up to this point, and its growth depends on the rate of net additions to the stock, that is, on the net investment rate. The deceleration in the rate of growth that is observed in individual earnings reflects the rate of decline of investments as the worker ages. Investments diminish over time because (1) benefits decline as the payoff period (remaining work life) shortens and (2) opportunity costs of time rise over the working life. While gross investment proceeds at a slackening rate throughout working life, net investments (gross minus depreciation) vanish or turn negative earlier. This happens when depreciation (including obsolescence) begins to outstrip maintenance, a progression which eventually brings about retirement" (Mincer, 1984). The height of the age-earnings profile depends on the educational attainment of the individual, with more-educated individuals experiencing higher age-earnings profiles relative to less-educated individuals (Fig 3.1). Since individual age-earnings profiles are hard to obtain, econometric techniques are used to create the earnings profiles. The 'earnings function method' developed by Mincer (1974) has been extensively used to create the age-earnings profiles. This method involves fitting a function (called the earnings function) with the natural logarithm of wages as the dependent variable, and age, experience, years of schooling, "ability" and demographic variables (like gender, race) as the explanatory variables.

Fig 3.1: The framework for measuring returns to education



A number of issues have been raised in the literature regarding the application of this method. The important issues relate to the kind of data available for analysis, measurement and omitted variables in the estimation of the earnings function, and sample selection problems. A brief discussion of these issues is presented below.

The estimation of the earnings function relies on cross-sectional data, as longitudinal data are difficult to obtain. The problem with cross-sectional data is that different age cohorts are mixed in the data. The labor market outcomes and earnings of different age cohorts could be vastly different. For example, the cohort size could influence earnings. Evidence suggests that the baby boom cohorts will receive reduced wages throughout their careers, with most of the loss occurring early in their careers. Apart from the different labor market outcomes of different cohorts, 'vintage effects' are also important. The 'vintage effects' are the differences in schooling that are experienced by different cohorts. The skills taught to one cohort could be vastly different from the skills that are taught to another cohort. To the extent that such vintage effects exist, the human capital content of education is systematically mismeasured by cohort (Lamoreaux, 1984). Another problem with cross-sectional data is that a constant age-earnings relationship is assumed over time. However, the real earnings of individuals could change over time leading to changes in the rates of return to education. For example, Mishel and Bernstein (1993) calculated the total percentage change in real average hourly wages (Table 3.3) by the level of educational attainment for the period 1979 through 1989. During this period real average hourly wages for all US workers declined by 2.7 percent. However, disaggregating by gender and educational attainment revealed dramatic variations in wage growth. For male high school graduates, the real average hourly wage rates declined by 12.7 percent over this period, while for female college graduates, they increased by 12.7 percent.

Measurement error and omitted variables are other important issues related to the estimation of the earnings function.

Table 3.3: Annual percentage change in real average hourly wage rates by education (1979-1989)

	Men	Women
High school	-1.349	-0.294
1-3 years of college	-0.863	0.422
College graduate	0.030	1.203
Graduate/Professional	0.939	1.185

Source: Mishel and Bernstein (1993)

The number of years of schooling may be an inappropriate proxy for the educational attainment of individuals because school quality or choice of major are not considered in the estimation of the earnings function. The bias associated with the measurement error in the schooling variable results in a downward estimate of the return to education. Ashenfelter and Krueger (1994) place the measurement error generated by the schooling variable at between 8 percent and 12 percent. Proxies for ability (like the Armed Forces Qualifying Test, SAT scores) that have been used in the literature are also subject to measurement error (Cardell and Hopkins, 1977). The omission of ability variables from the earnings function altogether are likely to generate biased estimates. Suppose that $Y = \alpha_0 + \alpha_1 S + \alpha_2 A + \mu$, where Y is earnings, S is schooling, A is ability and μ is the error term, which is assumed to be random and uncorrelated with S and A. "If schooling and ability are positively associated, then a measure of the contribution of education to income that ignores the ability variable will be biased upward by the amount $\alpha_2\beta_{SA}$, where β_{SA} is the regression coefficient of ability on education in the particular sample" (Griliches and Mason, 1972). There is considerable variation in the estimates of this omission bias in the literature. Griliches and Mason (1972) reported that the introduction of an ability measure reduces the estimated return to schooling while in the military by 7 to 10 percent, and reduces the return to schooling prior to military service by 22 to 35 percent. However, Ashenfelter and Krueger (1992) find no ability bias in their study of twins. Griliches (1977) concludes that attempts to control for ability and measurement error may contribute very little to estimates of rates of return to schooling. The debate on

the proportion of income that could be strictly attributed to education still continues in the literature.

Another important issue related to the estimation of the earnings function is sample selection. The problem lies in the fact that in the estimation of the earnings function schooling is considered an exogenous variable. However, the decision to go to school depends on several factors (such as tuition, expected lifetime benefits), which implies that schooling is an endogenous variable. Thus, the expected future earnings of individuals are likely to be determined with the amount of schooling obtained. Estimates of rates of return that do not account for the endogeneity of the schooling variable are likely to be biased. According to Kane and Rouse (1994), the failure to account for this problem results in an upward bias (approximately 25 percent) in the estimate of the wage differential between college and high school education. Ability is usually the variable that determines the amount of schooling an individual obtains. A second, and often overlooked source of sample selection bias arises from different propensities of individuals to remain in the workforce. Individuals with higher propensities to remain in the workforce are likely to enjoy higher returns to education relative to individuals with lower propensities to remain in the workforce. Using a sample of individuals that are working may, therefore, overestimate returns to education. The NPV of a college education may also be overestimated or underestimated assuming all individuals work continuously until retirement. The second source of sample selection bias is addressed in this study – workforce participation is considered as an endogenous decision.

Heckman (1976a, 1979) developed models to deal with such selectivity issues. The model that is used in this study is developed below.

3.8 Empirical Background

The NPVs of VT undergraduate degrees are estimated using the earnings function approach discussed earlier. In the first part of the study the earnings function (Equation 3.2) is estimated without the endogeneity correction. The natural logarithm of yearly

wages (W) is modeled as a function of variables that are likely to determine earnings of individuals (variables in the X vector).

$$LnW = X\beta + e \qquad (3.2)$$

In the second part of the study the decision to participate in the laborforce is considered endogenous in the estimation of the earnings function. The Heckman two-step procedure is used to estimate the earnings function. A brief discussion of the Heckman model follows.

The motivation for the Heckman model comes from the fact that earnings are observed for individuals who are working and not observed for those who are not working. However, the decision to participate in the laborforce can depend on several factors.

Consider the earnings function equation,

$$W_0 = X_1\beta + u_1 \qquad (3.3)$$

where W_0 is the natural log of wages, X_1 is the vector of variables that determines wages and u_1 is the error term. If we estimate equation (3.2) by OLS, based on the observations for which we have wages, we get inconsistent estimates of the parameters for the entire population of workers and non-workers. This is called as the selectivity bias (Maddala, 1983). We observe $W=W_0$ if and only if W_0 is greater than or equal to W_r (reservation wage), where W_r is given by,

$$W_r = X_2\gamma + u_2 \qquad (3.4)$$

The reservation wage is determined by the variables in the X_2 vector. The variables (in X_2) affect the workforce participation decision but not the wage (W_0).

In other words, the individual works if,

$$X_1\beta + u_1 \geq X_2\gamma + u_2 \qquad (3.5)$$

$$X_1\beta - X_2\gamma + (u_1 - u_2) > 0 \qquad (3.6)$$

$$X_1\beta - X_2\gamma + v > 0 \qquad (3.7)$$

where, $v = u_1 - u_2$. The Cov (v, u_1) is not equal to zero and the estimation of $X_1\beta$ with the sample of individuals that are working may lead to biased estimates of β for the whole population.

The earnings equation is adjusted for laborforce participation by jointly estimating an equation for workforce participation along with the earnings equation. This approach yields consistent earnings equation parameter estimates. These estimates are then used to predict earnings for individuals who are working and who are not working. Finally, the predicted earnings are multiplied by the estimated probabilities from equation (3.4) to get the probability-adjusted earnings. The next chapter specifies the empirical model used in the study.