1 Introduction to Human Capital and Economic Growth

During the last decade of the twentieth century, economics witnessed a revival of interest in the determinants of the rate of long-run growth, a revival that seemed to many economists long overdue after the emphasis on short-term aggregate fluctuations during the previous two decades. Both theoretical and empirical researchers embraced the subject with renewed fervor generating a vast literature that, itself, has been the subject matter of a number of surveys and books.[1] This ought not be a surprise given that the question at hand is one of the most fundamental questions that the discipline addresses. At the same time, it is one of the most complex issues tackled by economics, embracing not only various subdisciplines within economics, but also across other social sciences.

The subject matter of this book is the link between human capital accumulation and long-run growth. While both the theoretical literature and empirical studies have highlighted a number of economic, political, and social determinants of the rate of long-run growth, we have chosen to focus on a single determinant, human capital, for a variety of reasons. First, there is a long history of interest in human capital and growth by social scientists. In this book, we shall review briefly the historical development of the concept. During the post-World War II period, interest on this issue has concerned predominantly the contribution of human capital to the growth of per capita income. Second, human capital is a complex term that eschews a simple definition and measurement and

is a concept that has been investigated from a variety of perspectives by social scientists. Our intention is not to review the diversity of approaches but to concentrate exclusively on the nexus between human capital and economic growth. In this respect the most frequent measure of human capital in cross-country comparisons of growth is the quantity of formal education each adult member of society possesses. The concept of human capital, however, is much broader, encompassing the quality of education, the general state of health of the working population, and various forms of training such as on-the-job training or other types of informal education. Including the various aspects of human capital in a comprehensive measure has, so far, proved to be intractable for a large cross section of economies.[2] We will offer a brief discussion of attempts to broaden the concept of human capital, insofar as they relate to the human capital-growth literature. Finally, there is intuitive appeal to the proposition that human capital accumulation (frequently associated with increasing levels of education in public policy discussions) ought to make a country richer in the long run. Despite the elegant appeal of this proposition, theoretical and empirical verification has been difficult to establish.

In this book we review the main theories linking human capital accumulation and economic growth. Its main thrust, however, is the empirical evidence on the issue, as has been developed during the last two decades. While theoretical developments in this area have provided very useful insights, it is our belief that empirical work provides valuable lessons for our understanding of the contribution of human capital to the process of economic growth. We analyze and evaluate the extant evidence and also contribute to the debate by providing a thorough investigation of the empirical link between human capital and economic growth using a consistent data set and recently developed nonlinear estimation methods.

1.1 An Overview of Human Capital and Economic Growth

The importance of human capital to economic well-being has historically ebbed and flowed. During the first half of the twentieth century, human capital was de-emphasized at the expense of physical capital accumulation. Theories of the time placed inordinate emphasis on the accumulation of physical capital as the key engine of economic growth. Investment in physical capital, or capital fundamentalism, came to be widely accepted as

the predominant theory of economic growth.[3] During the 1960s interest in the contribution of human capital began to surface. In early contributions, the emphasis was on the contribution of human capital to a person's standard of living (income per person) and its contribution to aggregate wealth; later, emphasis shifted to its role as a contributor to aggregate economic growth. The pioneering work of Schultz (1960) and Becker (1962, 1964) contributed greatly to the swing in emphasis away from physical capital accumulation and pointed the way to a systematic study of the role of human capital. Schultz (1960) identified human capital narrowly with investment in education and put forward the proposition that "important increases in national income are a consequence of additions to the stock of this form of [human] capital" (p. 571). He went on to argue that investment in education could account in large part for the increase in per capita income in the United States.

Becker (1964) broadened the concept of human capital from that of formal schooling to include additional sources of human capital accumulation such as on-the-job training (both general and specific on-the-job training), informal gathering of information that enhances a worker's productivity, and other investments to improve "emotional and physical health." He went on to analyze the amount of investment individuals would undertake in training and the rate of return to that investment. Factors that influence the return include uncertainty and the nonliquid nature of the investment, as well as capital market imperfections and differences in abilities and opportunities. Becker and Chiswick (1966) argued that different investments in human capital and the corresponding rates of return (a result of individual maximizing behavior) determine in large part the distribution of earnings. "Institutional factors" (inheritance of property income, differences in abilities and opportunities, subsidies to education) in turn determine investments in human capital. Their empirical analysis showed that investment in formal education (the sole form of human capital for which adequate data were available) successfully explained differences in average (white male) wages across both the U.S. South and non-South and that the return to education for each schooling level (low, medium, and high number of years of schooling) was higher in the South. The variance of (the log of) earnings and years of schooling was also larger for the South. Becker and Chiswick interpreted the larger variance in schooling years in the South as an indication of less equal

opportunity while the higher returns to education (at all levels) as the result of lower education levels in the South, itself the result of fewer educational opportunities.

Subsequently, interest on the economic importance of human capital lay dormant for two decades. The current resurrection in interest began with the seminal paper by Barro (1991) and its emphasis on the empirical determinants of long-run economic growth. While Barro's paper did not pertain specifically to the role of human capital, it did propel human capital (identified with formal education and measured by enrollment rates) to center stage in the economic growth process.

Shortly after the appearance of Barro's empirical investigation of economic growth, the paper by Mankiw, Romer, and Weil (1992) provided theoretical justification for the central role of human capital in the growth process. The model demonstrated that inclusion of human capital in the aggregate production function yielded income shares for the factors of production that are consistent with empirical evidence. Their augmented Solow model places emphasis on human as well as physical capital accumulation and predicts that differences in cross-country income per capita can be explained by differences in saving, education, and population growth, an assertion they verified empirically. Moreover, they derived the transition to the steady state and obtained estimates of the speed of convergence to the steady state.

The Mankiw–Romer–Weil model treats human capital as an input into an aggregate production function that assumes decreasing returns to the reproducible factors of production (physical and human capital). In another widely cited paper, Lucas (1988) focuses on the reproducible nature of human capital and the possibility of externalities generated by human capital. It is natural to speculate that knowledge accumulated by human beings (whether as a result of formal education or otherwise) would have an impact on the productivity, not only of individuals accumulating knowledge, but also their co-workers, colleagues, and others. Thus, investigators began the search for human capital externalities, a research topic which, to date, has yielded mixed evidence.[4]

Another approach to evaluating the contribution of human capital to aggregate growth is Benhabib and Spiegel (1994). Their approach follows on the traditional growth accounting methodology according to which the

growth of output is determined by the accumulation of inputs and total factor productivity (TFP) growth. The point of departure and novelty of their approach is to include only physical capital and labor as (traditional) inputs and to model human capital as contributing to the growth of TFP rather than as an input to aggregate production. The contribution of human capital to TFP growth is twofold: (1) it determines the speed by which a country is able to close the gap between its level of TFP and that of the technological leader or the catch-up effect; and (2) human capital determines the pace by which a country can adapt and implement foreign technologies domestically, the imitation or endogenous-growth effect.

All the above approaches (at least in their empirical implementation by various researchers) emphasize a relationship between human capital and growth that takes various forms but is, nonetheless, linear. Motivated by theories of threshold externalities (e.g., Azariadis and Drazen 1990), several researchers have postulated that the impact of human capital on growth is nonlinear. Durlauf and Johnson (1995) divide countries into several groups based on the regression-tree methodology and show that the growth experience of the groups differs markedly. Importantly, for our purposes, the impact of education on growth depends on which group a country is a member. While the Durlauf and Johnson methodology divides countries into a small number of distinct groups, Kalaitzidakis et al. (2001) make use of recent nonparametric econometric techniques to model the human capital-growth relationship. The advantage of their methodology is that it allows the impact of human capital on growth to differ, not only by country, but also according to the time period. They find evidence to substantiate the nonlinear nature of the human capital-growth relationship.

At the empirical level, all the above studies identify a nation's level of human capital with the quantity of education possessed (on average) by each adult member of the nation's population. This is because, until recently, comparable data across countries were only available on rates of school enrollment and mean years of schooling. As data on qualitative measures of education have recently become available, several studies have considered, not only the quantity, but also the quality of education. Hanushek and Kimko (2000) use data from six international tests of student achievement in mathematics and science to derive a measure of labor quality for 31 countries. They find that the quality of education has a very

large and significant effect on the growth of per capita gross domestic product (GDP) across these countries. There is no doubt that the quality of education is an important facet of economic growth and an aspect that has been relatively neglected in the literature due to the lack of data on a wide cross section of countries and time periods. This is one of the areas where, in the future, the development of statistical data will allow examination of a number of interesting hypotheses.

1.2 Objectives

This book aims to achieve several objectives. First, we review briefly the historical development of the concept of human capital. Second, we outline the various theoretical approaches to the treatment of human capital in the growth process. Where possible, we emphasize the empirical implications of the theoretical models. Third, we review the empirical treatment of human capital and economic growth. We summarize the results of the empirical literature on the link between the quantity of education and growth and discuss various other aspects including differences by gender or level of education and the quality of human capital. Where the literature allows, we draw some general conclusions and also outline controversies.

The main thrust of this book is the use of a data set to analyze consistently the various empirical approaches on the role of human capital. Through the use of consistent data we aim to evaluate the merits of various hypotheses. While the application of linear estimation techniques needs no explanation, nonlinear estimation techniques are not as widely known. Another objective is to introduce these econometric techniques. Our emphasis is clearly on the applicability of these methods to empirical research on the human capital-growth link. In a subsequent chapter, we demonstrate how these techniques can be used with the same data and nonlinear estimation methods and compare the results of linear to nonlinear estimation methods. Both approaches have their relative merits and drawbacks and we conclude by summarizing and evaluating our results.

Notes

1. Several excellent books on economic growth exist at various levels of difficulty. At the introductory/undergraduate level, the books by Gylfason (1999),

Jones (2002), and Weil (2005) deserve separate mention. At the advanced/graduate level, Aghion and Howitt (1998) and Barro and Sala-i-Martin (2004) are thorough theoretical treatments while Barro (1997) concentrates on the empirical treatment of the subject. What all these books share, however, is an all-encompassing approach to economic growth: they examine the various facets of the growth process and, by consequence, are unable to provide a thorough treatment of each aspect of growth.

2. Throughout this book our concern is with cross-country comparisons of economic growth, not the experience of one or a small number of economies. Therefore, we shall limit our discussion to studies or measures of human capital that have wide applicability across countries at various stages of development.

3. The concept of capital fundamentalism and its contribution to economic growth is analyzed by King and Levine (1994). They argue that reliance on physical capital accumulation as the source of economic growth has been misguided.

4. The papers by Barro, Lucas, and Mankiw, Romer, and Weil are indeed three of the most widely cited papers to appear in the economics literature during recent years. The Social Sciences Citation Index reveals that (as of October 2007) the Barro paper had been cited 1,075 times, Lucas 1,586 times, and Mankiw, Romer, and Weil 832 times.