HUMAN CAPITAL, SCHOOLING AND HEALTH
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ABSTRACT

A consensus has been forged in the last decade that recent periods of sustained growth in total factor productivity and reduced poverty are closely associated with improvements in a population's child nutrition, adult health, and schooling, particularly in low-income countries. Estimates of the productive returns from these three forms of human capital investment are nonetheless qualified by a number of limitations in our data and analytical methods. This paper reviews the problems that occupy researchers in this field and summarizes accumulating evidence of empirical regularities.

Social experiments must be designed to assess how randomized policy interventions motivate families and individuals to invest in human capital, and then measure the changed wage opportunities of those who have been induced to make these investments. Statistical estimation of wage functions that seek to represent the relationship between wage rates and a variety of human capital stocks may yield biased estimates of private rates of return from these investments for a variety of reasons. The paper summarizes several of these problems and illustrates how data and statistical methods can be used to deal with some of them. The measures of labor productivity and the proxies specified for schooling and adult health are first discussed, and then the functional relationships between human capital and wages are described. Three types of estimation problem are described: (1) bias due to omitted variables, such as ability or frailty, (2) bias due to the measurement of an aggregation of dissimilar sources of human capital, e.g., genetic and socially reproducible variation, and (3) errors-in-measurement of the human capital stocks. Empirical examples and illustrative estimates are surveyed.
1. INTRODUCTION

Child and adult survival and schooling have increased rapidly in the second half of this century. According to some measures, health and education in the low-income countries are catching up to the levels in the high-income countries (Schultz, 1993). Does convergence in these forms of human capital between the world's poorer and richer populations promise to narrow international differences in productivity and by how much? To answer such questions, the relationship between survival and schooling, on the one hand, and personal productivity, on the other hand, must be quantified in a variety of countries. Even then, difficulties remain in comparing the productive quality of schooling within and across countries, and in measuring health status as a human resource. The social return to human capital incorporate social subsidies in the production of the capital and benefits from the capital enjoyed by individuals other than the responsible family unit. Public investments in schooling and health should be guided by the distinct priorities implied by these social rates of return. An example where private and social returns might diverge would be the control of infectious diseases where external social benefits arise from reduced contagion.

At the level of the nation, recent periods of sustained growth in total factor productivity (i.e., growth in economic output that is not explained by increases in inputs of
physical capital, land, or labour hours) are closely associated with improvements in a population's schooling, nutrition, and health (e.g., T.W. Schultz, 1961; Kuznets, 1966; Denison, 1967; Barro and Sala-i-Martin, 1995). At the level of the individual, statistical studies of random sample surveys and censuses reveal significant positive partial correlations between wages, earnings or income and a worker's schooling, nutrition, and health, stratified by sex and controlling for age or postschooling experience (Strauss and Thomas, 1995). Macro and micro data organized according to these parallel conceptual frameworks strongly suggest that these relationships have a causal basis. Nonetheless, estimates of the magnitude of productive returns to investments in education and health are subject to considerable uncertainty and are qualified by limitations in data and analytical methods. This paper reviews the problems that occupy researchers in this field and draws attention to the accumulating evidence of empirical regularities. Establishing the magnitude of these returns to schooling and health is a first step to concluding how much the convergence in these forms of human capital across and within countries can contribute to narrowing inter- and intra-country inequalities.

Investment of time and resources in the formation of human capital increases the productive potential of workers (and perhaps increases as well consumer benefits and leisure) that are realized over a lifetime. Measuring the internal rate of returns to human capital calls for an intertemporal analysis of costs and benefits of birth cohorts over their lifetimes. Most data pertain to cross sections, however, that describe inputs and outcomes in one period of time across different individuals grouped by age. Demographers are familiar with the limitations of such synthetic constructs built from cross-sectional data to represent cohort
experiences over time. Assumptions are made to translate cross-sectional evidence into human capital lifetime investment returns (Mincer, 1974). It is unclear whether these working assumptions are an innocuous simplification or a serious limitation on our knowledge. Growing examination of repeated cross sections from which "statistical" cohorts can be inferred and long prospective panels promise to reduce our reliance on cross-sectional data to infer cohort human capital regularities. Sample surveys that collect information on the life histories of respondents also alleviate the problem by retrospectively asking about the lifetime of a cohort, but errors in recall may thereby be introduced, and time-varying conditions exogenous to the individual, that are most useful for identifying dynamic models of behaviour, may still be lacking.

In addition, without true "social experiments" designed to assess how randomized policy interventions change the motivations for families and individuals to invest in different amounts of human capital, and consequently to affect their potential earnings, statistical estimation of the direct relationship between wages and human capital investments may not approximate the true effects that would be obtained from a properly designed randomized experiment. This paper considers several of these problems and illustrates how data and statistical methods are being used to deal with some of them.

2. THE DEMAND FOR HUMAN CAPITAL AND THE WAGE FUNCTION

Household demand for human capital is represented as a derived demand for the services of n types of capital (H). The economic determinants of these demands would include the private prices of inputs to produce these stocks, the discounted value of the increased after tax earnings they might yield, local public services and relevant conditions that
facilitate or restrict demand, and if credit markets are less than perfect, parent endowments that might also influence demands, e.g., their physical capital, human capital, and other sources of nonearned income. A linear approximation for this household demand function is as follows:

\[ H_{ij} = a_i Y_i + b_j X_j + e_{ij}, \quad j = 1, 2, \ldots, n \]
\[ \quad i = 1, 2, \ldots, m \]  

(1)

where \( i \) refers to the individual, \( j \) the form of human capital, and \( e \) the error that is assumed uncorrelated with the demand determinants, \( Y \) and \( X \). The critical distinction is between \( Y \) that affects the demand for human capital partly through its impact on wages that motivate investment in these forms of human capital, as well as through other possible channels, and \( X \) that affects the demand for human capital without modifying the wage opportunities, such as the local quality of schools or health care or parent physical capital endowments. Estimates of the reduced-form parameters \( a \) and \( b \) in the demand equations (1) embody the parameters in the underlying utility function, which is responsible for behavioural demands, and the human capital production technology parameters. The utility and production technology parameters are not separately identified in most empirical work.

A standard semi-logarithmic linear approximation of the wage function is expanded to include the \( n \) forms of human capital as inputs and the exogenous \( Y \) variables that affect wages including an intercept:

\[ w_i = \sum_{j=1}^{n} r_j H_{ij} + d Y_i + u_i, \quad i = 1, 2 \ldots, m. \]  

(2)

The parameter \( r \) measures the proportional increases in wages associated with a unit increase in human capital. In the case of schooling, where a unit of capital is years completed which also approximates the private opportunity cost of the capital in terms of years of earnings
foregone by the student, simplifying assumptions would lead to \( r \) being an approximation for the private internal rate of return on the students' time investments in schooling (Mincer, 1974).

The human capital stocks are commonly assumed to be exogenous in the wage function, or more formally the error in the wage function is uncorrelated with the errors in the human capital demand functions (i.e., the covariance \( (u_i, e_j) = 0 \) for all \( j \)). If a Hausman (1978) specification test rejects this simplifying assumption that certain types of human capital \( (H) \) are exogenous in the wage equation (2), then the standard single-equation ordinary least squares (OLS) estimates of the wage function will be biased and inconsistent.

The wage equation might then be estimated using instrumental variable (IV) methods to deal with the apparent endogeneity of the human capital stocks, using as the exclusion restriction the assumption that the vector of \( X \) variables do not enter the wage equation. For \( X \) to be suitable instruments, they must be correlated with \( H \) in (1) but be uncorrelated with \( u \) in (2).

Instrumental variable estimation of the wage function also eliminates bias due to random errors in the measurement of the human capital stocks, which may be a serious limitation with regard to measures of health human capital.

3. ARE HUMAN CAPITAL STOCKS EXOGENOUS OR ENDOGENOUS?

A number of problems in specifying the wage function can explain the correlation between the measured human capital stock and the error. There may be a determinant of the wage that is omitted from the estimated wage equation, and if this omitted variable is itself correlated with the included human capital variable, the estimated parameter on the human capital variable will be biased in proportion to the product of the partial regression coefficient
on the omitted variable in the complete (true) wage equation and the partial regression coefficient on the human capital variable in a regression predicting the omitted variable (Griliches, 1977; Lam and Schoeni, 1993). Thus, if ability increases a worker's wage, and schooling is positively correlated with ability, then the estimated coefficient on schooling in a wage function (2) when ability is omitted will be an overestimate of education's true effect on wages because it has captured some of the effect of ability.

Differences in the initial endowments of the individual can also induce unobserved compensatory behaviour on the part of parent and child, which would impart a more complex bias to our interpretation of $r$ as a return to only the observed human capital investment in an average individual. For example, consider the endowment of health, i.e., frailty, with which a child is born regardless of the behaviour of the parents (Rosenzweig and Schultz, 1993). This child endowment may lead the parents and the child to make complementary (positively correlated) or more likely compensatory (negatively correlated) health care investments. As a consequence, their behaviour would induce a spurious correlation between the omitted child endowment variable and the measured health input variables, $X$. This should bias the partial correlation between the health inputs and the observed human capital stock in eq (1), and potentially bias the wage function as well.

There are two approaches to such problems. Either measure the omitted variable, e.g., genetic ability in the case of schooling or initial health in the case of health care, and include it in the input demand equation (1) or the wage equation (2), or specify a suitably exogenous instrument for the human capital stock. The "market" price of inputs to produce the human capital (e.g., school fees) or random variation in the local health infrastructure might be
candidates for such an instrumental variable, which should impact human capital demands but
not otherwise affect subsequent wage opportunities of the individual.

Unobserved variables can more generally influence outcomes such as wages, and also
affect the accumulation of human capital, such as credit imperfections by economic class. One
approach to study investment behaviour is to estimate Euler equations from the changes over
time in investment and consumption as a function of relative prices and interest rates. For
example, human capital investments in child health may vary (decrease) in a period of
(adverse) production shocks, such as during a flood or drought. Landowners who can more
readily borrow to support their long-term optimal human capital investment (and
consumption) programme are less affected by the weather shocks than the landless families
(Foster, 1995). Similarly, the schooling of children is more likely to be interrupted by the
illness of a parent or a negative weather shock, if the family has less land or physical wealth
for collateral (Jacoby and Skoufias, 1992).

Another type of misspecification arises when two components of human capital are
measured in the form of a readily quantified aggregate, but each component has a different
effect on wages. If there are instrumental variables to account for the variation in at least one
of the two components, it may be possible to estimate the wage-effect of this component of
human capital and draw some inferences about the wage effect of the other residual form of
human capital. For example, assume that height is primarily determined by genetic capacities
or "genotype" of the individual that is determined at conception. But individual nutritional
intakes, exposure to disease, treatment of these diseases, and variation in other environmental
burdens on nutritional status may facilitate or stunt the expression of this genetic potential for
height across individuals. Height is recognized to be an objective measure encompassing a wide range of health characteristics that are otherwise difficult to quantify (Faulkner and Tanner, 1986). Changes in average height over time in a population that is closed to compositional change may be attributed to reproducible human capital investments, to exogenous changes in disease environments, or advancement in production technologies (Fogel, 1994; Steckle, 1995). But in the cross section, the component of height that can be explained by socioeconomic investments in health may have a larger (or smaller) effect on productivity than the residual of height that includes the genotypic component. The Hausman (1978) specification test of height in a wage function may then reject exogeneity because the socioeconomic instrumented height's effect on wages differs significantly from the effect of observed (aggregated) height. Height in the wage function may then be justifiably treated as endogenous (Schultz, 1996).

Another standard problem in estimating the effect of human capital on wages is that the human capital stock may be measured with error. In the simplest model of measurement error in which wages are determined by only one human capital variables that is measured with random error, the estimate of the wage effect of the human capital is biased down in proportion to the noise-to-signal ratio, or the ratio of the variance of the measurement error to the variance of the measured human capital variable (Griliches, 1977). Efforts to include more wage determinants that might reduce omitted variable bias also have the consequence of increasing the measurement error bias, because the added wage determinants tend to be correlated with the true human capital variables, increasing the remaining noise-to-signal ratio. It is unclear, therefore, whether estimates of the human capital returns from a wage function
are improved by the inclusion of more controls, even if the controls are exogenous and correlated with wages.

One common approach to dealing with genetic endowments and other heterogeneity across individuals and families is to estimate models holding constant for the community, family, or individual. Such fixed-effect estimation strategies preclude estimating the consequences of community, family, or individual factors, respectively, that do not change over time. These estimates may thus deflect analysis away from a large number of issues that originally motivated research in the field. But the fixed-effect method holds the promise of estimating the effect on wages of time-varying human capital stocks that can be explained by time-varying instrumental variables that are outside the family's control. Panel data offer the researcher a tradeoff, between using fixed-effects specifications and thus rely only on changes in variables, which introduces a bias because the method is likely to magnify measurement error, or rely also on the cross-sectional variation in the panel, which may spuriously attribute the effect of unobservables to the observed human capital variables (Griliches and Hausman, 1986).

There are then at least three hypothesized reasons for why the exogeneity of the human capital inputs in the wage equation might be rejected by the Hausman specification test: (1) bias due to omitted variables, (2) bias due to the measurement of an aggregation of dissimilar sources of human capital variation, i.e., genetic and socially reproducible, and (3) errors-in-measurement of the human capital. Because these sources of bias could be offsetting, e.g., omitted variables could increase the estimated wage effect and errors in measurement might decrease it, certain combinations of specification errors might undermine the power of
the specification test to reject the null or exogeneity.

4. THE FUNCTIONAL FORM OF THE WAGE EQUATION

Many empirical studies and economic and biological intuition suggest nonlinearities are likely to be important in the relationship between stocks of human capital and the wage. Interactions between different forms of human capital, such as positive complements or negative substitutes, have also been hypothesized and confirmed in empirical studies (Schultz, 1995; Strauss and Thomas, 1995). Capturing these features of the wage equation may be crucial for accurately understanding how policy interventions will affect the productivity of specific groups and hence how interventions will affect the personal distribution of wages.

In the analysis of earnings functions, it was first noted by Mincer (1974) that years of education and postschooling experience for U.S. males fit log earnings better than they did earnings. Statistical searches using the Box-Cox transformation by Heckman and Polachek (1974) suggested that Mincer's semi-log-linear specification was at least as good as the linear approximation, but that some intermediate position would further improve the fit.

The dependent variable in equation (2) should be the (log) hourly wage rate, and not earnings. The potential productivity effect of human capital may cause workers to demand more leisure and work less. Analyses of earnings will combine the primary productivity effect of human capital with the secondary labor supply decision. Labor supply choices are expected to depend not only on their wage opportunities but also on their nonearned income or educational debts and family support, for example. In the OECD countries, the average working year fell from 1913 to 1984 from about 2600 to 1700 hours (Maddison, 1989). If in a cross section, hours worked is lower for higher wage workers, private returns to human
capital would be underestimated if based on an analysis of earnings rather than wages.

The proportional effect of schooling on wages, call it $r$, in equation (2), may also not be constant across different levels of schooling. Becker (1964) thought returns to schooling would decline for the individual with more advanced schooling, until the marginal return would fall below the opportunity cost of borrowing, at which point the individual would stop investing in (attending) school. But in reality, some empirical studies find the reverse, in which private returns to schooling increase at secondary or higher education compared to the primary level. This is most common when virtually all members of a cohort complete the primary level and a bottleneck develops in the public educational system at a higher level (e.g., Côte d'Ivoire, Ghana and Thailand, see Schultz, 1993). The labour market may attach more importance to graduation from a certain school level than to preceding years, or to different types of schooling such as academic versus vocational high schools. Adjustment of years of education completed to include those years repeated by a student may also improve measurement of the time-costs of schooling and hence the real returns, but retrospective data on time spent in school is rarely available in surveys.

5. EFFECTS OF HEALTH ON PRODUCTIVITY

Health, nutrition, and productivity are closely interrelated, but less empirical study has documented the form of the relationships between household and individual characteristics, nutritional status, and adult productivity than is the case for schooling and wages. The availability of calories, proteins and certain micronutrients allow a child to grow and fight off infections and perform various energy-demanding tasks. Birthweight and gestational age at birth, height for age, weight for age, and weight for height (BMI), are all anthropometric
indicators of net nutritional status that proxy health, because they predict survival, reduced chronic illnesses, and seem to be correlated with later school and labour market performance. Child height by age four is a particularly good predictor of adult height (Martorell and Habicht, 1986), which has led to the assumption that adult height may be treated as predetermined from early childhood and enhances subsequent adult labour productivity in much the same way as does schooling. Consequently, it has been assumed that height is an exogenous argument in a wage function. If long-run net nutritional status is measured by height, then weight-relative to height is a shorter-run measure of current health and nutritional status and physical work-capacity (Steckle, 1995).

Waaler (1984) has shown in a large sample from Norway that when the body mass index (BMI=height in meters/weight in kilograms squared) is less than 21 or more than 29, age-specific mortality from a variety of causes increases for both men and women. Fogel (1994) has documented in a sample of U.S. Civil War veterans that height is inversely related to chronic health problems in middle age. Costa (1996) accounts for nonparticipation in the labor force (i.e., disability) by BMI in the Civil War Veteran's sample aged 50 to 64 and again among males in the same ages in the US NHIS in 1958-1991. The nonlinear relationships she estimates are remarkably similar to those reported by Waaler in his analysis of mortality in these age groups. Assessments of the effect of height and BMI on economic functioning, productivity, and time allocation are only beginning to occur. Until recently there was no consensus on how to measure adult health and the problems of endogeneity and measurement error emphasized in this paper were not extensively addressed. To estimate with much confidence mortality and clinically confirmed morbidity among the elderly requires large
samples and costly data collection programs that only a few high-income countries can currently afford. Among working-aged adults, health status cannot be reliably appraised by mortality, because it is rare and it is often swamped by mortality linked to special forms of consumption that may not signal low productivity or diminished welfare while alive, e.g., automobile accidents, alcohol abuse, other drugs, AIDS. Structural models need to distinguish between the demand for health human capital in eq (1) in the form of height and BMI and their consequences on productivity in eq (2). These new measures of adult health and econometric methods for evaluating human capital promise to improve our ability to assess the internal rate of return on household and government health investments.

One problem in measuring the effect of health on productivity is that productivity contributes to income, which allows expenditures to increase on food and other health-related inputs that may themselves boost health. In other words, nutrition may increase productivity, but productivity also leads to an increased consumption of nutritional-health inputs. To estimate without simultaneous equation (upward) bias the one-way effect of nutrition and health on labour productivity, some exclusion restriction must be identified, namely, a variable that is known to affect nutrition or the use of beneficial health inputs but which does not otherwise affect individual productivity. Errors in measurement of nutrition and health status may also bias (downward) direct estimates of health effects on labour productivity, as it does with schooling. Indeed, height and BMI were found to be subject to relatively larger measurement errors in a Côte d'Ivoire panel survey than schooling, and self-reported measures of health might be subject to an even greater measurement noise to signal ratio. Fortunately, instrumental variable estimation methods also correct for measurement error bias (Schultz,
John Strauss (1986) first described this problem, and proposed that variation in the community level price of food is suitably correlated (inversely) with food consumption and can serve as the instrument for nutrition in the family farm labour productivity function. He showed that in Sierra Leone in very low-income farm households the predicted availability of nutrition is related to increased output per family farm worker and the effect was substantially larger at the lowest levels of calories. Similar estimates for wage earners in India (Deolalikar, 1988) and Sri Lanka (Sahn and Alderman, 1988) were subsequently obtained. In Brazil, Thomas and Strauss (1996) estimated the effect on wages of height and education, treated as exogenous, and BMI, calories, and proteins, treated as endogenous and identified by local relative food prices. A one per cent increase in height is associated with a three per cent increase in wages for males and a two per cent increase of females. Calories exert a quadratic effect on wages, being subject to the expected diminishing productivity benefit as calories approach levels of 2,000 calories per day (Thomas and Strauss, 1996).

Another approach to adult health is to measure morbidity. Measures of adult morbidity in a household survey tend to be self reported. They are unavoidably subjective and possibly culturally affected, and they are therefore regarded by some as unreliable (Johansson, 1991). One approach to diminish this potential source of subjective bias and unreliability is to ask a series of questions on limitations of activity of daily living (ADL), e.g., unable to walk up stairs without assistance or feed oneself, which have recently become an accepted tool for evaluating the health functioning status of the elderly in high-income countries (Steward et al., 1992; Strauss et al., 1995).
Another measure of adult morbidity for the non elderly is self-reported functional activity limitations (days of work missed) due to illness, during a specified recall period of say a month. Although it is admittedly subjective, it may be a more reliable indicator of productive health for wage earners than for self-employed and home-production workers who can more often modify their work routines and adapt them to their health status. In the case of wage earners, who are mostly paid according to time at work, it may be assumed that employers would not want to hire a sick worker whose productivity is impaired. This constraint should discipline workers to not work when they are ill. It has been argued by Schultz and Tansel (forthcoming) that this indicator of health status is also potentially subject to simultaneous determination with expenditures on food and health care. This health indicator of "disabled-days" should therefore be treated as endogenous and instrumented by the local availability of health care and the relative prices of nutrition. Using these local area instruments for disabled-days, Schultz and Tansel estimate for male workers in Côte d'Ivoire and Ghana that one more disabled-day per month is expected to reduce a worker's wage by at least 10 per cent, and reduce hours worked by 3 per cent (Schultz and Tansel, forthcoming).

In Côte d'Ivoire and Ghana education, height, BMI and migration have all been included as joint determinants of the wage for men and women from 1985 to 1989. Local food prices, health and schooling services, along with parent education and occupation, are specified as instruments to account for an individual's human capital stocks. The exogeneity of all four human capital stocks are then submitted to Hausman tests. The evidence suggests that education and migration can be treated as exogenous, for their OLS and instrumental variable estimates are not statistically different. But the wage effects of height and BMI are
often substantially larger when they are treated as endogenous and estimated by instrumental variables than if they are estimated by OLS methods. The returns to schooling are larger in Côte d'Ivoire (8-11 per cent) than in Ghana (3-4 per cent) due perhaps to the more rapid and sustained economic growth since independence in Côte d'Ivoire than in Ghana (i.e., demand), and the greater proportion of educated workers in Ghana than in Côte d'Ivoire (i.e., supply). Migration of the worker from their province of birth is associated in both countries with workers receiving much higher (30-90 per cent) wages. An increment of one centimeter in height is associated with a 6-8 per cent increase in wages in Ghana, but not in Côte d'Ivoire. This is consistent with other evidence that for several decades child malnutrition has been more serious in Ghana than in Côte d'Ivoire. A unit gain in BMI is associated with a 9 per cent increase in wages for men in both countries, but for women the wage gain is 15 per cent in Côte d'Ivoire and half as large, or 7 per cent, in Ghana. Holding constant for migration, height and BMI, the estimated wage return to education is diminished by one-tenth, as is expected due to the omitted variable bias and the positive intercorrelation of these human capital stocks (Schultz, 1996).

6. CONCLUSIONS

Extensive historical and contemporary studies in low- and high-income countries document that health and nutritional status, measured in terms of a long-run indicator such as height and as a shorter-run indicator such as BMI (weight for height), influence labor productivity per unit time, and labor supplied per adult year to market work, and longevity (Fogel, 1994, Strauss and Thomas, 1995). At levels of real income when nutrition is very low, these effects of health and nutrition on productivity and survival appear to be substantial, but
there is not yet agreement on the precise magnitudes of the health productivity effects or how costly they are to achieve. Consequently, internal rates of return to particular interventions or institutional investments are not yet known. There are suggestions from many studies that BMI and nutritional intake should be treated as endogenous. Even adult height that is molded during childhood is modified by household and community resource allocations, is subject to measurement error, and consequently is appropriately viewed as an endogenous human capital variable in the adult wage function. The statistical methods outlined in this paper promise in the next generation to define with increasing precision the contribution of the health transition to modern economic growth in the low-income world since the second world war.

The evidence on the wage returns to education is much more advanced, having been replicated in hundreds of labor force and integrated demographic household surveys in countries at all levels of development (Schultz, 1988). As in the case cited of Ghana and Côte d'Ivoire, both the relative supply of educated workers to the economy, and the derived demand for educated workers that stems from the aggregate composition of the economic output and its growth will determine the size of these wage returns to education. The contemporary pattern is for private returns to diminish with development, and to be lower at higher levels of schooling, at least when the public costs of education are added to the private time costs. Although most of the evidence of returns to education is potentially subject to multiple sources of statistical bias (e.g., omitted variables, errors in measurement, endogeneity) these sources of bias are not all in one direction, and do not appear to seriously distort the simple pattern that workers who receive more schooling get proportionately higher
wages. In contrast to the biological basis for diminishing returns to increased nutrition as it affects longevity and productivity, where is less reason to expect that the pattern of returns to schooling will be uniform in all or even most settings. Indeed there many reasons for different distributions of the supply of education in the population and aggregate economy-wide demands for skills to account for notably different rates of return to schooling. And even within a country the pattern of returns can change rapidly, as in the United States where returns to college education declined during the 1970s and increased sharply after 1980. Neither changes in the supply of workers by age, education or sex, nor macroeconomic imbalances, nor increasing penetration of trade, can explain these fundamental changes in wage structures in the United States that are also emerging in most other OECD countries. Thus, wage structures for education may change unexpectedly and should be monitored by surveys frequently in all countries to provide guidance in expanding educational systems.

Evidence is accumulating that health and schooling contribute to higher labor productivity in a wide range of countries. But it is not clear when education first became a critical factor enhancing labor productivity. There are few representative surveys that provide information on education and wages before the 1940 US Census. It seems unlikely that education was an important qualifying characteristic for most workers in the 19th century, when apprenticeships, on-the-job and family training transmitted most productive skills. Why in this century did the opening up of the world economy to trade, capital mobility, and the diffusion of technology create extensive opportunities for better educated workers to outperform their peers in a widening range of jobs? With a better answer to this question, it may be possible to forecast the future evolution of returns to education and health.
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