Statistics New Zealand

Review of the Statistical Measurement of Human Capital

Adolf Stroombergen*
Dennis Rose
Ganesh Nana**

November 2002

* Infometrics Consulting ** Business and Economic Research Ltd.

Preface

Statistics New Zealand is pleased to publish this review of the statistical measurement of human capital in New Zealand. The review was commissioned to help Statistics New Zealand:

- identify the current and potential uses of human capital measures
- evaluate existing statistical series relevant to the measurement of human capital
- clarify the role it should have in the area of human capital measurement
- identify opportunities for future work in the area.

This review is part of a wider Statistics New Zealand research project on human capital. The project was funded by the Ministry of Research, Science and Technology's Cross Departmental Research Pool.

Statistics New Zealand would welcome comments readers have on the content of this review.

Brian Pink
Government Statistician

Review of the Statistical Measurement of Human Capital

CONTENTS

1. An Introduction to the Theory of Human Capital 1
Introduction.....1
Major issues.....2
A comparison of the three measures.....6
Macro economic perspectives on human capital.....9
Conclusions.....10

2. Current and Potential Uses of Human Capital Measures.....11
Economics of Education.....11
Employability.....16
Economic Growth.....17
Other uses of Human Capital Measures.....22

3. Evaluation of Existing Statistical Series.....24
Stock Measures.....25
Investment Measures.....26
Employability Measures.....27
Outcome Measures.....28

4. The Role of Statistics New Zealand in Human Capital Measurement.....35
Introduction.....35
Measures of Human Capital.....36
Data Sources.....38
Recommendations.....40
Human Capital Measures within Statistics New Zealands's Other Priorities.....42

References 45

Appendix A 49

Appendix B: Supplementary Data Sources.....50

Appendix C: Alternative Measures of Human Capital.....52

1. An Introduction to the Theory of Human Capital

Introduction

In the words of James S Coleman, a leading social theorist:

> "Probably the most important and most original development in the economics of education in the past thirty years has been the idea that the concept of physical capital, as embodied in tools, machines and other productive equipment, can be extended to include human capital as well (see Schultz, 1961, Becker, 1964). Just as physical capital is created by making changes in materials so as to form tools that facilitate production, human capital is created by changing persons so as to give them skills and capabilities that make them able to act in new ways." (Coleman, 1990, 304).

Unsurprisingly, many have reacted critically to the analogy drawn between machines and persons, but the rapidly expanding literature has demonstrated the utility of the concept of human capital in two main areas. Firstly, human capital theory has underpinned a wide range of micro-economic studies seeking to explain individual and family decisions relating to education and other matters. For example, to what extent can decisions to undertake tertiary training be explained in terms of a supposed trade-off between lower incomes during the period of study, against higher future earnings once qualifications have been gained? Secondly, human capital theory plays an increasingly important role in macro-economic studies analysing the causes of economic growth. To take one example, to what extent are the higher relative incomes of advanced industrial countries to be explained with reference to the acquired skills and competencies of their workforces?

Any analogy has its limits and it is important to acknowledge that while educational decisions do indeed impact significantly on the future earnings of students, the proper framework for evaluating educational decisions includes a wider range of considerations. Human capital theory has proved very fruitful but that does not imply that everything can be subsumed within it.

Definitions

Although there is an underlying unity, different writers define human capital in different ways and it is useful to consider a range of uses.

- **"Human capital.** The skills, capacities and abilities possessed by an individual which permit him to earn INCOME." (*The Penguin Dictionary of Economics,* 1984.)

- "To analyse man as a producer, some method must be found to measure and quantify his productive abilities. The idea of *human capital* is introduced into economic analysis to provide such a measure. Human capital is *defined* as an individual's productive skills, talents, and knowledge. It is *measured* in terms of the value (price multiplied by quantity) of goods and services produced. Since consumption is the ultimate goal of our economic system, the value of a man's human capital is the same as the value of the consumption goods and services which he directly or indirectly produces. When the value of goods and services rises, the value of human capital rises. When the value of goods and services falls, the value of human capital falls." (Thurow, 1970, 1)

- "The basic idea underlying … human capital models of labor supply is that much "wealth" – that is, a stock of something or other, such as health, children, knowledge, and so forth – is embodied in individual people or families, cannot be disposed of or sold to others (since slavery is illegal), can usually be acquired only at a cost (eg, outlays for physicians services, tuition charges, earnings and leisure time that must be foregone, etc), and yields a flow of services (greater vitality, happiness, productivity in the market or in the home, etc.) over the individual's, or family's, lifetime." (Killingsworth, 1983, 302).

- "A broader view of wealth may indeed be taken for some purposes; … Thus, for instance the carpenter's skill is as direct a means of enabling him to satisfy other people's material wants, and therefore indirectly his own, as are the tools in his work-basket; and perhaps it may be convenient to have a term which will include it as part of wealth in a broader sense. Pursuing the lines indicated by Adam Smith, and followed by most continental economists we may define *personal wealth* so as to include all those energies, faculties, and habits which directly contribute to making people industrially efficient". (Marshall, 1890, 57).

- "Since long-run labor supply adjustments involve *current* costs, but *future* returns, they are *investments*, and the theory of long-run labor supply is therefore the theory of decisions to invest in **human capital.** Investments in human beings may take many forms, but it is useful to divide our discussion between those that take place on the job, as part of market work activity, and those acquired elsewhere. Job-associated investment in human capital consists mainly of formal and informal training programmes within firms. Alternatively, schooling, health care, and job search primarily involve activities in which one's employer has much less direct involvement." (Fleisher and Kniesner, 1984, 287).

- "The definition of human capital used in this report is "*The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being"* (Organisation for Economic Co-operation and Development (OECD), 2001, 18).

- "The concept of human capital is comprehensively defined, and thus embraces

  "a) the capacity of interpreting flows of sensory data and structured information required for purposive individual actions and inter-personal transactions among economic agents;
  "b) the capacity for providing a variety of physical labour service-inputs in ordinary production processes;
  "c) the cognitive basis of entrepreneurial market activities;
  "d) the key resource utilised for managing market and non-market production, as well as household consumption activities;
  "e) the creative agency in the generation of new knowledge underlying technological and organisational innovations." (David, 2001, 5)

Major Issues

In this section we discuss a number of major issues relating to the definition, and thereby, to the measurement of human capital.

Human capital is embodied in the individual

As usually defined, human capital is embodied in the individual, and the national stock of human capital can therefore be thought of as the sum total of the human capital of all those normally resident in its territory.

However the creation of knowledge is clearly a social activity so it is necessary to ask whether a simple aggregation of the human capital possessed by individuals is sufficient. The answer to this is a qualified, yes, provided one accepts the boundaries commonly drawn between human capital, knowledge and social capital. Two quotations will be helpful. The first quotation is on knowledge:

> "The main measurement problem that we wish to emphasize here is the problem of measuring the output from innovative activity… That is, knowledge, like physical capital, is produced at an opportunity cost of current consumption, and like physical capital it will allow society to produce more in the future than otherwise, given the same inputs of all other factors of production. So when resources are diverted from producing consumption goods into producing knowledge, there is no more reason to think that the overall level of output or income has fallen than when they are diverted to producing physical capital. Nevertheless, under standard national income accounting procedures, measured GDP will fall in the first case and not in the second." (Aghion and Howitt, 1998, 267).

The development of individual human capital is therefore intertwined with the social and collective development of knowledge. Human capital and knowledge can be thought of as joint-products, but conceptually, they are distinct and in the ideal would be separately measured.

The second quotation is from the previously cited OECD (2001):

> "Human and social capital are closely related to the way in which institutions and political and social arrangements impact on society. However the various elements need to be carefully distinguished, since:
>
> - "Human capital resides in individuals.
> - "Social capital resides in social relations.
> - "Political, institutional and legal arrangements describe the rules and institutions in which human and social capital work" (13).

Estimating human capital with reference to future earnings

The value of an individual's human capital is dependent on the future stream of benefits that the individual can realise through the use of that capital. Because the future stream of benefits cannot be known with certainty, the value can only be estimated with respect to the expected future stream of benefits. Valuation therefore requires risk and uncertainty to be taken into account.

Furthermore, aggregation of earnings over a stream of time requires knowledge of the individual's time preference. Individual time preference can be thought of as equivalent, in an inflation free and certain world, to a rate of return that would make a person indifferent between spending $1,000 now and spending $1,000, compounded by that rate, at some future point.

In summary, the interest rate used to calculate the present value of an expected future stream of benefits needs to take account of both the individual's time preference and the uncertainty inherent in any assessment of expected future benefits.

The future stream of benefits to an individual is not exclusively market determined. Although in practice most research focuses on expected market returns, it is clear that in principle the individual derives a more all-encompassing stream of utility from their acquired capabilities and knowledge. The problem is, of course, that that wider stream of benefits is often intangible and therefore resistant to measurement. The problem is indeed deep set. As Thurow comments:

> "If individuals are always assumed to maximize utility rather than some pecuniary magnitude, no one can ever make an irrational consumption decision, or an irrational human investment decision. … As a result, it is easy for economic analysis of human capital investment decisions to slip into earnings maximisation. Good and bad decisions can then be delineated. Everyone knows this is not correct, but it is practically the only method of arriving at definite answers." (Thurow, 1970, p122).

In the ideal, the stream of future benefits that needs to be aggregated is the expected stream of utility that will be realised from the investment in human capital.

Estimating human capital with reference to a stream of past investments

To this point our comments have focused on human capital as a measure of the expected future stream of benefits to be derived by the individual from their investment in that capital. In principle, we can also look upon the stock of capital as being derived from a whole sequence of past investment decisions in the acquisition of human capital.

An individual's current stock of capabilities and knowledge is the summation of a lifelong stream of events.

Decisions affecting the size and structure of an individual's human capital are made by a great variety of actors, including most notably, themselves, their parents, their employers, the government (through the funding *inter alia* of public education and health systems) and a whole sequence of instructors and mentors.

In the ideal, we would be able to cost and sum each of these flows of inputs. In practice this would be a Herculean task and recourse is had to more summary measures. Schematically one could view an individual's human capital formation as the sum of three streams of costs: those incurred by the individual and the individual's family; those incurred by the individual's employer; and those incurred by central and local government. The present value of these streams of costs would need to be estimated by compounding past costs at some appropriate rate.

A summary measure of the first (individual and family) stream of costs would include as a minimum the direct costs of tuition and the opportunity cost of income foregone during post-compulsory education.

Employer-incurred costs would include on-job training, employer payments in support of attendance at outside courses and, arguably, an allowance for the employees learning by doing.

Government costs include, as a minimum, a proportionate share of the costs of running the educational system. Note, however, that estimation in this area has to take account of

whatever collective preference function underlies actual public expenditure in this area. In this context it is salutary to recall the words of Peter Fraser, as Minister of Education, in 1939:

> "The Government's objective, broadly expressed, is that every person, whatever his level of academic ability, whether he be rich or poor, whether he live in town or country, has a right as a citizen, to a free education of the kind for which he is best fitted, and to the fullest extent of his powers. So far is this from being a mere pious platitude that the full acceptance of the principle will involve the reorientation of the education system." (*Appendices to the Journals of the House of Representatives, Paper E1* 1939, 2, quoted in Alcorn, 1999).

This assertion of a citizen's entitlement to free public education "to the fullest extent of his powers" can, of course, be viewed as entirely consistent with an emphasis on developing the productive skills of the population to their highest extent, but it serves as a reminder that the development of human capital has to be seen as but one, albeit important, element within the full range of objectives that enter into the government's preference function for educational spending.

In addition to summing individual, family, employer, and government investments, any cost-based estimate of the value of human capital would need to allow for the fact that human skills are subject to depreciation. Unlike physical capital, many human skills continue to improve with use, but some skills become obsolescent and human capacities are, of course, subject to the attrition of age and exposed to accidental damage and loss.

Estimating human capital with reference to individual characteristics

The previously cited OECD definition of human capital as "The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being" raises the possibility that an individual's human capital could be described by comprehensively enumerating that individual's knowledge, skills, competencies and attributes.

The obvious difficulty with this approach is that the various characteristics do not have a common unit of measurement and are therefore not easily aggregated, although statistical techniques such as 'principal components' can sometimes get around this problem. We may be able to devise tests that would give measures of people's numerical, verbal, written and social abilities, and of their knowledge base within particular disciplines (sufficiently accurate to approximately rank persons within each category) but this leaves us short of an overall measure. This could be a serious problem if we are interested in making comparisons of human capital between individuals and groups at a point in time or over time.

Nevertheless, recent developments in human capital theory suggest that meaningful aggregate measures are coming within the range of feasibility, and it will be useful to explore the concept a little more closely.

A recent article by Samuel Bowles and others provides a useful starting point:

> "Enhancing individuals' capacity to succeed in the labour market is a major objective of both families and policy makers, one which in recent years has assumed special urgency with respect to those with low earnings. According to the canonical model, earnings are determined by human capital, which consists of capacities to contribute to production, generically called skills. Individuals possess a vector of these capabilities, c, and sell these on the labour market at hourly prices p, with hourly earnings $w=pc$." (Bowles et al, 2002).

Inherent in this formulation is the idea that it is possible, at least in principle, to attach a price, *p*, to each of the relevant individual capabilities. Two main issues arise.

Firstly, as we have noted many individual characteristics, while measurable, are not measured in common units and are therefore not readily aggregable. We thus need to be able to attach a price, or some other common unit of account, to each characteristic before they can be aggregated. For market related characteristics the answer lies, in principle, in relating each individual characteristic to its likely impact on subsequent earnings or market returns. We return to this later.

Secondly, if we adopt a broad definition of human capital, which places emphasis on wider life skills, and not simply on market outcomes, we face the problem of attaching a price to non-market related skills and attributes. In this case, we can hardly appeal to future market returns, but it is possible that measures based on investment costs would provide an answer.

A Comparison of the Three Measures

Diagram 1 (on the following page) sketches human capital as a stream of past investments.

Human capital can therefore be defined alternatively, as the present value of an expected future stream of returns, as the accumulated sum of a past stream of investment expenditures, or as the sum, measured at a point in time, of the individuals capabilities expressed in some common unit of account. In a perfectly competitive world with perfect information these alternative measures would coincide. In practice of course, the market for human capital, like that for any other capital asset, is characterised by many departures from perfect competition, by uncertainty, imperfect information and continuing change.

Consequently, we would expect to find in practice, many differences between the accumulated costs of human investment embodied in particular individuals, and realistic assessments of the present value of the income streams likely to accrue to persons with those acquired characteristics.

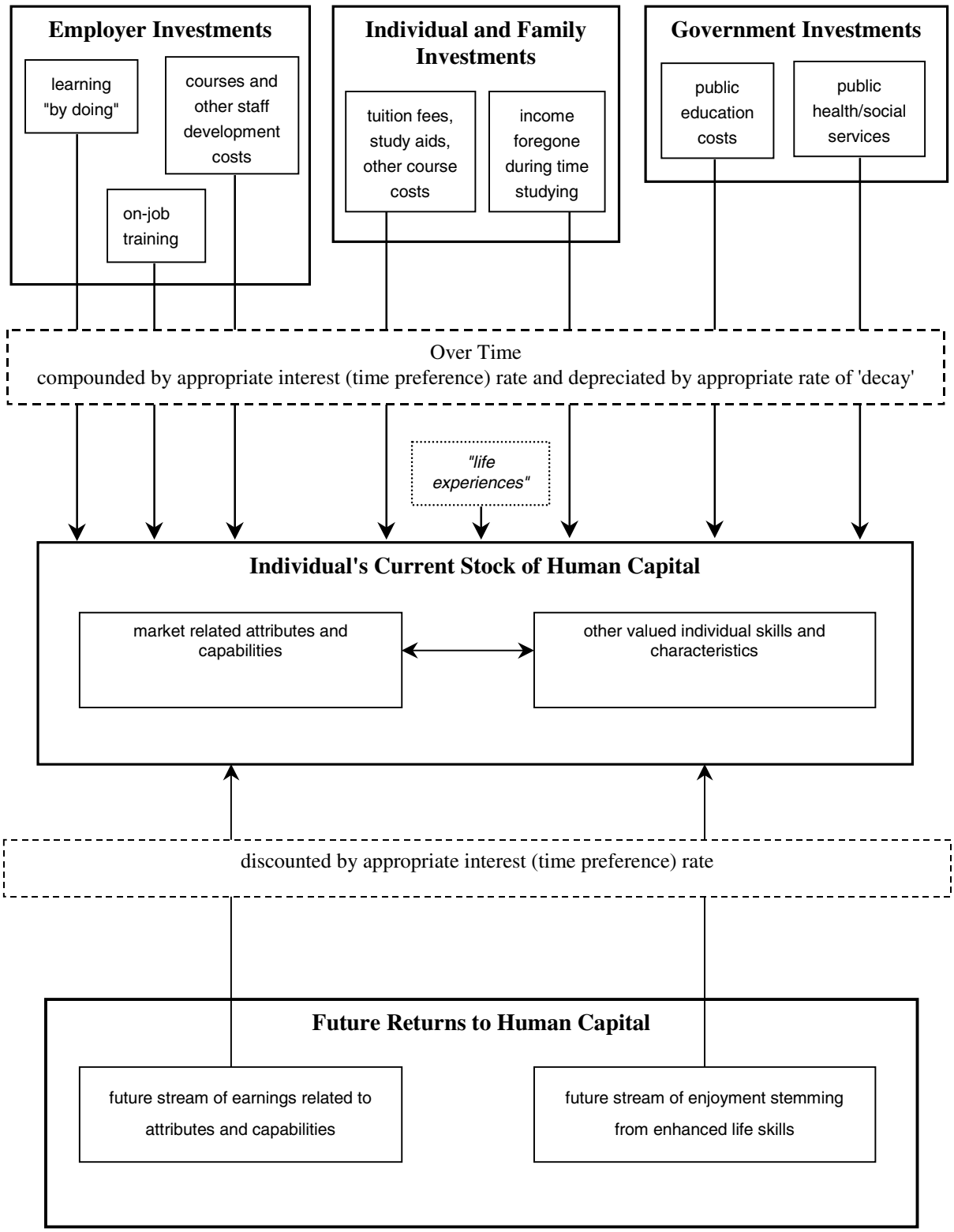
Algebraically, the alternative bases of measurement can be expressed as follows:

- Capital as a function of earnings

$$H_e = \sum_{t=p}^{n} \frac{E_t + B_t}{(1+i)^{t-p}} \qquad (1)$$

where: H_e = Human capital defined from earnings and other benefits
E = Earnings
(often expressed as the difference between actual earnings and a basic, unskilled, wage rate)
B = other (non-market) benefits derived from increased human capital
i = interest rate
p = the present
t = time

Human Capital: As Stream of Past Investments



- Capital as the summation of investment:

$$H_c = \sum_{t=0}^{p} C_t (1 + i - d)^{p-t} \qquad (2)$$

where: H_c = Human capital defined from investment costs
C = Investment costs, including direct and opportunity costs
i = interest rate
d = depreciation rate
p = the present.

- Capital as a summation of attributes and capabilities:

$$H_a = \sum_{i=1}^{p} m_i w_i + \sum_{j=1}^{q} o_j v_j \qquad (3)$$

where: m_i = market related attributes and capabilities
w_i = market returns for attribute or capability m_i
o_j = other valued individual attributes and capabilities
v_j = unit return for other (non-market) individual attribute or capability o_j.

In a recent research paper Wossmann (2001) presents a method, "the elaborate discounting method", which calculates the discount rate r which equates the stream of costs of education to the stream of benefits from education. The formula is:

$$\sum_{t=1}^{s} \left(C_{h,t} + W_{l,t}\right)(1+r)^t = \sum_{t=s+1}^{A_h} \left(W_{h,t} - W_{l,t}\right)(1+r)^{-t} \qquad (4)$$

where: C_h = the resource cost of schooling incurred to achieve a higher level h from a lower level l,
W_l = the foregone earnings of the student while studying
$(W_h - W_l)$ = the earnings differential between a person with a higher level of education and a person with a lower level of education
s = years of schooling
A_h = the highest possible working age.

As compared with our earlier Equations (1) and (2), three points deserve note. In measuring the investment cost of education Wossman explicitly includes the opportunity cost of wages foregone while studying. Secondly, he estimates future returns to education with reference to the difference in the income stream accruing to the person with the higher qualification. Finally, rather than bringing the investment and future income streams to a common point in time by using a standard discount rate, he estimates the internal rate of return that would align the investment with the future benefit.

If instead of calculating the internal rate of return we were to introduce a common discount rate we would destroy the internal logic of the equation but would effectively create two equations, analogous to our Equations (1) and (2) giving alternative measures of human

capital. Wossmann's internal rate of return identifies the discount rate that would align those two human capital measures.

Now, let us narrow our focus from the large issue of the lifetime returns to a person's schooling and consider an analogous framework for thinking about the acquisition of a particular attribute. Suppose that in the current year an individual seeks to improve their skills by undertaking a course in some career related subject, and also enrolls in a class for some recreational activity. In both cases some direct cost is incurred and some time committed that could be spent doing other things. This cost function looks like the left-hand side of Wossmann's function. Suppose also that this person's improved work skills increase their future earnings; this looks like the right-hand side of the function. What about the recreational skills? Here we must assume there is an enhanced stream of enjoyment (a stream of $o_j v_j$ in terms of Equation (3)), which implicitly must at least outweigh the cost of the classes.

Now if we can do this for each individual attribute then we can, in principle, do it for the sum total of an individual's attributes. Enlarging our view again we can then for any population for which we have a sufficiently detailed picture of attributes, including past education, and some basis for estimating likely future earnings (usually assumed to be similar to those currently having like characteristics) calculate both the cost of acquiring particular sets of attributes and likely future returns to such attributes.

As will be seen in Section 2 there is a large amount of international research attempting to exploit the potential of particular databases in such ways.

Macro Economic Perspectives on Human Capital

In a recent article, Krueger and Lindahl, (2001, 1108) review research into rates of return to education. They note:

> "Two issues have motivated the use of aggregate data to estimate the effect of education on the growth rate of GDP. First, the relationship between education and growth in aggregate data can generate insights into endogenous growth theories and possibly allow one to discriminate among alternative theories. Second, estimating relationships with aggregate data can capture external returns to human capital that are missed in the microeconomic literature."

Following Aghion and Howitt (1998) they note that the role of human capital in endogenous growth models can be divided into two main categories:

1. Models such as that proposed by Lucas (1988, 3–42), where the concept of capital is broadened to include human capital. In such models sustained growth is due to the accumulation of capital over time. Lucas assumes a production function of the form:

$$y = Bk^{\alpha}(uh)^{1-\alpha}(h_a)^{\gamma} \qquad (5)$$

where: B, α, γ = parameters
y = output
k = physical capital
u = the proportion of time devoted to work (as opposed to accumulating human capital)
h = the human capital of the representative agent
h_a = the average human capital in the economy.

2. The second category comprises models that attribute growth to the existing stock of human capital, which generates innovations or improves a country's ability to imitate and adapt new technology. Krueger and Lindahl cite Romer (1990, S71–S102) as an example:

$$Y = H_y^{\alpha} L^{\beta} \int_0^A X(i)^{1-\alpha-\beta} \, di \qquad (6)$$

where: α, β = parameters
Y = output
H_y = human capital employed in the non-R&D sector
L = labour
$X(i)$ = physical capital disaggregated into separate inputs characterised by their technological level
A = the highest technological level embodied within the nation's stock of physical capital.

Conclusions

Three major points stand out:

- The five equations listed above (excluding Equation (4)) implicitly contain no less than six measures of human capital. Although each usage could be accommodated under the general umbrella of the OECD definition quoted earlier, ie "The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being", the precise meaning of each has to be consistent with what might be inferred from the algebraic construction of the equation in question.

- In the absence of well-defined measures of human capital researchers have had to appeal to proxy measures, such as years of schooling. This has led to an extensive literature on relationships between educational inputs and attainments, on the one hand, and outcomes such as earnings and the rate of economic growth, on the other. In such cases it is characteristic that while the researcher's interest may lie in the connection between human capital and some particular outcome, such as income, what is actually being tested is the relationship between the proxy and the outcome. In practice, proxies for human capital have been gathered on the hoof and there is a lot of variability in underlying definitions. This points to a fairly eclectic programme of gathering together series and measures that relate to, but do not necessarily closely define human capital, but nevertheless could still be found useful by researchers investigating one or other aspect of human capital theory.

- With respect to national, macro level measures of human capital, there is also a need for alternative measures, including, the present value of expected returns, the accumulated cost of past investments and cross sectional studies on the human capital embodied in the population at a point in time, eg as at census date.

In the context of the current project, where the emphasis is on the measurement of Human Capital series, we do not see the absence of an all-encompassing widely accepted definition as an obstacle. Rather, it points to the need to proceed on a pragmatic basis identifying variables of interest whose measurement can be established and/or improved.

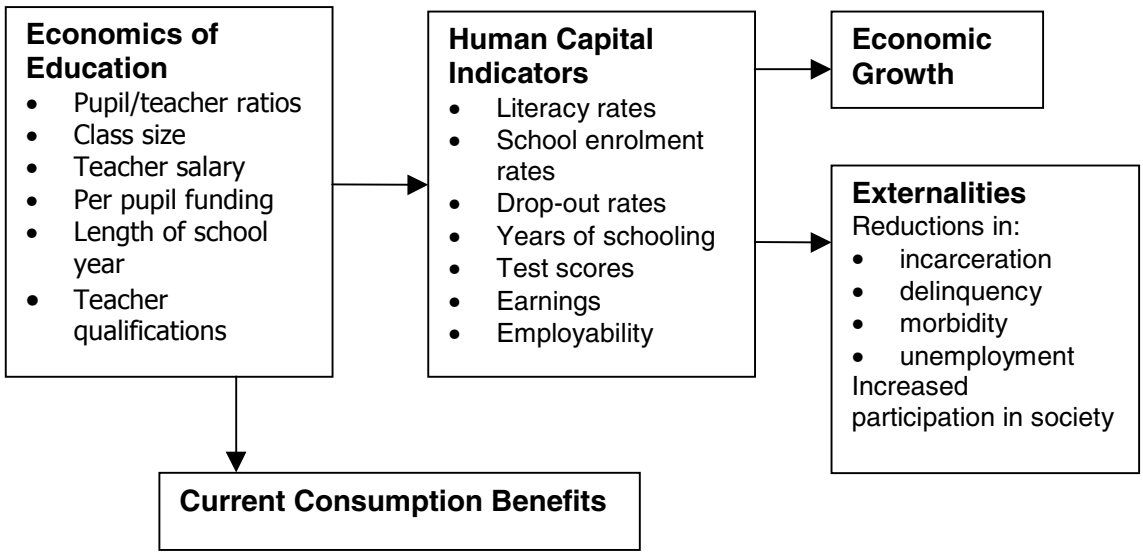
2. Current and Potential Uses of Human Capital Measures

The previous section ended with the observation that we do not see the absence of an all-encompassing widely accepted definition of human capital as an obstacle to its measurement. An implication of this is that various measures are likely to evolve. Inevitably there will be differences in quality. However, while we should always strive to improve the quality of the methodology of the measuring process, the interpretation of the quality of the resulting output will also depend on the uses to which a particular measure is to be put. Hence the opinion above – no single measure of human capital is likely to be suited to all research questions.

In this section we will discuss three key issues to which measures of human capital have been applied, and then mention some other areas where a small amount of literature exists. We also speculate on where else human capital measures may be relevant. The three main areas are:

1. economics of education
2. employability
3. economic growth.

Clearly these areas are not independent of each other. If we interpret economic growth in a wide sense as the ever-increasing ability of the economy to improve the economic, social and environmental welfare of its citizens, then the other issues on the list are really subsets of the last (although again this does not imply the same measure of human capital will apply to both). The inter-relationships may be represented as follows:



Economics of Education

If education enhances welfare by increasing human capital (and this will be discussed below), governments and individuals will want to know how much to invest in education, and what forms this investment should take. Are such influences equally important at all stages of learning, and is investment in education subject to diminishing returns? Measures of human capital are pervasive in this research.

Taking the public investment perspective, for a funding agency (typically local or central government) to answer this question it would need to have a measure of human capital which satisfies two conditions:

- It should be sufficiently well defined empirically such that the contribution of formal education is measurable.

- The output measure for formal education should be associated with (or at least point to) the sorts of resources and educational policies that are under the control of the funding agency. (For example, if the output measure was test scores, can test scores be related to teacher salaries, given that teacher salaries are stipulated by the funding agency?)

Here then is an example of finding a measure of human capital that is useful to a particular research topic. But even then it is not straightforward, as it begs some prior questions: what actually is the human capital related output that formal education delivers? If it does more than deliver a knowledge base in academic subjects, are the other outcomes also part of human capital, and are they a deliberate or incidental part of the formal education process? Are the different outcomes separately measurable? Does it matter?

Therefore what might have seemed initially to be a considerable simplification of the definition of human capital to just one of its components – formal education (albeit a major component) – it is apparent that the required analysis is by no means simple. Indeed, because the complexities in this area are typical of those encountered in other research areas where measurement of human capital is required, we will discuss in more detail how such complexities have been addressed in the literature on educational economics. A useful summary of the vast amount of material in this area, particularly on the effects of educational resources on educational outcomes, is provided by Norton et al (2000).[1]

Recall that what is desired is a measure of the human capital generated by formal schooling, and a link between this and what we can broadly label educational resources. We can re-express this as the need to consider:

- The effect of the *quantity* and *quality* of education on students' human capital outcomes – future incomes, for example.

- The effect of measurable inputs on the *quantity* and *quality* of education.

Quantity of education

As noted above, there are different views of what formal education is supposed to provide in the area of human capital. And from a practical viewpoint, there is the added complication of the time horizon over which measurement is sensible. Is education to provide a skilled and flexible work force to improve the nation's competitiveness and enhance economic growth – as per our 'first' role for human capital measures above, or is it to improve the knowledge, skills and quality of life for all citizens (via higher self-fulfilment, ability to participate in a democratic society, etc)? To what extent do these objectives overlap and to what extent might earnings provide an appropriate output measure, especially of the former?

Where earnings are used in the literature they are generally defined as hourly or weekly (full-time) wage rates rather than as annual income. The latter would introduce the confounding effects of labour-leisure choices, and thereby require a distinction between actual income and potential income.

[1] The following discussion is based largely on our findings in Norton et al.

Another common outcome measure is test scores. Whether they are a useful predictor of future income is an interesting question. Even if there is a relationship between school resources and later earnings, and between school resources and test scores, we cannot automatically infer that earnings are related to test scores. Card and Krueger (1996) question such a relationship, but Hanushek (1998) is generally supportive of it. It may be that certain resources and certain forms of pedagogy can achieve high test scores, but do very little to enhance a student's earning ability. Thus it is important to be clear about what is being measured.

While test scores and earnings are reasonably well measured, the wider societal and non-market outcomes are less easy to quantify. Some possibilities that have been proposed are that increases in human capital will reduce rates of incarceration and delinquency and reduce poverty, morbidity and involuntary unemployment. Equally, increases in human capital may be associated with a propensity to play a more active role in community, social and political affairs. Although it is reasonable to argue that schools have an effect on these variables, their effect is generally likely to be much less than on test scores and even earnings. Also, the time dimension and the influence of other forces make it horrendously difficult to isolate the effects of schools on these variables.

In terms of the *quantity* dimension of education, a common approach in the literature is to measure the effect of additional years of education on test scores or future earnings. It is concluded, almost without exception, that additional education has a positive effect on both outcomes. However, researchers differ on the magnitude of the effect.

This 'production function' approach is typified by Griliches (1977). A rigorous econometric approach to estimation made it clear that simplistic measures of the returns to education, which do not control for student background, will typically, but not always be too high. Innate ability, for example, will typically result in higher test scores and earnings, regardless of education. Hence the need to include a measure of ability in estimation.

Since the Griliches paper, there has been a broad consensus that student characteristics (family background, ability, etc) will obscure the effect of additional resources on educational outcomes. Much of the research since that time has focussed on refining the set of characteristics which need to be controlled for, or on transformation of data to remove the need to control for them at all. Among the approaches tried are:

- including a richer set of characteristics in the estimation procedure (Blackburn, McKinley and Neumark, 1993)

- finding variables that affect the quantity of education, but are not related to ability, and using them in place of the quantity of education (Card, 1993; Angrist and Kreuger, 1991; Bound and Jaeger (1996)]

- using data from samples of siblings or twins to get students with similar backgrounds, (largely) removing the need to control for background (Ashenfelter and Krueger, 1994; Bound and Solon 1998).

Studies considered in Norton et al find that the effect on earnings or test scores of an additional year of education is probably around 6-8 percent, and certainly less than 10 percent. That is, formal education as measured simply by the quantity of schooling, has a positive effect on human capital as measured by earnings or test scores.

The increase in resources required for additional years of education is only implicit in most production function models. That is, the authors are typically not concerned about whether

the increase in the quantity of education results from a direct increase in resources or from an improvement in the way existing resources are employed, nor do they consider the exact form increased resources will take. For a funding agency, however, this is important if it is to optimise the flow of resources into education. This moves us from the quantity of education to the quality of education.

Quality of education

Researchers who attempt to estimate the effect of the quality of education on students' human capital outcomes typically use measures of resources as a substitute for the unobservable 'quality' variable. Measures of resources usually include pupil/teacher ratios, class size, teacher salary and per/pupil funding. From a policy point of view, using such proxies for quality might be desirable as policy-makers would like to know the effect of the resources which they can control, but these measures probably do not do justice to the complexity of the educational process. As Catterall (1997, 297) says:

> "We know that the mere presence of resources – a teacher with certain skills, a given set of curriculum materials, a student-teacher ratio – does not an educational process make, no more than does a plateful of ingredients lead unmistakably to a soufflé".

The process by which the inputs are combined is likely to be at least as important as the level and type of the resource inputs. Process may include factors such as the following:

- whether the teacher has a clear purpose of what is to be accomplished with the class
- whether there are explicit pupil achievement standards
- whether the standards are high, clear and rigorous
- whether the classroom and school provides a supportive atmosphere
- which teaching techniques are used, and
- the degree of decentralisation in school management and expenditure control.

Unfortunately these are not easily quantified and thereby illustrate where econometric analysis is likely to encounter difficulties.

With regard to the effect of educational resources on test scores the evidence is mixed. Most authors do find a positive effect from increased resources on future earnings. The paradox that academic achievement is relatively unaffected whereas earnings *are* affected, is usually explained by asserting that test scores are only a narrow measure of the human capital (work and social skills) that formal education provides – and again, which are desired in the labour market. See for example, Card and Krueger (1992).

Test scores

Hanushek (1998) found that between 1966 and 1980, increases in real teacher salaries and per pupil spending, as well as decreasing pupil/teacher ratios, were accompanied by a deterioration in average student test scores. He saw this as evidence that there is no systematic relationship between expenditure on education and academic achievement.

Hanushek, Rivkin and Taylor (1996) supported the argument that educational resources do not positively affect educational outcomes. They argued that there is upward bias in most measures of such an effect, because of aggregation across school districts or states. Bound and Loeb (1995) rejected Hanushek et al's results, and backed this up with their own data on pupil/teacher ratios, term length and test scores.

Boozer and Rouse (1995) also argued that resources do affect academic achievement. They argue that using class size, rather than the more commonly used pupil/teacher ratios, provides

a more accurate (and higher) estimate of the positive effect of resources on test scores, especially where remedial education is common.

Krueger (1997) used a unique semi-experimental approach (Project STAR) to determine that:

- Class size has a significant effect on test scores (5-8 percent higher for smaller classes).
- Family background has an impact *at least as large as* class size.
- Teacher characteristics (qualifications) have only a weak effect on test results.
- Lower achieving students benefit more from smaller classes.
- Some schools are better at achieving improved performance with smaller class sizes.

A major part of the blame for the failure to demonstrate the importance of school quality on human capital outcomes seems to be that only crude input measures have been used. As shown by Boozer and Rouse, even what appears at first to be a small change – using class size instead of the pupil/teacher ratio – yields demonstrably positive effects of school quality, so defined.

Earnings

Card and Krueger (1992) estimated that the elasticity of earnings with respect to the pupil/teacher ratio is -11 percent, that is, a reduction in the number of pupils per teacher will lead to an increase in the future earnings of students. Heckman, Laye-Farrar and Todd (1995) also established a positive relationship between school resources and education, but it was less than Card and Kreuger (1992). One reason given for expecting a lower result is the dependence of funding arrangements on current school quality. If, for example, additional funds were directed at under-performing schools, then one might expect to see a negative correlation between resources and earnings.

Card and Krueger (1996) surveyed a collection of studies and found that the estimated positive effect on future earnings of an increase in per/pupil expenditure is in the range of 8.5-19.5 percent per additional dollar. They found an elasticity of 5.3 percent for the effect of the pupil/teacher ratio on future earnings.

Altonji and Dunn (1995) used sibling data to control for student characteristics and estimate the effect of four types of educational resources on income: the pupil/teacher ratio, teacher salary, expenditure per pupil and a composite index consisting of the first two, plus the counsellor/student ratio and books per pupil. The pupil/teacher ratio was found to have an insignificant effect, while around 10 percent of changes in the composite index and per pupil spending were reflected in earnings. The result for teacher salary (a one-for-one effect on earnings) was rejected as implausible, with low sample variance for this variable.

In summary, the literature on the effects of formal education on human capital illustrates four key lessons which are relevant to other uses of human capital measures. (We note the general points in italics and those specific to the topic in standard text).

1. *A clear research objective is required.*

   In this case, how can a funding agency improve the resources allocated to formal education so that human capital is increased, so that in turn the welfare of citizens is enhanced? The scope of this objective is too wide to be easily researchable, requiring adequate measures of aggregate citizens' welfare, human capital and funding, and calling for a research design sufficiently detailed to take account of everything else that might muddy the posited relationships. This leads to the next point.

2. *To answer a research question a number of simplifications are likely to be required to convert the problem into one that is amenable to quantitative investigation. Such simplifications may have no validity outside the issue of interest.*

   In this literature it is accepted that individual earnings are a reasonable proxy for those aspects of human capital that contribute to general societal welfare, or at least that educational policies which improve earnings do not worsen non-economic dimensions of welfare. This simplification is driven largely by data constraints, but is certainly not devoid of theoretical validity. The reasonableness of this premise should be assessed only with respect to this particular context. It may be entirely unreasonable in other contexts such as in cross-country growth comparisons.

3. *Proxy measures need to be selected carefully, both on the input side and the output side*.

   The research generally shows positive effects; formal education does improve human capital as measured by earnings. Test scores have also been used as an even narrower measure of human capital, but with less success.

   Support for the effects of school quality is mixed. Studies which find little evidence of a link tend to be more sophisticated in an econometric sense as they are careful to guard against spurious correlation, but those which support a link tend to use more meaningful measures of school quality. While it is useful to know that often-cited measures of school quality, such as pupil/teacher ratios are seemingly too crude to be linked to the development of human capital through formal education, future progress will depend on finding measures of school quality which better reflect factors such as pedagogy styles and school leadership.

   Although this is not directly within the ambit of human capital measurement and use, it may be that different measures of human capital on the educational outcome side link more closely to traditional measures of school quality.

4. *Any attempts at measuring the effects of other variables on human capital (or vice versa) must allow for the possibility of omitted variable bias, measurement error and correlated regressors*.

   With regard to the economics of education, most studies properly consider the possible confounding effects of innate ability and family/social background on the measured link between formal education and human capital. Other variables which tend to receive less attention are the funding mechanism (whether funds are allocated so that schools achieve the same increment in human capital across students, or whether schools with students of greater need are given more funding so that all pupils achieve a given educational standard), delivery (bulk funding, central resourcing), the use of vouchers, public versus private education, school size (economies of scale and subject range versus bureaucratic load and less school cohesion), and school management and governance styles.

Employability

Employability would seem to require a wider definition of human capital than just educational attainment and perhaps work-related training. Infometrics (1997) in a report for the Ministry of Education cite communication skills, good work habits, interpersonal relation skills, and teamwork ability as examples.

Arguably an employer would desire a measure of human capital for potential employees which conveyed an unambiguous signal of potential productivity. Regressions of earnings

against formal education [for example Maani (1997)] show a high goodness of fit and thus constitute *prima facie* evidence of formal education being a useful indicator of human capital. This is discussed further in the next section.

As employers generally look for more than academic ability, it has been suggested that formal education is no more than a signalling device about potential employees' broader human capital (including notably innate ability) and therefore suitability for the job. This theory is consistent with the use by many employers of other pre-employment screening mechanisms such as aptitude tests. However, the education literature shows clearly that there is a return to education (in the form of higher earnings) even after allowing for the effects of innate ability. Therefore while the signalling theory undoubtedly has credibility, it is not the whole explanation of the high correlation between earnings and formal education.

Apart from the points made above, the role of human capital in determining employability is discussed mostly in the literature on human resources and the management thereof. This puts it on the periphery of uses of human capital measures. In the next section we look at the quality of some of the measures used.

Economic Growth

As noted above, the most important use (and probably most common use) of human capital measures is in understanding economic growth.

There is a wide literature on explaining differences across countries in GDP per capita, and on why some countries consistently manage faster economic growth than others. (eg Denison (1967), Barro (1991), Gundlach (1995), and Hanushek and Kimko (2000) among others). Most researchers recognise the importance of the skills of a country's citizens in raising GDP per capita (and the virtuous circle this link can generate). Clearly, a wide definition of human capital is required here as economic growth captures not only the direct benefits to the individual of investment in human capital, but also the positive externalities that a skilled population encompasses, as manifested by informed democratic participation leading to good policy-making by governments, social cohesion, better health etc.

Is there a measure of human capital that is suited to this purpose, or is it better to incorporate numerous measures for the different means by which improvement in human capital can enhance economic growth?

Wossmann (2001) contains an excellent discussion of the empirical specification of measures of human capital in growth research. The main problem in the literature is that poor proxies are used for human capital. As discussed above with respect to the education literature, this can have a significant effect on research outcomes.

All of the three expressions for human capital given in Section 1 have been used in growth analysis. In Equation (1) human capital is defined as the sum of discounted earnings, but as the earnings of labour are the major component of GDP, an equation which expresses the change in GDP as a function of this measure of human capital may not be directly estimable by ordinary least square (OLS) regression. Equation (2) avoids this difficulty, but introduces another. It expresses human capital as the cost of its acquisition. Thus it is measuring an output or outcome by the value of its inputs. Even if this did provide a good fit (and undoubtedly links could be drawn between historic levels of spending on education and the stock of educational qualifications held by the current population) it introduces another source of error – that is, if growth and human capital are observed to be poorly correlated, it may

simply be because the latter is measured by its inputs.[2] Thus Equation (3) is preferred to Equations (1) and (2) as it measures human capital directly as a stock of skills and competencies.[3]

The early growth literature typically used measures of human capital such as:

Adult literacy rates – while an undeniable component of human capital it completely disregards the level of literacy, the type of literacy, and the contribution of additional skills in numeracy, analytics, technical knowledge etc. Also, literacy levels often do not correspond to educational levels.

School enrolment rates – a measure with little theoretical credibility as it relates largely to people who are not in the labour force and therefore provide almost no contribution to current GDP, and it is a flow rather than a stock (which is what human capital is) – indeed it is not even the flow in the desired stock.

The need to use a stock variable has meant that more recent studies have tended to use average years of schooling (see for example Krueger and Lindahl (2001)). This stock measure has typically been constructed in one of three ways:

1. From enrolment data using a perpetual inventory type method commonly used for measures of non-human capital stock.

2. Using lagged enrolment data projected to average years of schooling on the basis of past relationships between enrolment rates and years of schooling.

3. By direct computation from data from censuses and surveys.

While the last of these is theoretically superior to the others, it suffers from the infrequent nature of censuses and surveys. Therefore missing values are typically imputed by either of the other two methods, or by standard interpolation and extrapolation techniques.

Most applications of these methods also suffer, to various extents, from crude allocations of schooling time to particular qualification levels, disregard of changes in parameters over time, and the use of working age people rather than people in the labour force as the field of measurement. Apart from these shortcomings there are two other significant criticisms:

---

[2] Another potential problem with Equation (2) is that it may contain an element of consumption spending. This point is raised later in the paper.

[3] If we were to assume that the sole purpose of the educational system was to enhance people's future earning ability, and if we were to assume perfect foresight on the part of education providers, funders, parents and pupils, efficiency in provision, perfectly competitive factor and product markets, and so on, then we would expect to find that measures of aggregate human capital, derived from the three main approaches would all lead to approximately the same result. A measure of human capital as the summation of public and private investment in education (Equation (2)) would correspond to a cross sectional measure defined on relevant characteristics of the current population (Equation (3)), and that would in turn correspond to the discounted present value of future earnings (Equation (1)).

In short we have reason to think that current stock estimates will be intimately related to measures of past inputs and to measures of future outcomes. Indeed only when we have good measures of all three can we expect to be able to establish the extent to which each explains the other and to determine the relative importance of other factors.

- There is no allowance for diminishing returns to education as one person with 12 years of schooling is treated the same as two people with six years. Years of schooling should be weighted differently depending on how many years of schooling have already been completed.

- There is no allowance for the quality of the education received. Given the difficulty of measuring this (as discussed above with respect to Education Resources) this omission is perhaps not surprising.

A generic function is proposed by Wossmann:

$$h = e^{\phi(s)} \qquad (7)$$

This relates the average stock of human capital per worker (h) to some function (ϕ) of the average years of schooling (s). The power of the equation comes in the nature of the function (ϕ) and in the degree of disaggregation with respect to education level and country.

The derivative of the function should equal the rate of return to education. That is $\phi'(s) = r$, which is consistent with $\phi(s) = rs$. Converting ϕ into an additive function we can write:

$$h_i = e^{\sum_k r_k s_{ki}} \qquad (8)$$

so that the average level of human capital in country i is related to the sum of years of schooling at level k, weighted by the return to that level of education. This clearly allows for diminishing returns to education. Note the link here with the education literature. Values of r need to be carefully estimated to ensure that they are not biased by omitting variables for ability, family background, etc.[4]

To allow for school quality various researchers have tried to incorporate the same sorts of fairly crude variables used in the education literature, such as teacher/pupil ratios, education spending per capita/pupil, teacher salaries and so on. Again they are not really satisfactory as they ignore the processes by which these inputs are combined to yield educational outcomes.

Wossmann considers differentiating r by i (as well as by k) to allow for differences in school quality by country, but sensibly concludes that observed differences in country specific returns to education cannot be solely or even largely attributed to differences in educational quality. In particular they are more likely to be due to immobility of labour and imperfect labour markets (collective wage setting for example).

This leaves us with direct tests of cognitive skills, which is the approach used by Hanushek and Kimko (2000).[5] A weighted average test measure may be included in the above equation as follows:

$$h_i = e^{\sum_k r_k s_{ki} C_i} \qquad (9)$$

[4] Wossmann makes the point (18) that upward bias caused by omitting ability is offset by the downward bias from measurement error in years of education. However, Norton et al (28, 34) note that these are not the only sources of bias. In particular there is bias caused by endogeneity as the decision on how long to stay at school is not independent of expected earnings.

[5] Various international tests exist and these are discussed in Section 3.

– where C_i is a weighted average cognitive test result for each country. Wossmann *also* interprets this as a proxy for the quality of education, but this may be a bit too ambitious. Cognitive tests (and the Third International Mathematics and Science Study is an example) do not usually test only the quality of education. Innate ability also affects how people score, and to a lesser extent so does social and cultural background. From the point of view of measuring human capital and using it in growth research this may not matter much – the skills of the labour force generate economic growth irrespective of whether they are acquired at birth or through learning, whether formal and informal. Of course it does have implications for growth policy.

One desirable feature of this measure of human capital is that it has no upper bound. Even if all citizens received the maximum amount of formal education, the quality of education can continue to increase. Another feature is that it is a succinct single measure that augments a straight count of unit labour inputs. As a factor of production it operates jointly with labour. Indeed it would not make sense to have a stand-alone measure as human capital is embodied in the labour force. Nevertheless, there may be occasions when it useful to distinguish between numerical and literacy skills for example.

Wossmann demonstrates that as the quality of the human capital measure is improved it explains progressively more of the variance in output per worker, with correspondingly less being captured by the 'Solow-Denison' residual. The conclusions are definitive:

> "Given that the human capital specification [in Equation (9)] is relatively weakly related to other specifications, the recognition of international differences in the quality of education seems to introduce substantial amount of new information into the measure of human capital." (26)
>
> "The evidence shows that [neglecting differences in educational quality] in the specification of human capital stocks, can give rise to misleading results on the development effect of human capital in growth research. Furthermore, the empirical merits of different theories of economic growth and development may be severely misjudged when using misspecified measures of human capital." (27)
>
> "All this shows that the development impact of human capital seems to be severely understated by previous human capital specifications and by misreported human capital data."(28)

Lest one gets too euphoric about Wossmann's results, Hendricks (2002) shows that differences in human capital do not explain cross-country income differentials. His methodology uses data on immigrant workers from a variety of source countries, working in the same labour market (the USA). The database is a 5 percent census sample of 2.2 million natives and 178,000 immigrants (who arrived at age 20 or higher) with data on annual earnings, years of schooling (six categories), five-year age groups, gender and country of birth. Country data on educational attainment comes from the OECD. The approach allows for both observed and unobserved skill differences and is careful to address the problem of potential self-selection bias.

Some of Hendricks's results are presented in the following table.

Selected Results from Hendricks

All Measures Relative to United States	Australia	Sweden	United Kingdom	New Zealand	Full Sample	Low-income Sample
Effect of capital-output ratio	111.1	106.7	95.1	109.7	90.4	83.4
COR plus measured skills	94.9	89.5	74.9	96.4	67.1	59.2
COR plus all skills	118.8	113.6	92.9	117.8	65.7	53.1
Relative national earnings	82.4	77.2	72.8	69.1	30.4	17.7

The measures quoted above successively make allowance for inter-country differences in capital output ratios, measured skills and unmeasured skills (implicitly as a residual). The typical result for immigrants to the United States (US) from high-income economies is that they earn significantly above the US mean income. For example, New Zealanders working in the US earn incomes at 117.8 percent of the US average, but New Zealand's GDP per capita is only 69.1 percent of that in the US. Therefore in this case human capital, as used by Hendricks, not only fails to explain the difference between US and New Zealand income levels, but stretches it in the opposite direction.

Immigrants from low-income countries earn less than native US citizens, but still considerably more than a straight human capital comparison would suggest. This finding is certainly plausible if one considers the reverse situation. If a highly qualified physicist migrated from the US to Guyana[6] it is highly unlikely that he would earn the same level of income. Clearly, more human capital is not sufficient on its own to raise GDP. Hendricks attributes most of the unexplained difference in per capita GDP to total factor productivity.

Although Wossmann finds that differences in human capital are a powerful explanation of income differences, his findings are not as inconsistent with Hendricks's as might initially appear. Firstly, Wossmann's uses a superior measure of human capital – which he shows to be a significant point. Secondly, recall that when Wossmann searches for a measure of educational quality, he rejects the idea of using country specific rates of return (to given levels of education). He rightly points out that other factors such as wage setting procedures could explain inter-country differences in rates of return. In fact he might have added total factor productivity as another reason. However, this begs the question to some extent. What causes differences in total factor productivity?

One plausible explanation is that a certain mass or agglomeration of critical skills (that is, human capital) is required for the benefits of individual increases in human capital to be fully realised. In other words, there are externalities to the individual accumulation of human capital.[7] One top physicist in Guyana will not earn his world marginal product, but add in some more physicists, support staff, laboratories and equipment, research facilities, property rights, etc, and both the physicist's income and GDP per capita will start to rise.

[6] Guyana is one of the poorest countries in Hendricks's sample.

[7] This is not too different from the idea that growth is strongly related to the intensity of research and development, something for which a reasonable spread of human capital amongst the population would seem to be a necessary condition. See for example Jones (2002).

Wossman's work does not really overstate the return to human capital, it just embeds the benefits of the favourable externalities into the measurement. His finding, that differences in human capital explain almost all of the differences in income per worker amongst OECD countries, is consistent with this hypothesis. Hendricks discovers that if the externalities are stripped out (which is effectively what his method does) a substantial, though variable proportion of the benefits of higher human capital disappear at the same time. The whole is clearly more than the sum of its parts.

As with the economics of education, there is still much to be done in the specification and use of human capital in growth research. Even Wossmann's best measure takes no (direct) account of on-the-job training, learning by experience, or the depreciation of knowledge and skills. A more explicit treatment of the link between human capital and total factor productivity is also required. Then there are factors such as nutrition and health care which underpin learning potential, although whether they yield human capital in their own right, as opposed to via the learning process, is also an interesting point. This is discussed further below.

Other Uses of Human Capital Measures

It was noted above that nutrition and health care underpin learning potential. However, the reverse also holds, that greater human capital improves one's ability to be healthy. See for example Grossman and Kaestner (1996). Nordhaus (2002) takes a different approach by looking at the contribution that improved health has had on living standards. The concept is fairly simple, longer life expectancy and less time off work for ill health raises national output. Nordhaus then goes a stage further by linking improvement in health status to improvements in education. That is, well-educated workers tend to be better at looking after their health than poorly educated workers.

Schultz (2002) presents a rather novel approach whereby earnings are linked to human health capital, with the latter measured by height. Height is considered to be a lagged indicator of childhood nutrition and lifetime health status. (This does not pre-empt a role for genetics). Because of the simultaneity between earnings and health status Schultz uses the technique of Instrumental Variables instead of Ordinary Least Squares regression. He demonstrates that the latter gives results, which are considerably biased – downwards.

In the education literature various authors note that while human capital theory treats the costs of acquiring education as investment (in human capital), some of the benefits of education also accrue as consumption benefits. With respect to human health capital Schultz notes that this observation is probably even more true of expenditure on health. Currently consumption benefits accrue to both children and parents from parental spending on their children's health.

The research by Schultz and Nordhaus shows that health status has an effect on human capital (and thereby on earnings) that is separate from the effect of education, although this effect is augmented by education. Given also a reinforcing effect from good health to education and it is clear that there are interactive effects operating in both directions. We have not sighted any research that disentangles these effects. Hence the effect of health on human capital (and vice versa) would appear to be a potentially fruitful avenue for future research. A further step still is to follow the paradigm of education research by analysing which health interventions actually contribute to human capital and earnings.

In the education literature earnings are used to measure the gain in human capital that is attributable to more or better education. Care is needed to ensure that measurement is not biased by confounding influences such as ability and family background. This caution recognises that differences in education between individuals are not necessarily well correlated with earnings. Conversely though, broader measures of human capital may exhibit more correlation with earnings. Here then is another possible use for human capital measures; analysing the extent to which income inequality, or more particularly wage inequality, can be explained by differences in human capital.

It is apparent from the discussion in this section that the various uses of measures of human capital do not really fall neatly into the areas of:

- ascertaining the effects of resources in education
- distinguishing the effects of health on economic growth
- determining employment suitability
- decomposing economic growth
- decomposing earnings inequality.

There are many overlaps. Measures of human capital are inputs in some areas and outputs in others. And, as noted at the start of this section, different measures suit different research questions. While a brief survey of the literature has certainly revealed that some measures are far superior to others, a diversity of measures is likely to continue to prevail – for both practical and theoretical reasons.

Moving beyond the straight economics sphere many authors note that there are numerous dimensions of personal and national development, which are likely to be enhanced by greater human capital. Such dimensions include health (for its own sake, not just as a means of obtaining higher earnings), lower crime, the appreciation of arts and culture, and of science and reason, and capacity to enjoy freedom. These areas take us beyond the ambit of this paper, but they are not unrelated. In particular can these other consequences of human capital development be identified and separated from the effects of human capital on these same variables via economic growth? We will bear this question in mind when we look at existing (and potential) statistical measures of human capital in the following section.

3. Evaluation of Existing Statistical Series

The previous section had an output focus; looking at the various uses to which measures of human capital could be applied. The two main areas of use are in ascertaining the effects of educational resources on educational outcomes and in understanding economic growth, although these areas are not totally discrete. This is because the input series used to analyse growth overlap with the output series in the education research. We might envisage this relationship as something like the following:

	Uses of Measures of Human Capital			
	Education		Growth	Well-being
Measures of Human Capital				
Investment (eg costs of schooling)	X			
	↓			
Education (eg mean schooling years)	X	→	X	
Cognitive ability (eg literacy)	X	→	X	X
	↓			
Return (eg earnings premiums to educ)	X	→	X	X
Others (eg health)	X	→	X	X

In Section 2 we took a column perspective to this table. In this section we take a row perspective.

Over the last decade or so, the OECD has been developing internationally comparable indicators of skills and competencies in the context of their contribution to social and economic well-being. The main projects are the International Adult Literacy Survey (IALS), the Cross-Curricular Competencies Project and the Human Capital Indicators Project. The DeSeCo project (Definition and Selection of Competencies, OECD, 1999) arose to provide a review and synthesis of the various skills and competencies that evolved within this framework.

The domains of measurement in the Cross-Curricular Competencies Project were politics, economics and civics, problem solving, self-perception/self-concept and communication, but without any integrated theory to guide measurement. The results for civics and self-perception were judged to meet scientific standards, with problem solving and communications needing further work.

The IALS is a major step forward in the development of measures of human capital based on cognitive capabilities. Literacy is divided into prose literacy, document literacy and quantitative literacy, and for each category there are five levels of performance (see box below). The IALS appears to be theoretically well-grounded and empirically robust.

The third leg of the Human Capital Indicators project yielded a report entitled *Human Capital Investment: An International Comparison.*[8] Amongst its objectives were the development of indicators based on existing data and identifying gaps in internationally comparable data. The report recognises that the social benefits of individual skills and talents extend beyond economic activity, but restricts human capital to "assets with the capacity to enhance or support productivity, innovation, and employability".

It strongly recommends the development of direct measures of a range of individual attributes, as indicators based on just the formal education system (whether output or input

[8] OECD (1998)

focussed) are deficient, while those based on investment and wage differentials are too indirect.

Literacy

Adult literacy is a key component in human capital, but it is usually too simplistic a measure to be very useful. In the OECD's International Adult Literacy Survey, literacy is divided into prose literacy, document literacy and quantitative literacy.

- Prose literacy – knowledge and skills needed to understand text information such as news reports and fiction.
- Document literacy – knowledge and skills needed to understand documents such as timetables, application forms, maps, tables, etc.
- Quantitative literacy – knowledge and skills needed to apply arithmetic operations such as calculating interest on a loan, balancing a cheque book, completing order forms, etc.

For each category there are five levels of performance and scores in the range 0-500. The conceptual basis of these measures of literacy is they are not synonymous with education or training. They were also designed to allow empirical testing of the relationship between literacy and earnings – a useful feature in the context of the analysis of human capital and economic growth.

Nevertheless, in keeping with its brief the report presents a wide collection of measures that are currently available, albeit that most of them are imperfect with respect to the above desiderata. They are summarised in Tables 3.1 and 3.2. The original templates for these tables comes from the 1998 report. Also included are comments on the extent to which the various measures exist for New Zealand.

Stock Measures

The "stock" measures in Table 3.1 are essentially variations on the following:

Main Types of Human Capital Stock Measures

Education	Cognitive Ability
Educational attainment	Literacy
Years of schooling	Numeracy
	Science skills

Educational measures are generally confined to formal education. Eurostat (2001) makes the point that non-formal education and informal learning also contribute to an individual's human capital. Non-formal education includes activities such as evening school and vocational training – activities which are organised but occasional. Informal learning activities tend to be less organised, less structured and not taught. Examples include reading, and self-instruction computer aided learning.[9]

[9] A suggested classification of learning activities is shown in Appendix A.

The concept of the IALS has been extended to the International Life Skills Survey so that skills other than literacy may be also be compared internationally. The domains included are numeracy, problem solving, teamwork, practical cognition and computer familiarity. A report is due in 2002. This list is based on employability considerations.

The Cross-Curricular Competencies project seems to have evolved into the Programme for International Student Assessment, which addresses the domains of reading, mathematics and science. It draws on the Third International Mathematics and Science Study (TIMSS), which is probably the most internationally consistent and wide, attracting 38 countries in its 1999 study.[10]

Investment Measures

The main types of investment or input measures listed in Table 3.2 are usefully split into either monetary or non-monetary.

Main Types of Human Capital Investment Measures

Monetary	Non-monetary
% of GDP on education/training	Participation in job-related training
$/student	Time spent on training, etc
Business expenditure on training	Duration of job-related training

Three monetary measures are usually identified:

1. Private expenditure on educational goods and services – usually obtained from household expenditure surveys such as Household Economic Survey (HES).

2. Public expenditure on education.

3. Private expenditure on human resource development.

One immediate shortcoming of these series is that whereas we refer to them as measures of investment in human capital, in the national accounts they are treated as current expenditure. This is an inconsistency between human capital theory and national accounting theory that needs to be remedied.

Furthermore, standard national accounts do not provide an integrated picture of expenditure on learning (as itemised above) and the wider economy. A useful advance in this regard would be the development of a Learning Satellite Account (analogous to the Tourism Satellite Account) to incorporate supply side production of educational goods and services to match demand from public and private spending. This would also provide relatively quick (if temporary) redress for the current/capital classification of expenditure on education and training.

[10] See http://nces.ed.gov/timss/timss-r/index.asp

Employability Measures

As discussed in Section 2, the sorts of measures described in Tables 3.1 and 3.2 are not necessarily well targeted to considerations of employability – arguably an intermediate step in the link between education and earnings. To an employer, personality development, cooperation skills, and emotional education may be as important as cognitive abilities, although all of these attributes are at least partly an outcome of learning.

Many of the tests used by human resource specialists are described as psychometric tests. These tests claim to assess both personality and ability, although the accent is generally on the former. Questions typically relate to whether someone feels a need to be noticed, whether they need clear rules, whether they pay attention to detail, whether they want to control others, etc. These are very much personal characteristics, and as such are on the periphery of the concept of human capital. They are targeted more at determining whether an individual is suited to a given job, than at establishing the general skills that employers desire. The latter usually comprise the following types of competencies:

- Analytical problem solving – principles of logic, evaluation of alternate solutions
- Decisiveness and decision-making – timeliness versus thoroughness in obtaining all relevant facts
- Commitment to task
- Team work
- Coping with deadlines.

Even here there is not a clear line between personality and ability or competency. This makes it difficult to incorporate these dimensions into measures of human capital. More human capital is presumably better than less human capital, but personality characteristics do not generally fit into this type of scale. For example does someone who makes decisions quickly have more human capital than someone who researches the issue more before coming to a decision? We may be able to establish correlations between particular personality traits and the ability to perform particular tasks, but how are we to compare the practical utility of widely different aspects of character?

Apart from conceptual problems, two other factors have impeded the use of "employability competencies" in measures of human capital:

1. A lack of common standards and tests

2. Many people have never participated in such tests (and those that have may not be a random sample of the population).

Thus it is not even possible to ascertain empirically whether the concept of human capital should include more employability competencies. Nevertheless, given that the core components of human capital such as cognitive abilities and problem solving skills are not well assessed – indeed not even well developed, we would not attach priority to the development of measures of other employability competencies (notably personality characteristics) at this stage.

Thinking back to Section 1, there is a third approach to measuring human capital – its manifestation in certain outcomes, as distinct from the stocks or outputs given in Table 3.1.

From the discussion in Section 2 on the effects of human capital on economic growth, it is clear that different types of human capital will differ across countries in their effect on growth – a point also made by David (2001, 63) in a comparison of growth in Germany and the US, and the structure of their education systems. Nevertheless, if human capital is in some way valuable to the economy, it will usually be rewarded in some manner. Although causation can run in both directions, there is increasing empirical support for a causative link from education and skills to earnings.

Outcome Measures

Therefore there are two main outcome measures of human capital:

1. Earnings premiums
2. Economic growth rates.

We have seen that the link between human capital and economic growth is not straightforward. Competencies other than those reflected in earnings premiums contribute to economic growth. Or perhaps we should say that there are characteristics of human capital which contribute to economic growth over and above their effect on earnings – a social return. In addition human capital contributes to other social outcomes, whether via economic growth or not. Some of the outcomes represent a return to the individual; others are more in the nature of societal benefits. Hence we should augment the above list:

3. Health
4. Self-worth
5. State of the environment
6. Crime rates
7. Philanthropy.

Outcomes such as philanthropy and crime rates move us into the concept of social capital.

Social capital, like human capital, is variously defined. The OECD report, *The Well-being of Nations* (2001), notes four broad approaches, stemming from practice in four different disciplines. The anthropological literature suggests that humans have natural instincts for association. Sociologists describe social norms and the sources of human motivation. Economists suggest that individuals, seeking to maximise their personal utility, will interact with others in group activities. A strand in political science literature emphasises the role of institutions, political and social norms in shaping human behaviour.

The same report asserts that:

> "Human and social capital are closely related to the way in which institutions and political and social arrangements impact on society. However, the various elements need to be carefully distinguished, since:
>
> - "Human capital resides in individuals.
> - "Social capital resides in social relations.
> - "Political, institutional and legal arrangements describe the rules and institutions in which human and social capital work." (2001, 13)

Consistently with this viewpoint the OECD writers define social capital as "*networks together with shared norms, values and understandings that facilitate co-operation within or among groups*" (41).

Other writers use the term in other ways. For example, Joel Sobel (2002), in a recent review article writes:

> "Social capital describes circumstances in which individuals can use membership in groups and networks to secure benefits. This formulation follows the definition offered by Bourdieu (1986): 'Social capital is an attribute of an individual in a social context. One can acquire social capital through purposeful actions and can transform social capital into conventional economic gains. The ability to do so, however, depends on the nature of the social obligations, connections and networks available to you."

Sobel continues:

> "This formulation treats social capital as an attribute of an individual that cannot be evaluated without knowledge of the society in which the individual operates."

As will be evident, there is a sharp contrast between these two definitions. Sobel's characterisation of social capital as an attribute of individuals, contrasts with the OECD assertion that while human capital resides in individuals, social capital resides in social relations.

From Sobel's perspective, an individual's social capital could be viewed as an element within his or her human capital. In contrast the OECD report tends to talk of human capital and social capital as closely related but non-overlapping categories.

We do not discuss social capital further in this report but the contemporary emphasis on the concept, and its close interconnection with human capital, suggest that developments in this field should be monitored.

Table 3.1
Stock Indicators of Human Capital
(adapted from OECD [1998])

	Indicator	What it shows	Usefulness and limitations	Data availability and sources	NZ availability
a	Educational attainment of the population aged 25-64.	Percentage who have gained upper-secondary and tertiary level qualification.	Internationally standardised measure of educational level reached. But does not measure any specific set of knowledge and skills.	OECD collects comprehensive data on all countries, based on *International Standard of Education* (ISCED) definitions.	Highest qualification available from census data.
b	Average "years of schooling" of the population aged 25-64.	Estimated average number of years spent in completed episodes of primary, secondary and tertiary education.	Gives single figure for stock of human capital based on attainment, but takes a year of education as a constant unit regardless of level. And same limits as (*a*) above.	Source data as for *(a)*, but relies on estimating the average number of years associated with each attainment level.	Estimation required. Years of schooling not mapped 1-1 with given attainment.
c	Educational attainment of the adult population broken down by age.	Percentage who have gained at least upper-secondary education in the 25-34 and 35-64 age bands.	Indicates generational differences due to changes over time in youth attainment rates. But does not separate out the effect of adult education.	Source data as for *(a)*.	As for *(a)*.
d	Educational attainment and qualification rates broken down by gender.	Differences between men and women: (*i*) in upper secondary attainment among adults aged 25-64 and (*ii*) in current upper secondary qualifications rate.	Compares historic gender biases with present trends in education systems.	Attainment rates: as for *(a)* Qualification rates: *Education at a glance-* OECD *Indicators* (1997), 324.	As for *(a)*.
e	Overall distribution of literacy skills in adult population.	Percentage performing at each of five levels of measured literacy in three domains.	Gives a direct measure of a set of skills with economic relevance. Results not attributed solely to education.	*International Adult Literacy Survey* results for 12 countries, published by the OECD in 1995 and 1997.	New Zealand participates in the IALS.
f	Literacy by sector of economic activity.	Percentage of workers in selected industries with high (levels 4/5) and low (1/2) literacy levels on 'document scale'.	Focus on those in employment, not total population. Shows how literacy tends to be highest in more knowledge-based industries.	*International Adult Literacy Survey* results for 12 countries, published by the OECD in 1995 and 1997.	As for *(e)*.

	Indicator	What it shows	Usefulness and limitations	Data availability and sources	NZ availability
g	Literacy by educational attainment.	Average literacy score in each country of people with respective attainment levels.	Shows how much difference education makes to literacy in each country, and also allows comparisons across countries of literacy among people with similar education attainment.	As for *(f)*.	As for *(e)*.
h	Proportion of work force in research and development.	Labour resources involved in innovation and pushing out knowledge frontiers.	While this reflects a certain level of human capital in the work force, it is also an investment indicator of the type presented in Table 3.2	Well documented in OECD countries, but definitions are not clear-cut.	Primarily census and Household Labour Force Survey, (HLFS).

Table 3.2
Investment Indicators of Human Capital
(adapted from OECD [1998])

	Indicator	What it shows	Usefulness and limitations	Data availability and sources	NZ availability
a	Share of national income devoted to education and training.	Public and private expenditure on formal programmes, as a percentage of GDP.	Estimates overall resources devoted to investment. Excludes informal learning. Imperfectly compares national effort relative to need: countries with higher youth populations need to spend more.	Comprehensive data on public programmes available but limited availability of data on private spending.	Crown accounts for public spending, and HES for household spending. Business data is poor.
b	Average spending per student, by educational level, relative to income per capita.	Average annual expenditure on a student at primary, secondary and tertiary education, as a percentage of GDP per capita.	Shows how much effort is devoted to each student, relative to each country's means. Takes no account of variations in investment due to participation rates outside compulsory schooling.	As for *(a*).	As for *(a*).
c	Spending on public labour market problems.	Expenditure as a percentage of GDP, classified by type of participant.	Shows direct expenditure by governments to improve workplace skills. Excludes some employment service spending relevant to human capital that is not strictly on training.	Data incomplete. See annex to the *Employment Outlook* OECD, (1997*a*).	Not well defined, but may be possible to compile some data of probably limited comparability with other countries.
d	Spending by enterprises on training.	Expenditures as percentages of total labour costs.	Gives a rough indication of the scale of spending by firms. But much private human resource investment is hidden.	Data from various surveys (including EU Labour Cost Survey) is incomplete, and not strictly comparable.	Ad hoc data only.
e	Family computer ownership.	Percentage of households with personal computers.	Gives one indicator of a family-based resource that aids human capital investment.	Data for twelve countries provided in *Information Technology Outlook,* OECD (2000).	New Zealand data is listed in OECD report. The 2002 Census has data on internet access.

	Indicator	What it shows	Usefulness and limitations	Data availability and sources	NZ availability
f	Employee participation in job-related training.	Percentage who report having undertaken training in specified periods.	Gives a rough idea of the proportion involved in some kind of training, but does not distinguish length or quality. Data from different sources are not always comparable.	Several household, enterprise and administrative sources are available including the *International Adult Literacy Survey* and the *European Labour Force Survey*.	Education and Training Survey – occasional publication, last one in 1996 as supplement to HLFS. Also in the IALS.
g	Participation by different groups in job-related and other education and training.	Breakdowns by economic status, age, gender, educational attainment.	Detailed comparisons for a limited number of countries.	IALS. Most breakdowns available for about 10 of the twelve countries. But for some categories (*eg* unemployed people), sample sizes limit validity of results.	Limited to *(f)*.
h	Average duration of job-related training.	Annual hours of training undertaken- *(i)* per person with any training *(ii)* average for all employees.	Qualifies indicator *(f)* by showing quantity of investment rather than just the percentage of employees making some investment.	Hours of training available from IALS. *European Labour Force Survey* classifies participation by length of course.	Limited to *(f)*.
i	Time spent in learning.	Time spent in training of various sorts (eg field,[11] type, and delivery mechanism).	Also useful would be contextual information on who pays, reason for participating, satisfaction with the learning event, working arrangements, childcare facilities and general obstacles to learning. – noted by Eurostat (2001, 23).	Data tend to be sporadic and not consistent across countries or time. Source is mostly time-use surveys.	New Zealand undertakes time-use surveys occasionally.
j	School enrolment rates.	Analogous to participation in training.	Some researchers assume that enrolment in school is proportional to rate of human capital accumulation. As discussed in	Data is widely available.	Ministry of Education has this information.

[11] Eurostat (2001) recommends that field of education follows the International Standard Classification of Education. (New Zealand and Australia use a different system, but a concordance is available). A similar idea is proposed for classifying training. For more information: http://europa.eu.int/comm/education/leonardo/leonardoold/stat/trainingstatis/areas/area6.html

			Section 2, this is problematic.		

4. The Role of Statistics New Zealand in Human Capital Measurement

Introduction

As we have seen human capital is an individual characteristic. The value of such capital is a function both of past activities and of future expected returns, but in its essence human capital resides in individuals at a point in time. This suggests that the primary focus in official measurement should be on the relevant characteristics of individuals, and thereby of wider groups, including the population at large, at particular times.

That said, most of the interest in human capital stems from the desire to understand its role in economic and social life. What contributes to the formation of human capital and what is the role of human capital in promoting human well-being? Questions such as these suggest that an official programme of human capital measurement should be sufficiently comprehensive to support the needs of researchers investigating such wider issues.

Before discussing these issues in more detail, two other introductory issues arise. The first is that of audience. Any official programme of statistical measurement begs two questions. Are there potential groups of users who will find the information useful and will those uses yield benefits sufficient to justify the cost of collection? The answer to the second question will have to be determined along the way in accordance with the usual routines for determining statistical priorities (more on this later), but on the first question we note that research on the application of human capital theory in New Zealand is relatively sparse.

It is probable that improved data availability along with increased international and local interest in the roles of human capital in promoting growth in individual and national well-being will lead to increased research in this area. Five main constituencies stand out:

1. Policy advisers, such as those in the Treasury, Ministry of Education and Department of Labour

2. Social science researchers, particularly those in economics and education

3. International agencies, interested in economic development and educational policy, such as the OECD, the World Bank and UNESCO

4. The interested public, including non-governmental organisations, advocacy groups and politicians

5. Statistics New Zealand, as a potential user of human capital data, in developing statistical measures in other areas such as the national accounts, technology and knowledge.

Finally, by way of introduction, we note again that practical measurement in the area of human capital theory is still a developing art. This contrasts with the situation with respect to the national accounts where there is a half-century-long sequence of United Nations Statistical Office manuals setting out good practice in the area. With respect to human capital measurement we are in an earlier exploratory phase. There has been a flood of academic research for several decades and in the last decade a burgeoning official interest, reflected particularly, in a series of OECD publications.

As discussed in Section 3, one of these, *Human Capital Investment, An International Comparison* (OECD, 1998), provides a comprehensive and well-organised survey of the currently available information and constitutes something akin to a template. The following sections develop our own suggested framework.

Measures of Human Capital

Following our earlier quotation from OECD (2001), human capital is defined as:

> "The knowledge, skills competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being".

The definition carries several implications:

First, because human capital is embodied in individuals, the bedrock unit of account is the individual. There is therefore a primary focus on censuses and sample surveys where the basic unit is an individual. Depending on situation, individuals may be surveyed as part of a wider grouping such as a family, a class, or a group of employees. The appropriate universe for a survey will depend on the situation.

Secondly, the focus of the measure is on a range of characteristics (*knowledge, skills competencies and attributes*) that facilitate particular outcomes (*the creation of personal, social and economic well-being*). The noted characteristics are goal directed and therefore are only relevant to the extent that they are instrumental in facilitating the stated outcomes.

Thirdly, the outcomes are broadly drawn. The focus is on individual attributes that facilitate the creation of personal, social and economic well-being. The reference frames for determining what might contribute to personal, social and economic well-being are of course quite different.

Individuals are the ultimate judge of their own well-being, and are able to define their own life objectives. These may be consonant with maximisation of the discounted stream of lifetime earnings, and then again they may not. They may, alternatively, be defined in terms of altruistic, artistic, religious, or other goals.

Social and economic well-being carry connotations of collective, and collectively judged goals. These may, for example, be quantified in terms of particular outcomes, such as community health status, income per head and income distribution.

The above argument implies that the primary focus for official statistics on the measurement of human capital should be on individual characteristics that are instrumental in facilitating personal, social and economic well-being, without necessarily prejudging how these objectives might be defined. The OECD (1998) report cited three approaches then being developed which exemplify such a focus. These were:

- Student achievement in particular areas of knowledge and competence at different stages of school education
- Competencies of school-age children that cross the boundaries defined by subject curricula
- Adult skills and competencies relevant to everyday life and work.

The last of these three is the most directly relevant to an assessment of the human capital embodied in the adult population. As seen in the previous chapter, however, the measurement of competencies is but one of three methods of measuring human capital, specifically:

1. measures of activities contributing to the investment or formation of human capital; for example schooling, tertiary study, on-job training

2. output or stock type measures of human capital; for example individual and group competencies, skills and characteristics

3. measures relating to the contribution of human capital to individual and social outcomes; for example future earnings and economic growth.

Measures of activities contributing to the formation of human capital

The range of factors contributing to the formation of human capital is of course legion, as is obvious to anyone who has watched a child grow. In policy terms the main interest is in those activities where the state contributes to or plays a leading role, as in school funding and setting of curricula, or in the development of tertiary education. Measurement issues in these are discussed elsewhere in this report within the context of school effectiveness. However, broad aggregates such as state spending on primary, secondary and tertiary education, and work force training are an essential component of input based measures of human capital. Complementary to this is the whole gamut of private sector expenditure in these areas, ranging from educational expenditure incurred by parents, to the direct cost and the opportunity cost of post-school education and training incurred by employees and employers. The regulatory and legislative environment often influences private decision-making in these areas.

Measures of the direct outputs of investment in human capital

Here we offer a couple of observations relevant to the approach of *Statistics New Zealand* to measuring the contribution of educational and other agencies to the development of human capital. As noted in the introduction to this report the economists' emphasis on the role of education on human capital formation has often sat uncomfortably with the views of educationalists on the roles of public schooling.

This unease suggests that Statistics New Zealand should strive to ensure that its output measurements in this area meet the requirements implicit in the objective set of educationalists as well as the requirements of those interested primarily in the economic benefits of education. This should not be difficult inasmuch as the two sets of objectives are likely to have substantial overlap – for example literacy and numeracy. Looked at broadly, schools serve two intricately linked functions. The nurturing of children inevitably combines elements of consumption and of investment. Children need to be cared for from day to day at the same time as they learn. Again their learning, which entails an ongoing transformation and development of their personalities, encompasses the whole range of attributes and skills which the community would like to see grow in them.

Market related attributes and skills – in the sense of those which earn a monetary return – are a subset within this wider range. In practice many investigations within human capital theory have tended to focus on this subset, and this restricting tendency is arguably a prime cause of the disquiet among educationalists.

However that may be, the lesson to be drawn at this point, is that official measurement should aim to be comprehensive, covering (or more probably sampling) the full range of individual

attributes that schooling aims and hopes to promote. Researchers interested primarily in market related attributes could then focus on those. Others can look at the wider picture.

Measures relating to the contribution of human capital to individual and social outcomes

We have referred elsewhere to the extensive international research into links between human capital, future incomes and economic growth. This research interest can be expected to continue, and raises the question, not only of the approach to measuring human capital itself, but also of the adequacy of downstream statistical measures relating to individual and national income. There is therefore a need for Statistics New Zealand to review its programmes of development in these areas in light of the probable increase in research interest in the links between human capital formation and income generation.

Additionally the programme of national accounts development carries its own imperatives in these areas. Interest in productivity measurement is creating a demand for better measures of labour inputs as is evident in attempts to build quality adjusted indices of labour supply (as recommended in Rose (1992) over a decade ago). A good example this of may be found in BLS (2001) which finds that quality adjusted labour inputs rose by 0.4 percent pa more than a simple count of hours.

Again, the OECD report *Human Capital Investment* (1998) notes several national accounting areas in which human capital theory needs to be taken into account. These include the boundary between consumption spending and investment spending (discussed earlier) and questions related to the distribution of human capital. The latter of these is arguably a subset of the underdeveloped, but important area of the relationships between income distribution and growth. It is clear that one of the major zones of political tensions within high income economies stems from concern that the benefits of growth are not equitably shared. The statistician cannot resolve these tensions, but an accounting framework that properly contextualised them would play an important part. Again this brings us back to the idea of a Learning Satellite Account.

Data Sources

Before moving from these broad strategies for the development of human capital measures in New Zealand to more specific recommendations, we should survey the major data sources.

Current Sources

From the summary tables in the previous section, it is straightforward to see that the number of New Zealand data sources that are relevant to the measurement of human capital are relatively few:

1. Census data (educational qualifications [level and subject], occupation, income, training, years of education).

2. Regular surveys, notably the Household Economic Survey and the Household Labour Force Survey.

3. Occasional surveys such as the 1996 Education and Training Survey, the 1999 Time Use Survey, and self-assessment health surveys.

4. Ministry of Education – expenditure, enrolment and attainment data.

5. New Zealand's contributions to international studies such as the IALS and TIMSS.

In addition to the above there are three other fairly comprehensive sources of data, but each relates to only a subset of the population. These are:

- University Graduate Destinations – undertaken by the Vice Chancellors' Committee
- Human Resource Capability – a survey of human resources in Public Service departments published by the State Services Commission.
- Migration data – data on the occupations of migrants

Further details on these data sources are given in Appendix B.

Future Data Sources

Apart, of course, from repeating some of the past occasional surveys or making them more regular, there are some immediate prospects:

1. Household Savings Survey: this survey is directed at measuring net worth and its distribution. In the first instance, its objective is to measure net worth as at the date of the survey; essentially a measurement of all assets if they were liquidated. More pertinent to this exercise, however, the survey also contains a number of personal and household questions to enable researchers to estimate a measure of future net worth via projections of future earnings.[12] The survey is a one-off event at this stage.

2. Longitudinal Survey of Families, Income and Employment: this is intended to provide information on changes in the economic well-being of individuals and households. Because it will record on-going changes in earnings and on-going participation in education and training (as distinct from a static census type measure such as 'highest qualification'), it provides the opportunity for more detailed investigation of the link between earnings and education. Note, however, that there are no questions that test for cognitive abilities. The survey has sufficient funding to be run for eight years.

3. Tertiary Loan Scheme data: the scheme has been in operation for a decade, so the first wave of borrowers has already had a few years of experience in the labour market. Over time this data should enable detailed analysis of the returns to tertiary education, although there are some potential issues of bias in the data which would need to be addressed.

4. Follow-on phases to the IALS and TIMSS: the former has been succeeded by the Adult Literacy and Life Skills Survey (ALL). It will directly measure document and prose literacy (as in the IALS), numeracy (to replace and improve on the IALS measure of quantitative literacy) and analytical reasoning. Teamwork and literacy in the field of information and communication technology will be indirectly measured. Unfortunately, New Zealand is not participating at this stage.

   Building on the TIMSS is the Programme for International Student Assessment (PISA). This assesses literacy skills in reading, mathematics and science of children at age 15. It also provides complementary data on socio-economic background, family background

[12] The variables are age, sex, ethnicity, highest qualification, years in paid labour force, current labour market income, current occupation, hours worked per week, years in New Zealand, family size and composition.

and various other dimensions that are potentially useful in explaining variation in PISA scores. New Zealand participates in this study. (In fact, New Zealand compares very favourably in most areas – see OECD (2001)).

In a general sense it would, presumably, also be possible to augment existing surveys such as the Household Labour Force Survey to include other questions related to human capital (qualifications, training, etc). [13]

Another possibility, which is already being pursued in other areas, is to make more use of statistical matching or at least complementarities between survey (and census) data and administrative data.[14]

Recommendations

The foregoing discussion clearly points to the need for Statistics New Zealand to develop or lead the development of a wide range of measures of human capital; encompassing input/investment measures, output/stock measures and outcome measures. At this stage there is no definitive measure of human capital. Different research topics will require different measures of human capital that may well involve combining numerous individual series, for example via principle components analysis. However, skills such as problem solving and capacity for team work, while thought to be important contributors to human capital, are not systematically documented – in terms of how they are measured, how they are acquired, and how they affect outcomes such as earnings. It is not the role of a central statistical agency to push the frontier in this regard.

Our recommended priorities for Statistics New Zealand are as follows:

1. In order to better understand and assign priorities for development, compile a matrix which cross-classifies series that are potentially useful in measuring human capital against the above data sources. This should include measures that are collected by other agencies, notably data on schooling outcomes.[15]

   Something like the table on the following page is envisaged, but with more rows and columns, and more detail.

2. For all on-going data collection instruments such as the population census and HLFS survey, consider how their coverage could be improved so that the data collected relates more clearly to the measurement of human capital, and ensure that it is collected in ways which conform as much as possible to human capital theory and practice in other OECD countries.

[13] This was also recommended in Rose (1992). See Dwyer (2000) for a discussion on measuring job related training.

[14] Sweden leads the way in this regard as all citizens have a unique identification number which is used for all dealings with government. See for example Statistics Sweden (2000).

[15] Mirroring research which seeks to establish the relationship between schooling and earnings or growth, is determining what makes a good school. As discussed in Section 2, standard school input measures such as pupil/teacher ratios, per pupil spending and teacher salaries, have a mixed effect on educational quality. Therefore improved measures of school inputs are required, although such data is probably beyond the ambit of Statistics New Zealand's responsibilities in the area of human capital measurement.

Human Capital Measures	Ministry of Education	Census	Time Use Survey	Longitudinal Survey	TIMSS
Formation Measures					
Public education spending	allocation by year of schooling				
Participation in job training			detailed, but one-off	eventually a 10 year record	
Stock Measures					
Cognitive ability in mathematics	national exam marks				for certain ages
Educational attainment	detailed data for those educated in NZ	highest qualification	few categories	standard classification	
Return Measures					
Earnings		total income in bands	total income in bands	earnings over certain spells	

3. Follow the Bureau of Labour Statistics (BLS) approach to calculate a quality adjusted employment series. With the major role that human capital measurement has in growth analysis, a quality adjusted labour series should be a priority.[16] From the BLS paper and an unpublished paper by the Australian Bureau of Statistics using a very similar methodology, we believe that sufficient data exists for a quality adjusted labour series to be calculated for New Zealand. (Indeed, it is our opinion that further enhancements are possible).

4. Develop a Learning Satellite Account (LSA) (analogous to the Tourism Satellite Account) to incorporate the supply side production of educational goods and services to match demand from public and private spending.

5. The LSA should eventually be extended to treat some of the expenditure on education and training as capital expenditure rather than as current expenditure. However, to do this properly requires estimates of depreciation rates for different types of learning. This is not a trivial exercise.

6. The LSA would also benefit from data (perhaps a periodic survey) on education and training expenditure by businesses, to complement government and household data. In this connection, if the 1996 Education and Training Survey is repeated and extended to include costs, it should align as much as practicable with OECD data and protocols.

As previously mentioned on several occasions, the OECD report Human Capital Investment, An International Comparison (1998), comprehensively surveys available information on human capital within the OECD. Almost all their country tables contain entries for New Zealand. Supporting data are provided in an annex to that report, and it would be straightforward to prepare a brief publication reporting the New Zealand data along with that for a reference group of other countries, such as Australia, the United Kingdom, the United States, France, Germany and Sweden. Wossmann (2001) also provides a range of human

[16] Mulligan and Sala-I-Martin (2001) may also be useful in this regard as they use index number methods, also used in the BLS report.

capital measures for a vast group of countries. We reproduce this information for a small subset of countries in Appendix C.

Preparation of a publication along these lines offers a very economical way of contributing to discussion of the role of human capital in relation to economic and social development in New Zealand. We suggest that Statistics New Zealand should consider this possibility. It would also help Statistics New Zealand to gain an understanding of users' priorities.

Human Capital Measures within Statistics New Zealand's Other Priorities

Statistics New Zealand has an Advisory Committee on Economic Statistics that, amongst other roles:

"Advises the Government Statistician on improving the scope, coherence and integration of social and economic statistics to enhance the value of official statistics as a whole." (ACES Terms of Reference).

This role involves providing advice on priorities for the development of economic statistics.

Discussion on such priorities has occurred, with SNZ presenting the committee with a draft paper on proposed future directions in economic statistics. The objectives of this paper were:

1. To outline developments needed to develop a full range of economic statistics
2. To estimate the cost of their development and ongoing production
3. Prioritise them.

Priorities were grouped into four categories:

1. Required to meet commitments to the Crown or to third parties who fund particular projects
2. Essential to maintain the quality of the core statistical framework
3. Essential to address widely recognised shortcomings
4. Desirable to maintain or improve quality and scope.

In this section we ascertain how the recommendations raised in our review could fit into this proposed programme.

Currently the only explicit reference to human capital measures in the proposed programme is under the Priority 3 list, where the "development of human capital statistics" was programmed for work in 2001/02 only. The funding came from the competitively accessed Cross Departmental Research Pool (CDRP) administered by the Ministry of Research, Science and Technology. Our understanding is that there was scope within this budget for an investigation into the feasibility of recommendation (3) on deriving a quality adjusted labour input.

Measures of human capital are indirectly relevant to another proposed Priority 3 activity "Multi-factor Productivity Measures" which was tentatively programmed over the next six years with a target completion date in 2004. They are also relevant to a proposed Priority 2 activity "Improve Labour Market Statistics" which was programmed up to 2004/05.

In the proposed Priority 4 group the development of an employer-employee database is intended to include data on the transfer of human capital (however defined) between firms.

As well as the 4 level priority system, Statistics New Zealand also proposed to classify economic statistics into "core" and "non-core," based on Eurostat and IMF standards. All Priority 2 and most Priority 3 statistics (including the two mentioned above) are proposed to come within the core definition.

No funding has been allocated to these priorities and it is recognised that Statistics New Zealand may not have sufficient funding in the future to even produce all of the proposed core statistics. Thus the implementation of recommendation (3) within the CDRP funding would be an excellent result as it would contribute to three of the areas mentioned above; human capital statistics, productivity measures and improved labour market statistics.

Recommendation (1) provides a stock take of what is available and where. It needs to have a high priority in any development of human capital statistics. It is not a costly exercise so it should be undertaken as part of Priority 2 activity – Improving Labour Market Statistics. This will lead naturally to recommendation (2), the second part of which, on international compatibility, the Department should be doing anyway as part of the ongoing refinement of its surveys. If this is not possible within the budget (including the CDRP funding) we would recommend that ACES reconsider the priorities and look in particular at the detailed developments within the various areas identified above.[17]

With the exception of the Tourism Satellite Account, which is funded by third parties, other planned satellite accounts are proposed as Priority 4 activities. This includes a satellite account for the non-profit sector, which is not unrelated to human capital as it is likely to include valuation of unpaid labour services. We accept that a Learning Satellite Account probably cannot be accommodated within the proposed Priority 2 group. However, given the policy emphasis of the Government on the 'knowledge economy' and its objective of regaining our international ranking in GDP per capita, we contend that an LSA should merit at least a Priority 3 grading within the proposed programme. It is an important component in establishing a framework for the collection, classification, and comparison of human capital measures.

It will not have gone unnoticed that we have not made explicit recommendations about particular statistical series to contribute to the measurement of human capital. Partly this is because we consider it too early to be specific in this regard, although the implementation of recommendation (1) in the context of the findings in this report should provide some clear guidelines.

As noted in Section 1, we do not see the absence of an all-encompassing widely accepted definition of human capital as an obstacle. Many different measures exist and are likely to continue to do so. The manner in which these individual variables (or proxies) should be combined to provide an overall human capital index is unlikely to be settled or agreed by the profession in the short term. Nevertheless, improving the range, credibility and availability of proxy indicators will assist and encourage researchers and advisers in defining and refining measures of human capital and its impacts.

The other reason for not being specific is that it is not obvious to us that human capital measurement is exclusively the domain of a central statistical agency. Given Statistics New Zealand's place within the public service there is certainly a strong argument for it providing the framework and coordinating, probably leading, the development of human capital series. However, other departments, notably the Ministry of Education are in a good position to collect data on output/stock measures such as literacy levels, and input measures such as

[17] Adolf Stroombergen, a member of ACES, would be prepared to propose this as an agenda item and speak to it.

school expenditure. Departments such as the Treasury and Labour are also potentially major contributors.

Finally we urge Statistics New Zealand to stimulate interest in human capital theory and measurement, by producing a discussion document which summaries the main findings from Wossmann, and the OECD report Human Capital Investment: An International Comparison, (1998) from a New Zealand perspective.

References

Aghion P, Howitt P (1998). *Endogenous Growth Theory*, MIT Press, Boston.

Alcorn N (1999). *To The Fullest Extent of His Powers: C.E. Beeby's Life in Education*, Victoria University Press, Wellington, 99.

Altonji J, Dunn T (1995). "The effects of school and family characteristics on the return to education," *NBER Working Papers*, Massachusetts, 5072: March.

Ambler J (1994). "Who benefits from educational choice? Some evidence from Europe", *Journal of Policy Analysis and Management*, 13:3, 454–476.

Angrist J, Kreuger A (1991). "Does compulsory school attendance affect schooling and earnings?", *Quarterly Journal of Economics*, 106: November, 979–1014.

Ashenfelter O, Kreuger A (1994). "Estimates of the economic return to schooling from a new sample of twins", *American Economic Review,* Princeton, 84, 253–284.

Barro R (1991). "Economic growth in a cross section of countries", *Quarterly Journal of Economics*, 106:2, 407–443.

Barro R, Jong-Wha L (2001). "International data on educational attainment: Updates and implications", *Oxford Economic Papers,* 53:3, 541–564.

Becker G (1964). *Human Capital*, 2nd edition, Columbia University Press, New York, 1975.

Benhabib J, Spiegel M (1994). "The role of human capital in economic development: Evidence from aggregate cross-country and regional US data", *Journal of Monetary Economics,* 34:2, 143–173.

Blackburn M and Neumark D (1993). "Are OLS estimates of the return to schooling biased downward? Another look", *NBER Working Papers*, Massachusetts, 4259: January.

Bureau of Labour Statistics (1993). *Labour composition and productivity growth 1948-1990*, US Department of Labour*, Bureau of Labour Statistic Bulletin,* 2426: December, US Government Printing Office, Washington DC.

Boozer M, Rouse C (1995). "Intraschool variation in class size: Patterns and implications", *NBER Working Papers*, Massachusetts, 5144: June.

Bound J, Jaeger D (1996). "On the validity of season of birth as an instrument in wage equations: A comment on Angrist and Kreuger's 'Does compulsory school attendance affect schooling and earnings?'", *NBER Working Papers*, Massachusetts, 5835: November.

Bound J, Solon G (1998). "Double trouble: on the value of twins-based estimation of the return to schooling", *NBER Working Papers*, Massachusetts, 6721: September.

Bourdieu P (1986). "Forms of capital", *Handbook of Theory and Research for the Sociology of Education*. ed Richardson J, Westport, CT, Greenwood Press, 241–260.

Bowles S, Gintis H and Osborne M (2001). "The determinants of earnings: A behavioural approach", *Journal of Economic Literature*, Stanford, December.

Card D (1993). "Using geographic variation in college proximity to estimate the return to schooling", *NBER Working Papers*, Massachusetts, 4483: October.

Card D, Krueger A (1992a). "Does school quality matter? Returns to education and the characteristics of public schools in the United States", *Journal of Political Economy,* 100: February, 1–40.

Card D, Krueger A (1992b). "School quality and black-white relative earnings: A direct assessment", *Quarterly Journal of Economics,* 107, February, 151–200.

Card D, Krueger A (1996). "Labor market effects of school quality: Theory and evidence", *NBER Working Papers*, Massachusetts, 5450: February (also in Burtless [1996]).

Catterall J (1997). "Economic analysis of education policy: Reflections on economic analysis and education policy", *Educational Evaluation and Policy Analysis,* Chicago, Winter, 19:4.

Chiswick B (1998). "Interpreting the coefficient of schooling in the human capital earnings function", *Journal of Educational Planning and Administration,* 12:2, 123–130.

Coleman J (1990). *Foundations of Social Theory*, Belknap, 34.

David P, Lopez J (2001). "Knowledge, capabilities and human capital formation in economic growth", *NZ Treasury Working Paper*, Wellington, 01/13.

de la Fuente A, Domenech R (2001). "Human capital growth regressions: How much difference does data quality make?", *CEPR Working Papers*, 2466: May.

Denison E F (1967). *Why Growth Rates Differ: Postwar Experience in Nine Western Countries*, Brookings Institute, Washington DC.

Dwyer, M (2000). *Options for Improving Information of Job-Related Education and Training*, report prepared for the New Zealand Department of Labour, Wellington, August.

Eurostat (2001). *Report of the Eurostat Task Force on Measuring Lifelong Learning*, February 2001, Statistical Office of the European Commission.

Fleischer B, Kniesner T (1984). *Labour Economics: Theory, Evidence, and Policy*, Prentice Hall, New Jersey.

Griliches Z (1977). "Estimating the returns to schooling: Some econometric problems", *Econometrica*, 45:1, January, 1–22.

Gundlach E (1995). "The role of human capital in economic growth: New results and alternative interpretations", *Weltwirtschaftliches Archiv,* Grossman and Kaestner, 131:2, 383–402.

Hall R, Jones C (1999). "Why do some countries produce so much more output per worker than others?", *Quarterly Journal of Economics*, 114:1, 83–116.

Hanushek E (1998). "Conclusions and controversies about the effectiveness of school resources", *Economic Policy Review,* Federal Reserve Bank of New York, 4:1, 11-27.

Hanushek E and Kimko D (2000). "Schooling, labor-force quality, and the growth of nations", *American Economic Review*, Princeton, 90:5, 1184–1208.

Hanushek E, Rivkin S and Taylor L (1996).“Aggregation and the estimated effects of school resources”, *NBER Working Papers*, Massachusetts, 5548, April.

Heckman J, Laye-Farrar A and Todd P (1995). “The schooling quality-earnings relationship: using economic theory to interpret functional forms consistent with the evidence”, *NBER Working Papers*, Massachusetts, 5288, October.

Hendricks K (2002). “How important is human capital for development? Evidence from immigrant earnings”, *The American Economic Review,* Princeton, March 2002, 198–219.

Infometrics (1997). *Capability of the Post-Compulsory Education and Training System to Meet Industry Needs*, study prepared for the Ministry of Education, Wellington.

Killingsworth M (1983). *Labour Supply*, Cambridge University Press, Cambridge.

Krueger A (1997). “Experimental estimates of education production functions”, *NBER Working Papers*, Massachusetts, 6051, June.

Kruegar A, Lindahl M (2001). “Education for growth: Why and for whom”, *Journal of Economic Literature*, Stanford*,* 39:4, 1101–1136.

Jones C (2002). “Sources of US economic growth in a world of ideas”, *The American Economic Review,* Princeton, March 2002, 220–239.

Loeb S, Bound J (1995). “The effect of measured school inputs on academic achievement: Evidence from the 1920s, 1930s and 1940s birth cohorts”, *NBER Working Papers*, Massachusetts, 5331, November.

Lucas R (1988). “On the mechanics of economic development”, *Journal of Monetary Economics*, 22:1.

Maani S (1997). *Investing in Minds: The Economics of Higher Education in New Zealand*, Institute of Policy Studies, Wellington.

Mankiw N, Romer D and Weil D (1992). “A contribution to the empirics of growth”, *Quarterly Journal of Economics*, 107:2, 408–437.

Marshall A (1890). *Principles of Economics*, Macmillan, London.

Mincer J (1974). *Schooling, Experience and Earnings: An Introductory Volume*, Eighth edition, Macmillan, London.

Mulligan C, Sala-I-Martin X (2001). “Measuring aggregate human capital”, *Journal of Economic Growth*, 5:3, 215–252.

Nehru V, Swanmson E and Dubey A (1995). “A new database on human capital stock in developing and industrial countries: Sources, methodology and results, *Journal of Development Economics*, Amsterdam, 46:2, 379–401.

Nordhaus W (2002). “The health of nations: Contributions of improved health to living standards”, *Cowles Foundation Discussion Papers*, Yale University, 1355, NBER, February.

Norton P, Sanderson K, Booth T and Stroombergen A. “The effect of school resourcing on educational outcomes”, Report to the Ministry of Education, Wellington.

OECD (1998). *Human Capital Investment: An International Comparison*, Centre for Educational Research and Innovation, OECD, Paris.

OECD (2001). *Knowledge and Skills for Life: First Results from PISA (Executive Summary)*, 2001, OECD, Paris.

OECD (2001). *The Well-being of Nations: The Role of Human and Social Capital*, 2001, OECD, Paris.

OECD, Swiss Federal Statistical Office (1999). *Definition and Selection of Competencies, Projects on Competencies in the OECD Context: Analysis of Theoretical and Conceptual Foundations*, Neuchatel, Switzerland.

Psacharopoulos G (1994). "Returns to investment in education: A global update", *World Development*, 22:9, 1325–1343.

Romer P (1990). "Endogenous technological change", *Journal of Political Economy*, 89:5.

Rose D (1992). "A review of labour market statistics", report prepared for the New Zealand Department of Statistics, Wellington.

Schultz T (1961). "Investment in human capital", The American Economic Review, Princeton, Vol. LI, March 1961: Number One.

Schultz T (2002). "Wage gains associated with height as a form of health human capital", Yale University, Economic Growth Center Discussion Paper 841: February 2002.

Sobel J (2002). "Can we trust social capital?", *Journal of Economic Literature*, Stanford, March.

Statistics Sweden (2000). "Transition from education to the labour market", Örebro, April 2000.

Thurow L (1970). *Investment in Human Capital*, Wadsworth Publishing Company, California.

UNESCO (2000). *World Education Indicator,* http://unescostat.unesco.org/en/stats/stats0.htm [2002]

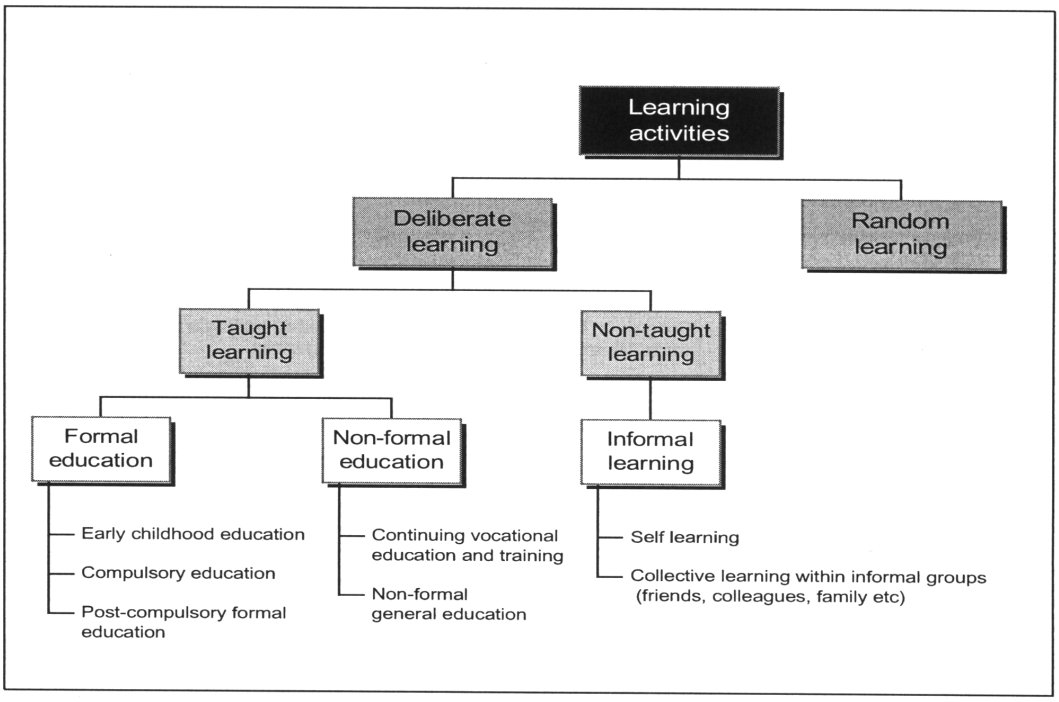
Wossmann L (2001). "Specifying human capital: A review and some extensions", Kiel Institute of World Economics, [August 2001].

Appendix A

The Classification of Learning Activities

used for the German Time Use Survey 2001/2002

Federal Statistical Office of Germany, January 2001



Appendix B: Supplementary Data Sources

University Graduate Destinations (2001)

This survey is undertaken by the New Zealand Vice Chancellors' Committee (NZVCC). It is the fifth of an annual series (1997 to 2001) covering all university graduates over the prior calendar year in question (that is, the 2001 survey relates to those recorded as completing their degrees during the 2000 calendar year, and so on). Earlier surveys (from 1973 to 1996) are available, they were undertaken under a different methodology and hence are not strictly comparable.

The survey captures details of graduates' status six months following completion of their degree according to:

- study status - full-time, part-time, or no longer in study
- employment status - full-time, part-time, not in employment, employer, type of activity, weekly hours worked, income/salary.

Age, gender, ethnicity as well as qualification characteristics of graduates are also captured and so relevant cross-tabulations may be undertaken, bearing in mind of course relevant sampling error.

The response rate to the 2001 survey was 33.6 percent – providing a sample size of 8,609 out of a total population of 25,267. The 2001 report notes that this response rate is significantly down on the 40.8 percent recorded for the previous survey. It is also noted that the survey is under review by a panel appointed by the NZVCC, with the view to considering greater use of electronic gathering and dissemination of source data. Pending the outcome of this review a survey for 2002 (ie covering those graduating during the 2001 calendar year) is not being conducted.

The survey collects useful detail on graduates and their entry into the labour force and so potentially contributes both output type measures of human capital (levels of tertiary education) and outcome type measures (earnings).

A BERL 1999 report to the Department of Labour, *Human Capital*, provides a broad indicative estimate that tertiary graduates potentially add 1-1.5 percent to the stock of human capital. The NZVCC survey potentially captures data covering half of these graduates, as graduates from non-university tertiary institutions are not covered.

A clear advantage of such a series is its provision of a time series of such information – potentially allowing (with provisos) the 'accumulation' of flows into an overall stock. On this basis the possibility of such a survey being suspended is of concern, from the point of view of wishing to maintain or improve contributions to the measurement of human capital.

Human Resource Capability

The annual survey of human resources in Public Service departments published by the State Services Commission provides occupation, salary, gender, ethnicity, and age data on those

employed in Public Service departments. In addition, data on length of service and turnover also appears to be available.[18]

As at June 2001 this data provides details of those occupying over 30,000 FTE positions.

The value of this dataset would clearly be limited to those using or wishing to investigate human capital characteristics within a specific subset of the labour market. Nevertheless, the data is also potentially useful in a broader context where such a subset is likely to account for a large proportion of total activity in a particular sphere (for example policy advisers).

Migration Data

Data on the occupations of migrants provide another useful source of information on flows into and out of the stock of human capital.

The 1999 BERL report *Human Capital* provides indicative estimates of the impact of annual migration flows on the stock of human capital using such data. It suggests that such flows are likely to be largely offset over the business cycle. The impacts within certain occupation categories, however, (in particular, professionals and technical and associate professionals) could potentially provide significant additions to the stock of human capital at times of overall strong migration inflows.

[18] There is no data on qualifications, but demographic data including qualifications are collected from the Career Progression Survey of public service departments. The sample size is 6500, but it is not undertaken regularly, the last one being in 2000.

Appendix C: Alternative Measures of Human Capital

The following table reports Wossmann's (*2001*) estimates of human capital on eight different bases for a small group of countries, including New Zealand.

Definitions for the series are reported below. Variables *e* are expressed as enrolment rates; variables *s* refer to years of schooling, while variables *h* (which depend on an exponent of *e*) can be viewed as index numbers expressed relative to a base value of unity, which represents the human capital possessed by an unschooled person.

Variable	New Zealand	United States	Australia	Sweden	United Kingdom	Singapore
e	79.9	91.1	76.0	74.1	74.5	61.3
e^{MRW}	11.9	11.9	9.8	7.9	8.9	9.0
s^{PIM}	8.5	11.6	7.6	9.8	10.2	7.3
s^{PRO}	9.3	12.1	8.7	9.6	8.5	6.9
s^{ATT}	11.2	11.7	10.3	9.5	8.7	5.9
s^{DD}	12.1	12.9	12.3	10.4	10.9	n.a.
h^{HJ}	3.2	3.3	3.0	2.8	2.7	2.1
h^{M}	7.2	6.9	6.1	5.1	4.8	2.9
h^{r}	5.8	4.3	4.0	3.3	3.0	1.8
h^{Q}	17.0	6.9	9.8	7.3	8.1	5.1

e Gross enrolment rates in primary, secondary and tertiary education for both sexes in 1990. [UNESCO, (2000)]

e^{MRW} Average percentage of the working age population enrolled in secondary schools for 1960–1985. [Mankiw et al. (1992)]

s^{PIM} Average years of schooling calculated by the perpetual inventory method, for primary, secondary and tertiary education in 1987. [Nehru et al. (1995)]

s^{PRO} Projected average years of schooling for 1985. [Kyriacou (1990), as reported in Benhabib and Spiegel (1994)]

s^{ATT} Average years of schooling based on attainment census method, with reference to years of total (primary, secondary and higher) education in the total population aged 15 and over in 1990. [Barro and Lee (2001)]

s^{DD} A revision of Barro and Lee's average years of schooling in 1990 with reference to OECD countries. [de la Fuente and Doménech (2000)]

h^{HJ} The stock of human capital per worker in 1990, following Hall and Jones (1990).

h^{M} The stock of human capital worker, estimated for 1990 by combining data on years of schooling with rates of return estimated in micro labour studies which weight each year of schooling by its market return. [Mincer (1974), Cheswick (1998) and others].

h^{r} A quality adjusted Mincerian measure of human capital stock per worker in 1990 based on country-specific rates of return to education. [Psacharopoulos (1994)]

h^Q A quality adjusted Mincerian measure of human capital stock per worker in 1990 based on measured cross-country differences in educational quality. [Wossmann, using data from Hanushek and Kimko (2000)].