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The Relationship between Education and Health in Australia and Canada

Steven Kennedy

SEDAP Research Paper No. 93

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Requests for further information may be addressed to:
Secretary, SEDAP Research Program
Kenneth Taylor Hall, Room 426
McMaster University
Hamilton, Ontario, Canada
L8S 4M4
FAX: 905 521 8232
e-mail: qsep@mcmaster.ca

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February 2003

The Program for Research on Social and Economic Dimensions of an Aging Population (SEDAP) is an interdisciplinary research program centred at McMaster University with participants at the University of British Columbia, Queen's University, Univérsité de Montréal, and the University of Toronto. It has support from the Social Sciences and Humanities Research Council of Canada under the Major Collaborative Research Initiatives Program, and further support from Statistics Canada, the Canadian Institute for Health Information, and participating universities. The SEDAP Research Paper series provides a vehicle for distributing the results of studies undertaken by those associated with the program. Authors take full responsibility for all expressions of opinion.

The Relationship between Education and Health in Australia and Canada

Steven Kennedy [a]

December 2002

Abstract

It is well accepted that education is positively related to health. However, there is considerably less agreement as to the explanation of this relationship. I examine the strength of the empirical relationship between education and health for Australia and Canada. I find that education is indeed related to health and to a very similar extent in both countries. I discuss three important explanations of the education and health relationship: technical efficiency, allocative efficiency and time preference explanations. Empirical analysis is presented which attempts to distinguish between the alternative explanations. I find evidence for all three explanations.

Keywords: Health Status, Education, Health production

JEL: I12, I29

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[a] Steven Kennedy, Australian Treasury, Langton Crescent, Canberra, ACT, 2600, Australia. This research was undertaken whilst I was studying at the Economics Program, Research School of Social Sciences, The Australia National University, Canberra, ACT, Australia and does not represent the views of the Treasury. I wish to thank the Australian Bureau of Statistics and seminar participants at The Australian National University and particularly Garry Barrett, Bruce Chapman, Tom Crossley, Jeremiah Hurley, and Lonnie McGee for helpful comments.

Introduction

The relationship between education and health has been studied widely by economists, sociologists and health researchers. Whilst there is general acceptance of a positive relationship between education and health, explanations of this relationship are still much debated.

In order to frame effective health policy, it is important to determine not only if there is an association between education and health but also if there is a positive causal relationship. If there is a causal relationship, public health policy makers need to consider the effects of education policy when forming optimal health policy. It is possible that one of the most effective public health policies is to increase the general level of education in the population.

In their review of education and health studies, Grossman and Kaestner (1997) discuss three broad explanations of the relationship between education and health. The first is that education improves health, the second that education and health are related through their relationship to a third variable, and the third that health improves education. Grossman and Kaestner (1997) note, “the three explanations are not mutually exclusive”, and this makes it difficult to identify the most significant explanation.

There are two theories for why education causes health. One suggests that additional education increases an individual’s ability to produce health given a set of inputs, technical efficiency. A related explanation is allocative efficiency: here additional education improves an individual's ability to make the best choice of inputs with which to produce health.[1] In this paper, health production functions are estimated for Australia and Canada to examine technical and allocative efficiency. By comparing results for Australia and Canada, I gain insights into how education might affect health and further establish the robustness of relationships. Importantly, the similarities of the Australian and Canadian data sets used in this study allow me to very carefully compare results.

The second explanation of the relationship between education and health is that individuals who invest in education have low rates of time preference (a low discount rate) and individuals with a low rate of time preference will also invest more in health. In this case, there is not necessarily a direct relationship between education and health; the association is because of their relation to a third variable, such as time preference.[2]

One way to think about technical and allocative efficiency and time preference is in terms of heterogeneity. Technical and allocative efficiency may capture heterogeneity in health production while time preference is associated with heterogeneity in the discount rate. For technical and allocative efficiency, the heterogeneity in health production is captured by education where for time preference the origin of heterogeneity is less clear.

The third explanation for why education and health are related is that health causes education: I do not consider the issue of reverse causation in this paper. However, I do discuss a model developed by Berger and Leigh (1986) that allows for health in an earlier

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[1] That is, given a set of inputs individuals with higher education will choose a more efficient combination of inputs in producing health than would individuals with less education.

[2] The third variable explanation doesn't have to be related to time preference. An alternative common third variable might be ability.

period to affect education. In this paper, I am primarily interested in clarifying the efficiency and time preference explanations of how education affects health and providing some preliminary empirical evidence of their relative importance.[3]

The paper is structured as follows: In section 2, efficiency and time preference explanations of the education and health relationship are set out. The data underlying my analysis is discussed in section 3 followed by an examination of the association between education and health in Australia and Canada including a shift-share analysis in section 4. In section 5, I present empirical evidence for each explanation of the association and the paper concludes with a discussion of the methodological issues in section 6.

2 Models of the Education and Health Relationship

2.1 Technical Efficiency in Health Production

The technical efficiency explanation of the education health relationship arises directly out of Grossman's (1972) model of health (human) capital. In Grossman's health capital model, individuals maximise their lifetime utility with respect to wealth, time, and technical constraints.

Following Grossman (1972) the health capital model can be represented algebraically as

[3] This empirical analysis in this paper focuses on people aged 25 years or more. This may reduce some of the potential for reverse causation as most investment in education has already taken place by age 25.

$$U = U(\phi_0 H_0, \ldots.., \phi_n H_n, Z_0, \ldots.., Z_n) \quad (1)$$
$$h_i = \phi_i H_i \quad (2)$$

$$H_{i+1} - H_i = I_i - \delta_i H_i \quad (3)$$

$$I_i = I_i(M_i, TH_i : E_i) \quad (4)$$
$$Z_i = Z_i(X_i, T_i : E_i) \quad (5)$$

$$TW_i + TL_i + TH_i + T_i = \Omega \quad (6)$$
$$\sum \frac{P_i M_i + V_i X_i}{(1+r)^t} = \sum \frac{W_i TW_i}{(1+r)^t} + A_0 \quad (7)$$

The arguments of the utility function (equation 1) are healthy time $\phi_i H_i$ and other goods Z_i (usually represented as a single composite good). As this is a household production model, individuals produce these goods under the technical constraints of each production function, equations 4 and 5. In equations 4 and 5 M_i and TH_i are market goods and time used to produce health investment, X_i and T_i are market goods and time used to produce other goods, and E_i is education or human capital. The prices of inputs M_i and X_i are P_i and V_i respectively and appear in the wealth constraint, equation 7. The other variables in the wealth constraint are W_i, TW_i, A_0 and r; the wage rate, time working, non-labour sources of income and the market interest rate respectively. The arguments of the time constraint (equation 6) are TL_i, time lost to sickness, Ω total time available, and TH_i and T_i defined earlier.

In this model, health is a capital stock that depreciates over time but can be increased through investment: equation 3 is a net investment identity and represents this relationship (δ_i is the depreciation rate in equation 3). In Grossman's model health can be thought of as both an investment and consumption good. Individuals consume health (healthy time) directly as well as invest in health to increase future returns from the health capital stock. There is an assumed relationship between the stock of health and healthy time as represented by equation 2. It is assumed that there is a concave relationship between the health stock and healthy time where an additional unit of health stock increases the amount of healthy time at a declining rate.

Grossman makes specific assumptions about the way education affects health production (equation 4) and the production of other goods (equation 5). He assumes that increases in education lead to input neutral outward shifts in the production functions.[4] Thus, as education increases factor (input) proportions will remain constant: that is, Grossman is assuming increases in education induce Hicks neutral technological change.[5]

It is easy to quibble with the long set of assumptions Grossman uses to set up his model. However, one thing the model does do very well is point to potential econometric issues in directly estimating health production functions. The key point is that some of the inputs into the health production function are choice variables and therefore when directly estimating a production function these variables are not exogenous and coefficients are likely to be correlated with regression error. Rosenzweig and Schultz (1983) show how biased coefficients on health inputs can arise in the direct estimation of health production functions

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[4] Given Hicks neutrality and assuming the health production function is linear in inputs, education can be included as an additional variable in an estimated production function as education will increase the production of health independently of other inputs.

[5] An implication of the Grossman model is that if there is an increase in demand for health driven by an increase in education this increase in demand can be exactly offset by an increase in the supply of health because of the decreasing cost of producing health. Therefore, an increase in education may induce no change in the amount of inputs used (demanded) for health investment production despite changes in the demand for health.

and in what they term augmented health production functions. Rosenzweig and Schultz (1983) define augmented health production functions as combinations of reduced form demand equations (such as those that can be derived from Grossman's model) and some health production inputs. They suggest that the coefficients on health input variables from augmented health production functions can't be interpreted as reflecting just the technical relationship between inputs and health.[6]

One way to avoid the problems associated with directly estimating health production functions is to use reduced form equations, health demand equations. In estimating health production functions by a set of reduced form equations or by instrumenting, one has to use prices and other exogenous variables, or find appropriate instruments with which to identify endogenous health inputs. The exogenous variables required are often not available (as is the case in this data sets used in this paper) for such an estimation strategy and finding appropriate instruments is difficult and often requires strong and less than plausible assumptions. It is also the case that even when data on the price of health inputs is available prices often do not vary across individuals in cross section data sets. Thus, while direct estimation of the production function is problematic estimation of the full model is often difficult due to data constraints and identification issues.[7]

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[6] In addition to the biases arising out of estimating an augmented health production function, Rosenzweig and Schultz (1983) also show how heterogeneity in the health technology of individuals can also lead to biases in appropriately estimated standard health production functions.

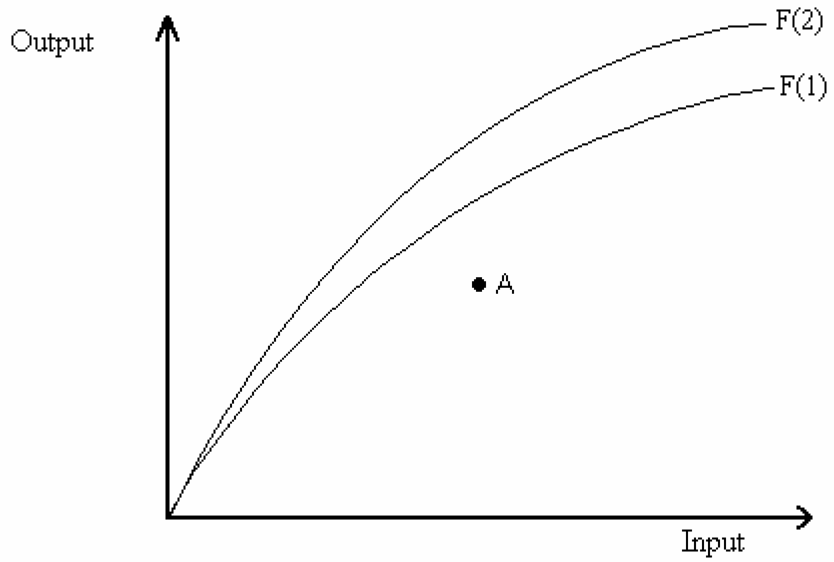
[7] Difficulties in estimating more theoretically pure versions of health production functions is probably what explains the more commonly estimated augmented production functions in the health production literature (see for example, Ettner 1996). There have been of course many worthwhile attempts to estimate full Grossman style models, for a review see Grossman (2000).

It is worth relating the health production literature to the firm production literature to gain a better understanding of the explanation of how education might affect health. Household production can be treated similarly to firm production and the terms used to describe firm production applied to household production. In the literature on firm production, technical efficiency refers to the case where firms are operating on their production function. That is, firms are producing as much output as possible given their inputs or alternatively they are using the smallest amount of inputs possible given their output.

When Grossman discusses technical efficiency in the context of health production he suggests that the more highly educated operate with reference to a different production function to the less educated. This is different to technical efficiency as defined for firm production. In the context of technical efficiency as defined for firm production more education makes individuals more productive, less education does not mean individuals are technically inefficient since with their production function (technology) they may be producing as much health as is possible.

Figure 1

Technical Efficiency and Pure Productivity



This can be illustrated using a one input - one output production relationship. We can think of the single input as a composite of all health inputs and of output as health. In Figure 5.1 F(2) is the production function for a high education group and F(1) for a low education group. Individuals in the low education group may well be operating on their production function F(1) and given their technology this means they are technically efficient. An individual with low education operating at point A is technically inefficient as they could reduce the (health) input they are using to produce the same output (health) or increase current output given input. Similarly, there could be high education individuals operating below their production function. Thus, differences in technical efficiency as described by Grossman are perhaps more accurately described as pure productivity effects. To remain consistent with the existing health production literature I will continue to use the term technical efficiency throughout this paper though it is important to keep in mind that this has a specific meaning in this literature.

2.2 Allocative Efficiency in Health Production

An explanation related closely to technical efficiency is allocative efficiency. Allocative efficiency suggests that more highly educated individuals have a better health knowledge and this leads them to choose better mixes of health inputs than less educated individuals, which results in better health for the more highly educated. Kenkel (1991) examined allocative efficiency by studying how education is related to different health behaviours. It is well accepted that not only are more educated people healthier, but they also consistently choose better health behaviours. For example, they smoke less and exercise more. Kenkel (1991) used information on individuals' knowledge of the effects of smoking, drinking and exercise to see if after incorporating this knowledge the effect of schooling was attenuated or diminished. Kenkel found that whilst the more highly educated do use health information more effectively there was still a direct effect of education on health that was not explained by the allocative efficiency hypothesis.

Allocative efficiency (similarly to technical efficiency) can be defined in the context of firm production. We can think of individuals (like firms) having the same underlying technology but being allocatively inefficient by not using a cost minimising set of inputs. Allocative efficiency can be most easily demonstrated using a one output / two inputs diagram, see Figure 2.[8] In Figure 2, the individual operating at point q is allocatively inefficient but technically efficient. They could produce no more output (health) from the inputs they are using but they could further reduce costs by moving to point q'. We could think of one health input as medical care and the other as a composite of all other health

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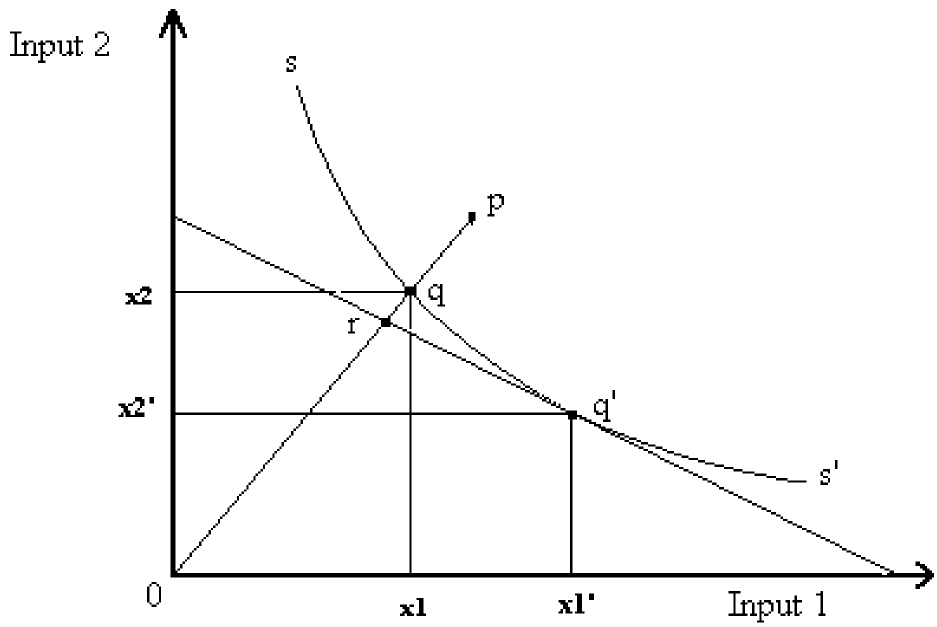
[8] In Figure 5.2 the line SS' represents an isoquant and all points on this line represent different combinations of the two inputs requires to produce the same amount of output.

inputs. Allocative inefficiency arises because individuals do not appear to understand the budget constraint that is; they do not accurately understand the relative price of inputs. In practice, the effect of this misunderstanding or lack of information would be a decrease in real income or wealth. It also means that these individuals would use inputs in different proportions to allocatively efficient individuals.

Figure 2

Allocative and Technical Efficiency



What is implied in some discussions of allocative efficiency is that people with different amounts of education have different underlying production functions which leads them to use more of some inputs. However, this is technical efficiency rather than allocative efficiency. The only difference between this technical efficiency effect and the one described earlier is that the effect of more education on health is non-neutral. That is, we have relaxed the assumption of homotheticity imposed on the production function in the standard Grossman model.

Both allocative inefficiency and non-neutral variation in technical efficiency lead to differences in health production input proportions. Therefore, differences in input proportions (between education groups) are not necessarily a test of allocative versus technical efficiency. This can only be done if the extra assumption is made that the health investment production function is homothetic.[9]

It is worth reflecting on whether the distinction between allocative and technical efficiency has any relevance to public health policy.[10] Both arguments suggest that education is causally related to health and that increases in education would increase health. However, distinguishing between these two explanations may be important for public health policy given differences in education across the population. For example, putting aside the influence of other variables such as income, technical efficiency suggests that the only way the health of the less educated can be improved when compared to the more educated is to increase health inputs for the less educated. Allocative efficiency as posited in this paper suggests that a more appropriate response to health inequities driven by educational differences might be to provide more information to the less educated about the relative price of various health inputs.

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[9] The assumption that health is constantly increasing in all inputs may also be problematic. For example, medical care is likely to have a positive marginal product over a range of the health stock and a zero or possibly negative effect beyond this range.

[10] Testing for allocative efficiency as Kenkel did may not distinguish between allocative efficiency and non-neutral technical efficiency. For example, individuals who process health knowledge more effectively may use this knowledge to better determine the relative price of health behaviour, allocative efficiency. Alternatively, they may be better at producing health given this knowledge (a non-neutral change in their production function),

2.3 Time Preference, Education and Health

Another interpretation of the empirical relationship between health and education is that individuals who invest relatively more in schooling will also invest more in health, a time preference effect. For time preference, there is no direct effect of education on health - instead, there is a third variable to which both education and health is related. If the time preference explanation holds an observed relationship between education and health is at least partly spurious.

Fuchs (1982) used estimates of individuals' inter-temporal interest rates to examine time preference and the health and education relationship. He derived estimates of inter-temporal interest rates by surveying persons and asking time-money trade off questions. Fuchs (1982) then estimated regressions on health and included inter-temporal interest rates as an explanatory variable: he found little evidence for time preference in these regressions. However, Farrell and Fuchs (1982) found that additional schooling between the ages of 17 and 24 did not influence smoking behaviour. They viewed this as evidence that schooling and smoking behaviour were caused by a third variable, time preference. They drew this conclusion based on the idea that the additional education did not influence a health habit.

Examining whether particular health habits or behaviours are related to time preference is one way we may be able to gain insights into how health might be related to education. Evans and Montgomery (1994) tested whether smoking behaviour could be used as an instrument for education in wage equations. If smoking and education were correlated because they both have strong time preference components and smoking was not related to

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technical efficiency.

ability, smoking would prove a useful instrument for education in wage equations. They found that smoking was a good instrument for education and they suggested that this was consistent with a time preference explanation for why people smoked and invested relatively less in education. Since there is evidence of smoking and education being related through a common time preference component, this relationship can be used to try to disentangle a time preference component of education when examining the effect of education on health.

Berger and Leigh (1986) took a different approach to Fuchs in attempting to disentangle the effect of education on health. They estimated the following two-equation model.

$$E_1 = X_1\beta_1 + Y_1\beta_2 + H_1\beta_3 + \varepsilon_{s1} \qquad (8)$$

$$H_2 = X_2\alpha_1 + E_1\alpha_2 + Z_2\alpha_3 + H_1\alpha_4 + \varepsilon_{s2} \qquad (9)$$

In this model: H is health, E is education, X a vector of variables affecting health and education, Y a vector of variables affecting only education, and Z is a vector of variables affecting health. This is a two period model where education in period one affects health in period two. Berger and Leigh estimate this model by using predicted education from equation 8 to instrument for education in health equation 9. They also include the error term from equation 8 and the interaction of the error term and instrumented education. This allows them to gauge the effect on health of unobservables in the education equation, and the interaction of education and unobservables. Unobservables in the schooling equation can be thought of as a time preference indicator as other potential determinants of education are captured by the explanatory variables included in the education equation. Berger and Leigh concluded that their results were consistent with a direct effect of education on health and not the time preference explanation.

The strength of Berger and Leigh's model is that it allowed them to estimate a direct effect of schooling on health. However, the identification of the direct education effect swings on the power of the instruments used to identify schooling effects.[11] Grossman (2000) points out that some of the instruments used to identify the education effect are likely to be correlated with time preference weakening somewhat Berger and Leigh's conclusions. Grossman concludes that the debate over time preference versus technical and allocative efficiency is largely unresolved.[12]

The policy implications arising out of Fuchs' time preference explanation of how education and health might be related are clear and appear diametrically opposed to those arising out of the efficiency explanations. The time preference explanation suggests that policies such as increasing the level of education in the population would be largely ineffective in improving public health. If time preference is the most important explanation of

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[11] Berger and Leigh used two data sets and different instruments and assumptions in analysis of each data set. In one data set, they merged with individual data aggregate US State level data on education expenditures per capita. In this data set they did not have a past health variable and had to assume that X_1 and X_2 from equations (8) and (9) were the same and that β_3 was equal to zero. In the other data set, they had more information available and used IQ and family background variables to instrument or identify education. In this instance, it appears likely that these variables would be correlated with time preference and thus be correlated with the error term in equation (8).

[12] A variation on the time preference explanation is that individuals who invest in education are after this investment more likely to invest in health. Here education doesn't directly, though in can in part, affect health rather education leads individuals to be more forward looking by lowering their current time preference. Individuals with a lower time preference will invest more in health capital for the future rather than consume health today. This model, which Grossman (2000) discusses in the context of Becker and Mulligan (1994), is difficult to identify and separate from an allocative efficiency argument or a more straightforward time preference determination process. However, it is no less plausible than other models of the education and health relationship. I don't discuss endogenous determination of the discount rate in this paper. Instead, I focus on efficiency and (Fuchs') time preference explanations.

why education is related to health, policies which influenced individuals' forward looking behaviour would clearly be much more effective in improving the health of the less educated.

3 The Data

3.1 Australian Data

The Australian Bureau of Statistics (ABS) 1995 National Health Survey[13] was run over a 12-month period from January 1995 to January 1996. Approximately 23,800 dwelling households were surveyed and of these households, approximately half were 'invited' to answer the Short Form 36 health status questionnaire (SF-36). Households selected to respond to the SF-36 were not asked questions about their education, alcohol consumption, health insurance or supplementary women's health questions. In this paper, I use that half of the sample where individuals were required to answer questions about their education. The overall response rate for households was 91.5%.

Health is measured using self assessed health status. Self assessed health status is becoming an increasingly common measure of health in empirical research (see for example, Smith, 1999, Ettner, 1996, Saunders, 1996, Kennedy et al 1998 and Deaton & Paxson, 1998). This is supported by a large literature that shows that self assessed health status predicts mortality and morbidity (see Idler & Kasl, 1995, McCallum et al., 1994, Connelly et al., 1989, Okun et al., 1984, and Ware et al., 1978[14]).[15]

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[13] See ABS (1995) Cat no 4363.0.

[14] Ware et al. (1978) as cited in Smith (1999).

[15] However, there are some limitations to the self assessed health status measure. For example, Crossley and

The income measure used in this analysis is household equivalent income. Household income was equivalised using a modified Henderson equivalence scale, see ABS (1995) for more detail.

Education was measured using reported highest educational attainment. The eight categories of educational attainment available in the data set are collapsed to three categories for most of the analysis. Education categories were constructed in the following way. The bachelor degree plus level of education was composed of higher degree, post graduate diploma and bachelors degree, the skilled level of education was composed of the categories diploma, associate diploma, skilled and basic vocational, the no higher education group consisted of persons reporting no higher qualifications. A measure of smoking status was used where the categories were smoking, smoked or never smoked. An exercise index composed of four categories was used in this analysis. The exercise index was constructed by combining nine questions on exercise, see ABS (1995) for more details. Other information included marital status, labour force status, age and gender.

Measures of occupation and employment type were used in testing the robustness of the health equation but are not reported in this paper.

3.2 Canadian Data

The Canadian National Population Health Survey (CNPHS) was collected over a one-year period from 1994 to 1995. This survey was constructed as follows; "*The sample design considered for the household component of the NPHS was a stratified two-stage design. In*

Kennedy., (2000) found that measurement errors associated with self assessed health status were related to individual characteristics such as age.

the first stage, homogeneous strata are formed and independent samples of clusters are drawn from each stratum. In the second stage dwelling lists are prepared for each cluster and dwellings, or households, are selected from the lists", see Statistics Canada (1995) for more details. The response rate for households in this survey was 88.7 percent.

Some of the variables drawn from this survey were the same as those found in the Australian National Health Survey: variables that were the same were self assessed health status, age and sex. Other variables such as highest educational attainment, marital status, labour force status (working status in the CNPHS), smoking status, and physical activity were able to be closely matched to their Australian counterparts. For highest educational attainment the Canadian responses were: no schooling, elementary schooling, some secondary schooling, secondary school graduation, other beyond high school, some trade school etc, some community college, some university, diploma/certificate trade school, diploma/certificate, community College, cegep, bachelor degree, master degree & doctorate. These responses were collapsed into three categories similar to the Australian categories: bachelor degree and higher forming one category, any qualifications post secondary school forming the second category, and secondary school or less the third category. There was less detail available on the Canadian marital status variable however, the categories were still very similar to the Australian categories. In the Canadian data the measure of exercise is a physical activity indicator, for more details on its construction see Statistics Canada (1995).

One variable which was a little different between the two surveys was the income variable. In the Canadian survey, I have used the derived five-category income measure. This variable is based on income ranges conditional on household size (see Statistics Canada, 1994 for more details). Thus, there is considerable variation in the number of persons in each category with the majority of persons being in the middle income categories. For equivalised Australian household income, the number of persons in each income category is approximately the same as they are coded in income deciles.[16] This means that in the Australian data the range of income between deciles can vary dramatically.

Measures of employment status in the Canadian data were reported differently to those in the Australian data. However, they represent similar groups: unemployed, employed and those not in the labour force. Smoking status was reported in considerably more detail in the Canadian survey. It was possible to collapse the Canadian categories so that they closely resembled the Australian categories of smoking, smoked and never smoked.

3.3 Descriptive Statistics

In Table 1a, I report the distribution of self assessed health status and education responses. Canadian self assessed health status is slightly higher than that reported for Australia whilst there are also more individuals with higher qualifications in the Canadian data set. In Table 1b, I report self assessed health status responses by education for Australia and Canada. The patterns of responses are similar for both countries: those with higher educational qualifications report better health status.

[16] They are not exactly the same because of sample restrictions and because the income deciles are constructed using weighted estimates.

Table 1a

Descriptive Statistics – Canada and Australia

Persons aged 25 or more	**Australian NHS 1994-95**	**Canadian NHS 1994-95**
	Percentage of sample	Percentage of sample
Self Assessed Health Status		
Excellent	19.23	21.79
Very Good	33.69	36.82
Good	29.71	27.25
Fair	12.93	11.08
Poor	4.45	3.07
Education		
Bachelor +	13.47	13.78
Skilled	32.29	40.49
No Higher	54.24	45.79

Table 1b

Descriptive Statistics - Self Assessed Health Status by Education

Persons aged 25 or more	Self Assessed Health Status (%)				
	Excellent	Very Good	Good	Fair	Poor
Australian NHS					
Education					
Bachelor +	28.96	40.61	24.03	4.98	1.42
Skilled	21.06	35.99	29.29	10.31	3.35
No Higher	15.72	30.60	31.37	16.46	5.86
Canadian NHS					
Education					
Bachelor +	34.85	40.16	19.34	4.38	1.26
Skilled	23.46	40.35	25.88	8.09	2.31
No Higher	16.46	32.68	30.85	15.73	4.28

4. The Association between Education and Health

4.1 The Association between Education and Health

I begin by examining the association between education and health in Australia and Canada. By establishing the existence and strength of a relationship between education and health, I provide impetus for examining in detail potential explanations of this relationship.

In Table 2, I present the results of ordered probit regressions for Australia and Canada where self assessed health status was regressed on age, income, sex, marital status, smoking status, an exercise index, labour force status and education. An ordered probit model was used because the self assessed health status variable has a natural ordering from poor through to excellent health. The samples for these regressions were restricted to persons aged 25 or more years to consider persons that would have probably completed higher education.

All variables were related to health in the expected way: self assessed health declines with age, increases with income, and increases with the level of educational attainment.[17] In Australian and Canadian regressions I used three collapsed education attainment categories outlined in Section 3 to capture differences in education.

[17] There were other variables that I could have included in this regression for example, occupation and employment type. However, there is an issue of collinearity in these data sets both in terms of education and occupation categories being closely related and also older age groups are coded as not applicable for occupation and employment type making it difficult to identify age, employment and occupation effects.

Table 2

Ordered Probit Regressions on Self Assessed Health Status

Australian National Health Survey 1994-95			Canadian National Population Health Survey 1994-1995		
Variables	Coefficient	t statistic	Variables	Coefficient	t statistic
Age 30-34	0.041	1.170	Age 30-34	-0.066	-1.734
Age 35-39	-0.051	-1.416	Age 35-39	-0.186	-4.761
Age 40-44	-0.064	-1.700	Age 40-44	-0.244	-5.910
Age 45-49	-0.177	-4.578	Age 45-49	-0.366	-8.658
Age 50-54	-0.205	-4.958	Age 50-54	-0.428	-9.479
Age 55-59	-0.356	-7.914	Age 55-59	-0.539	-11.525
Age 60-64	-0.326	-6.734	Age 60-64	-0.445	-9.056
Age 65-69	-0.188	-3.658	Age 65-69	-0.392	-7.688
Age 70-74	-0.313	-5.710	Age 70-74	-0.442	-8.344
Age 75-79	-0.306	-4.846	Age 75-79	-0.465	-7.886
Age 80+	-0.465	-6.753	Age 80+	-0.499	-8.270
Male	-0.171	-8.791	Male	-0.050	-2.536
Income D 2	-0.195	-4.371	Low middle	0.100	2.421
Income D 3	-0.217	-5.057	Middle income	0.215	5.549
Income D 4	-0.004	-0.087	Upper income	0.383	9.598
Income D 5	0.081	1.858	High income	0.501	10.609
Income D 6	0.061	1.389			
Income D 7	0.120	2.764			
Income D 8	0.109	2.522			
Income D 9	0.131	3.093			
Income D 10	0.215	5.007			
Smoker	-0.279	-11.804	Smoker	-0.297	-12.413
Ex-smoker	-0.103	-4.810	Ex-smoker	-0.120	-5.217
Married	0.124	4.143	Has partner	-0.052	-2.031
Defacto	0.086	1.810	Is separated	-0.074	-2.195
Separated	0.080	1.455			
Divorced	0.112	2.392			
Widowed	0.226	4.513			
High exercise	0.670	15.758	Moderate exer	-0.158	-5.116
Med exercise	0.359	14.864	Inactive exer	-0.384	-14.455
Low exercise	0.187	8.699	Currently wking	0.385	2.397
Employed	0.436	15.489	Not Cur wking	0.343	2.086
Unemployed	0.368	7.145	No wk 12mths	-0.093	-0.574
Bachelor +	0.207	6.934	Bachelor +	0.237	7.472
Skilled	0.117	5.667	Skilled	0.086	4.065
Cut 1	-1.543	0.054	Cut 1	-2.320	0.170
Cut 2	-0.673	0.052	Cut 2	-1.414	0.169
Cut 3	0.302	0.051	Cut 3	-0.441	0.168
Cut 4	1.327	0.052	Cut 4	0.659	0.168
Observations	14148		Observations	13246	
Log Likelihood	-19202.12		Log Likelihood	-17345.58	

Omitted Australian categories: age 25-29, income decile 1, never smoked, no exercise, out of labour force or na, single, no higher education. Omitted Canadian categories: age 25-29, low income, never smoked, single, active exercise, Na or ns labour force, no higher education.

Regressions were also run where all the available education attainment categories for each country's data set were included.[18] Likelihood ratio tests indicated that restricted regressions (regressions where only three education categories were used) were not statistically different from unrestricted regressions.[19] Given that this restriction holds, I use three education categories to characterise education differences in the analysis that follows.[20]

Perhaps the most immediate and striking result from the regressions is that the coefficients on education categories for Australia are very similar to those for Canada. In addition, it is also interesting that the association between education and health can be effectively captured using the same three categories of educational attainment in both countries.

To examine whether the magnitude of the relationship between education and health was similar in Australia and Canada marginal effects were calculated. The base case for this exercise was married males aged 35 to 39 who where in the medium exercise category, and the middle income category. The marginal effects on all self assessed health status categories of an increase in educational attainment are presented in Table 3a.

[18] There were eight education categories in the Australian data and twelve education categories in the Canadian data.

[19] Australian results LR Stat 7.63, Chi-squared (5) prob 0.1776, Canadian results LR statistic 9.13, Chi-squared (5) prob=0.1665.

[20] Grossman (1975) found that the education health gradient was significant even at high levels of education, as cited in Fuchs (1982).

For Australia, the probability of reporting excellent health (the highest category of self assessed health status) increases for the skilled education category compared to the no higher education category by 4.1 percentage points or 14.2 percent. For Canada, the probability of reporting excellent health increases by 2.7 percentage points or 11.5 percent for the same change in education categories. The probability of reporting excellent health increases for the higher education category compared to no higher education for Australia and Canada by 7.5 and 7.8 percentage points or 25.6 and 33.7 percent respectively. The results of the ordered probit regressions suggest that not only is education and health related similarly for both countries, but that in both cases the relationship is substantial in size. [21]

Table 3a

Marginal Effects Ordered Probit Regressions on Self Assessed Health Status

	Poor	Fair	Good	Very Good	Excellent
Australia					
Skilled	-0.274	-1.215	-2.544	-0.096	4.130
Bachelor +	-0.439	-2.030	-4.502	-0.503	7.474
Canada					
Skilled	-0.247	-1.062	-1.828	0.441	2.697
Bachelor +	-0.580	-2.683	-5.117	0.550	7.829

The base case is married males aged 35 to 39 who where in the medium exercise category, no higher education, and the middle income category.

4.2 Blinder-style Decomposition

In Section 3.3 I noted that for Canada self assessed health status was slightly higher compared to Australia, and that there were also slightly higher proportions in the higher

[21] The relationship between health and other variables was also very similar between countries, for example, the relationship between health and smoking and age categories.

education categories. To examine whether the difference in health status between the two countries could be explained by the difference in their distributions of education, I undertook a Blinder (1974) style decomposition. The health regressions for Australia and Canada can be represented by Equations 10 and 11.

$$H_i^A = \beta_0^A + \sum_{j=1}^{2} \beta_j^A E_{ji}^A + \sum_{k=1}^{m} \beta_k^A O_{ki}^A + \varepsilon_i^A \quad (10)$$

$$H_i^C = \beta_0^C + \sum_{j=1}^{2} \beta_j^C E_{ji}^C + \sum_{k=1}^{m} \beta_k^C O_{ki}^C + \varepsilon_i^C \quad (11)$$

Where H_i^C and H_i^A are the health status of Canadians and Australians respectively, E_{ji} is education, O_{ji} the set other explanatory variables, and the β s the coefficients to be estimates. The health and education variables are the same for Australia and Canada however; the other explanatory variables vary between countries. This was the reason I was not able to undertake a full Blinder decomposition.

Predicted probabilities for two different cases were calculated taking into account that both countries have the same dependent variable and set of education variables. First, predicted probabilities were recalculated for self assessed health status categories for Australia where Canadian coefficients on education categories were used (see equation 12). In this case, I am examining whether the health returns to education in Canada would affect the average level of health in Australia.

$$H_i^A = \beta_0^A + \sum_{j=1}^{2} \beta_j^C \overline{E}_{ji}^A + \sum_{k=1}^{m} \beta_k^A \overline{O}_{ki}^A + \varepsilon_i^A \quad (12)$$

There was virtually no difference in predicted probabilities between a base case, where the base case was calculated at the mean of explanatory variables, and the case using Canadian returns to education, see Table 3b. This result emphasises the similarities of health returns to education in Australia and Canada.

Second, another set of predicted probabilities for Australia was calculated where the full set of Australian coefficients were used but the Canadian distribution of education (see equation 13). In this case, I am interested in whether variation in the distribution of education between Australia and Canada drives differences in health.

$$H_i^A = \beta_0^A + \sum_{j=1}^{2} \beta_j^A \overline{E}_{ji}^C + \sum_{k=1}^{m} \beta_k^A \overline{O}_{ki}^A + \varepsilon_i^A \qquad (13)$$

There was a small change in the predicted probabilities for Australian self assessed health status categories compared to the base case, see Table 3b. For example, the predicted proportions in two upper most health status categories increased by 1.6 percent. This means that the difference between these two categories for Australia and Canada falls from 6.9 percent to 5.3 percent.

In their review of education and health studies, Grossman and Kaestner (1997) cite more than thirteen US studies that also find that education and health are strongly related. In these studies, health is measured a number of different ways including self assessed health status, the measure of health used in this paper. Grossman (2000) concludes that the review conducted by Grossman and Kaestner (1997) “suggests that years of formal schooling completed is the most important correlate of good health”.

Table 3b

Blinder-Style Decomposition of Ordered Probit Regressions on Self Assessed Health Status for Australia

	Predicted Probabilities for Australian Self Assessed Health Status Categories				
	Poor	**Fair**	**Good**	**Very Good**	**Excellent**
Australia					
Base Case at the mean of all variables	2.87	12.30	32.67	35.58	16.58
Case 1, Canadian Education Coefficients	2.89	12.35	32.72	35.53	16.50
Case 2, Canadian Education Distribution	2.61	11.61	31.98	36.18	17.63
Canada					
Base Case at the mean of all variables	1.74	9.71	29.45	39.88	19.22

5 Empirical Evidence for Models of Education and Health

In the following section, I present empirical evidence for technical and allocative efficiency and time preference explanations of the relationship between education and health.

5.5.1 Technical and Allocative Efficiency

I begin by putting to one side time preference and examining the two efficiency explanations. The first explanation – technical efficiency – suggested that education increased the amount of health available to the highly educated individual for a given level of inputs. If I estimate a health production function and assume that the function is linear and homogenous then the coefficient on education captures the shift in technical efficiency per unit of education.

The second explanation – allocative efficiency – was that more highly educated persons were more able to combine inputs efficiently given prices. If technical efficiency is considered in conjunction with assuming health production functions are linear and homogenous in inputs, one way of distinguishing between the two efficiency explanations is to estimate health production functions conditional on education and compare coefficient vectors. Variation in coefficient vectors arising out health production functions estimated conditional on education suggests that inputs vary in their influence on health by education.[22] However, if individuals with different amounts of education have different underlying production technologies, ie non-neutral technical efficiency, coefficient vectors would also vary between education groups.[23] In this case, we cannot distinguish between (non-neutral) technical efficiency and allocative efficiency.

Three regressions were run for Australia and Canada conditional on the collapsed education categories, see Tables 4 and 5.[24] These conditional regressions contain the same explanatory variables reported in the earlier unconditional regressions, see Table 4. The regressions are probably best characterised using Rosenzweig and Schultz's (1983) notion of augmented health production functions, and therefore it is difficult to interpret the estimated

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[22] If the health production function was linear and homogenous the only observed variation in coefficient vectors between the conditional regressions should be in the constant.

[23] We could also use the idea that if an increase in education improves technical efficiency and the health production function is assumed linear and homogenous, factor inputs will continue to be used in the same proportions. Thus, if input proportions conditional on education are compared they should be the same if the technical efficiency homogeneity assumption is correct.

[24] As before the samples are restricted to persons aged 25 or more years.

functions as production functions as such.[25] However, given the unavailability of suitable data to estimate Grossman style health production functions these regression at least give us some insights into the overall pattern of the relationship between health inputs and health.

Likelihood ratio tests of whether coefficients vary between the conditional on education regressions for Australia and Canada rejected the null that they do not vary. Despite the rejection of this restriction, interestingly some coefficients vary little between education groups in particular; those on smoking status, exercise, and labour force status. The largest variation in coefficients appears to be between age and income coefficients, particularly for Australia. In the Canadian regressions, there is a small amount of variation in all coefficients and thus the null hypothesis that all the coefficients are the same is not rejected by as much as in the Australian case. The Canadian and Australian results are suggestive of either allocative efficiency or non-neutral technical efficiency - keeping in mind the caveats surrounding the specification of the health production function.

It is instructive to look in more detail at some of the interesting variations in coefficients arising from the conditional on education regressions to identify the sources of differences in health between education groups. Variations in age are particularly interesting as these variations may provide insights into patterns of health investment and depreciation. For Australia, by examining the pattern of age coefficients we see that age-health profiles by education category were quite similar until age 70-74. However, the bachelor plus education category appeared to have a much larger relative decline in health associated with age 75 years and more. This particular age effect may in part be a selection effect. If at younger ages those

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[25] The coefficients on inputs represent choices (preferences) as well as a technical relationship between inputs

with no higher education are less healthy, it may be the case that these individuals also have higher mortality rates. Whilst for more highly educated people mortality rates may not increase until old age and thus (as a group) they experience a relatively larger decline in health at these ages. It is also appears to be the case that average health is better for the more educated over the entire lifecycle and therefore as a group they experience a more dramatic decline in health at very old age before dying.

For Australia and Canada, there is a stronger income-health gradient for those with less education. In Australian regressions, two issues make this gradient hard to judge. First, there is the unusual positive relationship to health of the first income decile when compared to the next two income deciles. Second, the Australian income dummy variables represent household equivalent income deciles and therefore the range of income in each decile can vary.

5.2 Time Preference

In order to examine the time preference hypothesis regressions were estimated where the sample was disaggregated according to a time preference indicator, smoking status. If smoking status captures individual differences in time preference, and time preference is the primary explanation of the observed health and education relationship, we would expect the health gradient on education to diminish in these conditional regressions.

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and outputs.

Table 4

Ordered Probit regression conditional on Education Category - Australia

Australian National Health Survey 1994-95						
	Bachelor +		Skilled		No Higher	
Variables	Coefficient	t statistic	Coefficient	t statistic	Coefficient	t statistic
Age 30-34	-0.043	-0.478	0.015	0.244	0.082	1.653
Age 35-39	-0.167	-1.831	-0.035	-0.580	-0.026	-0.503
Age 40-44	0.030	0.311	-0.145	-2.239	-0.056	-1.056
Age 45-49	-0.132	-1.324	-0.133	-1.972	-0.223	-4.120
Age 50-54	-0.149	-1.277	-0.196	-2.725	-0.225	-3.980
Age 55-59	-0.343	-2.421	-0.351	-4.551	-0.356	-5.845
Age 60-64	-0.607	-3.312	-0.285	-3.286	-0.312	-4.948
Age 65-69	-0.266	-1.326	-0.056	-0.575	-0.210	-3.246
Age 70-74	-0.349	-1.681	-0.244	-2.244	-0.321	-4.700
Age 75-79	-0.830	-2.660	-0.178	-1.424	-0.303	-3.909
Age 80+	-1.295	-3.370	-0.599	-3.899	-0.389	-4.774
Male	-0.047	-0.912	-0.183	-5.344	-0.205	-7.633
Income D 2	-0.523	-2.856	-0.223	-2.566	-0.142	-2.531
Income D 3	0.114	0.656	-0.301	-3.635	-0.162	-2.993
Income D 4	-0.057	-0.316	-0.041	-0.512	0.052	0.926
Income D 5	0.015	0.091	-0.035	-0.454	0.167	2.925
Income D 6	0.037	0.257	0.026	0.346	0.091	1.559
Income D 7	-0.042	-0.340	0.058	0.768	0.198	3.296
Income D 8	-0.074	-0.638	0.027	0.363	0.210	3.460
Income D 9	-0.044	-0.407	0.006	0.076	0.283	4.647
Income D 10	0.104	0.987	0.136	1.792	0.300	4.702
Smoker	-0.364	-4.686	-0.354	-8.471	-0.228	-7.281
Ex-smoker	-0.132	-2.249	-0.107	-2.906	-0.094	-3.176
Married	0.027	0.373	0.240	4.426	0.075	1.790
Defacto	0.145	1.156	0.161	1.939	0.022	0.339
Separated	0.133	0.828	0.079	0.802	0.066	0.891
Divorced	-0.003	-0.022	0.165	2.035	0.094	1.455
Widowed	0.021	0.094	0.179	1.712	0.224	3.619
High exercise	0.652	6.378	0.696	10.028	0.643	9.805
Med exercise	0.283	3.847	0.433	10.092	0.320	9.900
Low exercise	0.068	0.998	0.186	4.825	0.209	7.357
Employed	0.237	2.430	0.480	9.244	0.451	12.411
Unemployed	0.110	0.588	0.404	4.472	0.395	5.860
Cut 1	-2.169	0.164	-1.624	0.097	-1.501	0.071
Cut 2	-1.424	0.151	-0.786	0.093	-0.599	0.069
Cut 3	-0.345	0.148	0.228	0.093	0.351	0.069
Cut 4	0.774	0.148	1.283	0.094	1.336	0.070
Observations	1906		4568		7674	
Log Likelihood	-234.57		-6062.41		-10729.46	

Omitted Australian categories: age 25-29, income decile 1, never smoked, no exercise, out of labour force or na, single, no higher education.

Table 5

Ordered Probit regression conditional on Educational Category - Canada

Canadian National Population Health Survey 1994-1995						
	Bachelor +		Skilled		No Higher	
Variables	Coefficient	t statistic	Coefficient	t statistic	Coefficient	t statistic
Age 30-34	-0.044	-0.451	-0.041	-0.769	-0.100	-1.515
Age 35-39	-0.199	-1.971	-0.130	-2.336	-0.238	-3.601
Age 40-44	-0.142	-1.384	-0.184	-3.074	-0.355	-5.094
Age 45-49	-0.326	-3.137	-0.339	-5.406	-0.414	-5.940
Age 50-54	-0.287	-2.411	-0.354	-5.127	-0.550	-7.763
Age 55-59	-0.502	-3.806	-0.400	-5.455	-0.684	-9.638
Age 60-64	-0.588	-3.761	-0.339	-4.220	-0.536	-7.495
Age 65-69	-0.527	-3.109	-0.208	-2.451	-0.507	-6.931
Age 70-74	-0.233	-1.304	-0.285	-2.942	-0.572	-7.745
Age 75-79	-0.400	-1.825	-0.245	-2.245	-0.601	-7.499
Age 80+	-0.638	-2.990	-0.309	-2.694	-0.606	-7.402
Male	0.050	0.943	-0.105	-3.434	-0.038	-1.272
Low middle	0.104	0.545	0.173	2.331	0.063	1.207
Middle	0.254	1.646	0.241	3.599	0.200	3.949
Upper income	0.486	3.296	0.384	5.692	0.371	6.824
High income	0.482	3.182	0.546	7.044	0.504	6.825
Smoker	-0.357	-4.898	-0.343	-9.239	-0.257	-7.224
Ex-smoker	-0.098	-1.651	-0.122	-3.334	-0.123	-3.558
Has partner	0.020	0.238	0.010	0.252	-0.107	-2.954
Is separated	-0.040	-0.416	0.021	0.392	-0.148	-2.913
Moderate exer	-0.234	-3.000	-0.135	-2.875	-0.155	-3.203
Inactive exer	-0.499	-7.047	-0.362	-8.873	-0.371	-9.181
Currently	0.211	0.506	0.533	2.360	0.309	1.119
Not Cur	0.238	0.551	0.417	1.803	0.320	1.139
No wk 12mths	-0.252	-0.592	0.056	0.245	-0.180	-0.650
Cut 1	-2.573	0.462	-2.093	0.243	-2.555	0.285
Cut 2	-1.812	0.457	-1.276	0.240	-1.582	0.284
Cut 3	-0.780	0.455	-0.283	0.240	-0.622	0.283
Cut 4	0.372	0.455	0.865	0.240	0.418	0.283
Observations	1825		5363		6058	
L Likelihood	-2138.9		-6877.49		-8277	

Omitted Canadian categories: age 25-29, low income, never smoked, single, active exercise, Na or ns labour force, no higher education.

In Table 6, the coefficients on education categories are reported for regressions conditional on smoking status for Australia and Canada. For both countries, in most of the conditional regressions, the education gradient remained largely unchanged and was similar to the education gradient obtained from unconditional regressions. However, there were some differences between education coefficients for the regressions conditional on the smoking group compared to other conditional regressions. In the smoking group regressions, the skilled education category is no longer significantly different from the no higher education category. It may be the case that the smoking group is more homogeneous in terms of time preference and this has lead to a reduction in the education gradient for this group. It may also be the case that education is still capturing heterogeneity in time preference in the smoked and never smoked groups.

Table 6

Education Coefficients from Ordered Probits conditional on Smoking Status*

	Never Smoked		Smoked		Smoking	
	Coefficient	t statistic	Coefficient	t statistic	Coefficient	t statistic
Australian						
Bachelor +	0.216	5.273	0.196	3.549	0.188	2.460
Skilled	0.127	3.986	0.169	4.661	0.024	0.574
No Obs	6484		4285		3379	
Log Likelihood	-8659.32		-5837.66		-4650.48	
Canadian						
Bachelor +	0.298	6.127	0.226	4.030	0.167	2.447
Skilled	0.156	4.094	0.100	2.707	0.014	0.401
No Obs	4699		4402		4194	
Log Likelihood	-5889.47		-5757.97		-5647.61	

* In this table, I only report the coefficients on education. The coefficients on other variables were similar to those in regressions reported in Table 2. Omitted Australian categories: age 25-29, income decile 1, never smoked, no exercise, out of labour force or na, single, no higher education. Omitted Canadian categories: age 25-29, low income, never smoked, single, active exercise, Na or ns labour force, no higher education.

5.3 A Lifecycle View - Gross Health Investment Profiles

The final way I examine the education and health relationship is to think about this relationship in a lifecycle setting. As discussed earlier, in the Grossman model or more generally in inter-temporal maximisation models, health can be treated as a capital stock that can be increased through investment but also declines in each period because of depreciation. Consider the following equation

$$H_t - H_{t-1} = I_{t-1} - \delta_{t-1}H_{t-1} \tag{10}$$

This is simply an identity where net investment equals gross investment minus depreciation from the last period. The difficult part is that in most analyses we never observe health investment though we do observe proxies for the stock of health.[26]

It is easy to re-arrange equation 10 so that

$$I_{t-1} = H_t +(1- \delta_{t-1})H_{t-1} \tag{11}$$

Thus, if I know the depreciation profile and the health stock from period to period I can derive a gross investment profile. Even when I don't know the exact depreciation profile as long as it is unchanged between education groups I can still make inferences about the investment profiles of different education groups by examining changes in the stock of health (net investment).[27] If I observe variation in investment profiles across education groups this might indicate differences in time preference. If the investment profiles were the same, this

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[26] If we assume that the depreciation rate is close to zero and our health measure is a measure of the change in health status, we can still use change in health status to estimate the investment production function.

[27] In estimating this relationship from a cross-section there are some potentially substantial cohort effects which

might suggest that more education simply increases technical efficiency by raising the level of investment across the age profile.

Viewing human capital over the lifecycle by examining age earnings profiles is a common way of exploring human capital. The author is not aware of similar approaches to examining health capital. There are of course some differences to the method of examining health capital presented in this section and a typical examination of human capital. For example, earnings can be thought of as the return to human capital investment whilst measures of health can be thought of as a direct measure of the stock of health. Some measures of health, such as disability free days, might be more accurately thought of as a flow of services arising from the stock of health. However, as long as the relationship between the stock of health and the flow of services is proportional, measures of the flow of health services can also be used to examine changes in the stock of health.

In Figures 3a and 3b, I present age-health profiles by education group for Australia and Canada respectively. The age-health profiles were calculated as the mean of self assessed health status by age, and as expected, mean health status declines with age. What is most striking about both figures is that the difference in self assessed health by education groups is present at age 25 to 29 and remains roughly constant across all age groups. That is, whatever drives the relationship between education and health is present at a relatively early age and in both countries.

I derived gross investment profiles for Australia and Canada by assuming that each education group had a common exponential depreciation profile and by using the relationship

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have to be assumed away.

presented in equation 11. An exponential depreciation profile suggests that health stocks depreciate at an ever-increasing rate.[28] I calculate the depreciation profile by calculating the exponential of the set of numbers -3.4 to –1.2 by increments of 0.2. I could just as easily assumed a common linear depreciation profile. This would have changed the shape of the set of investment profiles presented in Figures 3c and 3d but it does not affect our ability to compare different education groups investment profiles.

Gross investment profiles for Australia and Canada are presented in Figures 3c and 3d respectively. There was remarkably little variation in the gross investment profiles by education group. This was not surprising given that the difference in mean self assessed health is so constant across age groups and the assumed common exponential depreciation profile.

[28] It could also be argued that the depreciation profile of the stock of health could vary by education group.

Figure 3a: Australian Mean Self Assessed Health Status by Age

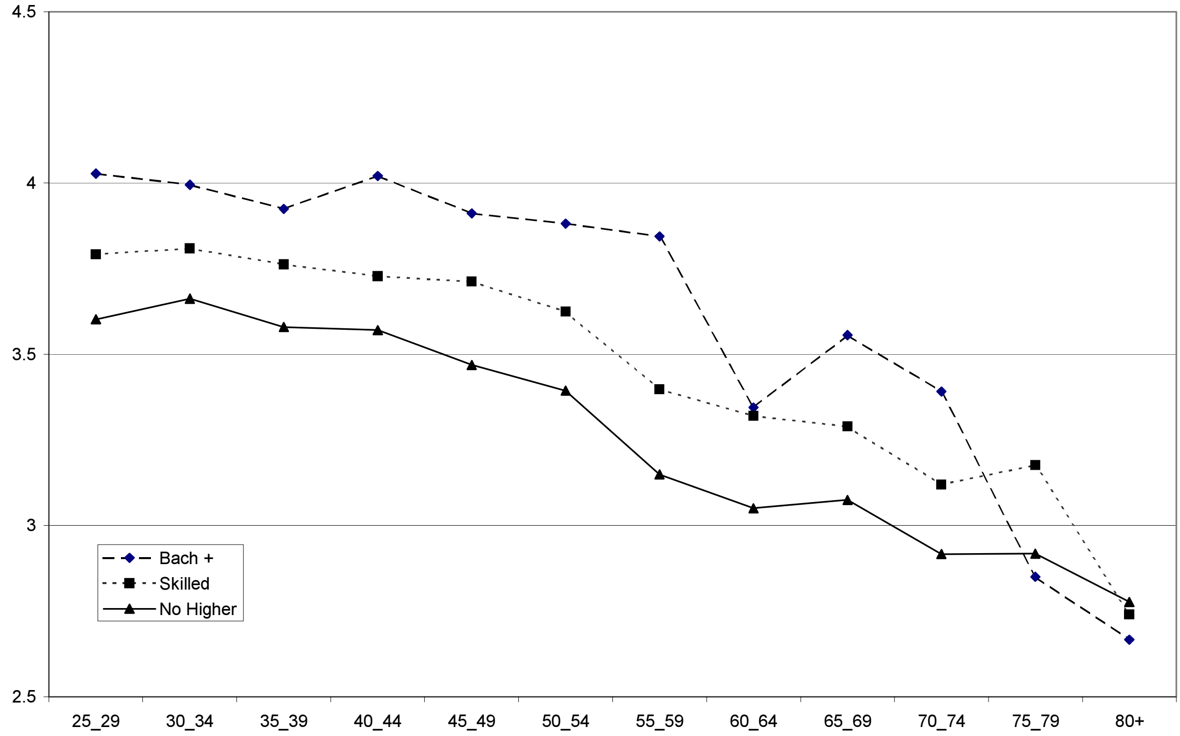


Figure 3b: Canadian Mean Self Assessed Health Status by Age

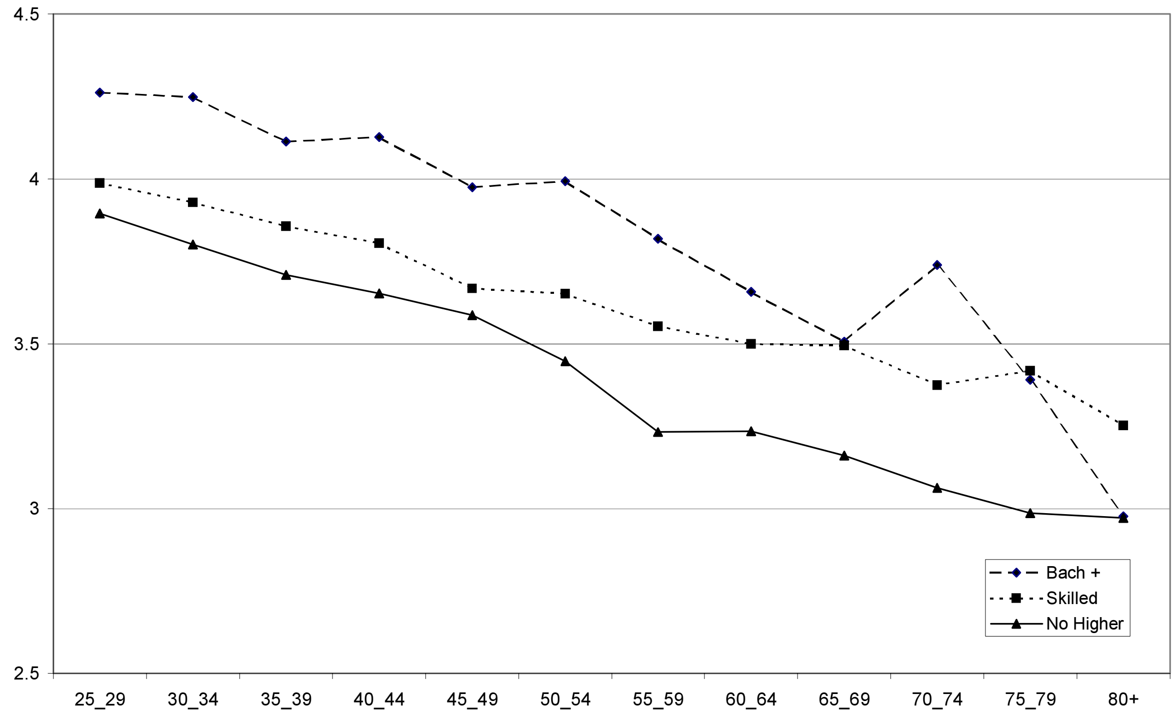


Figure 3c: Australian Derived Health Investment Profiles

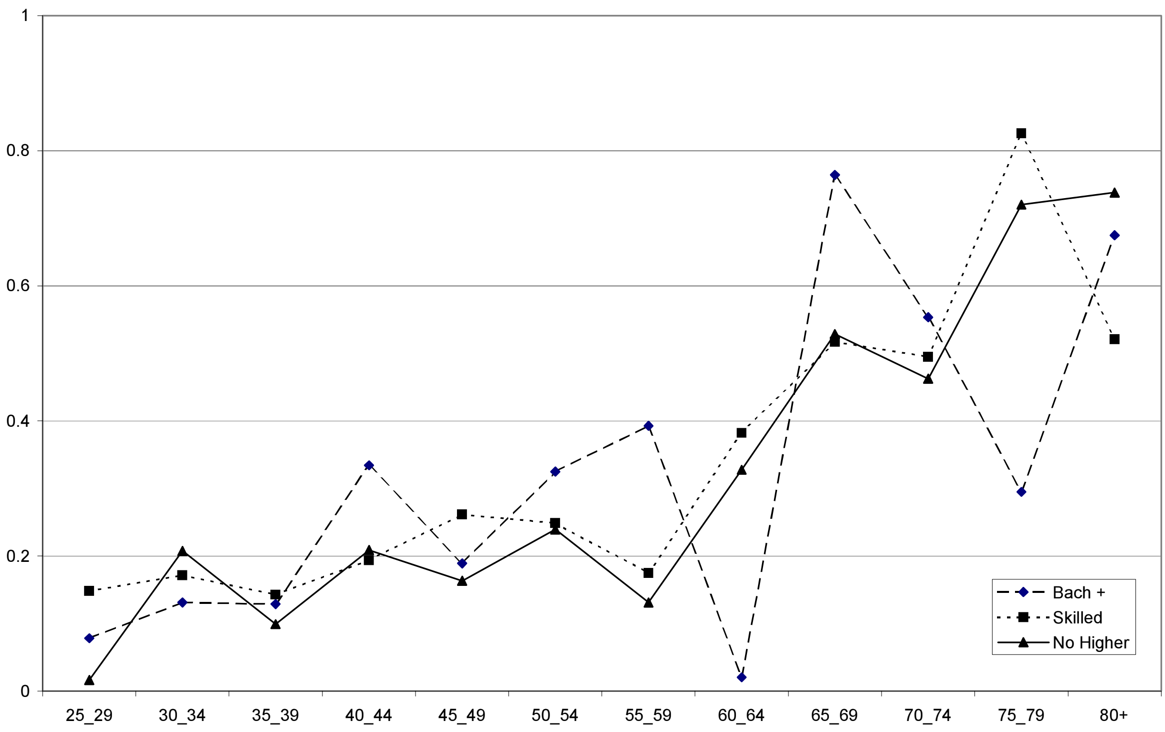
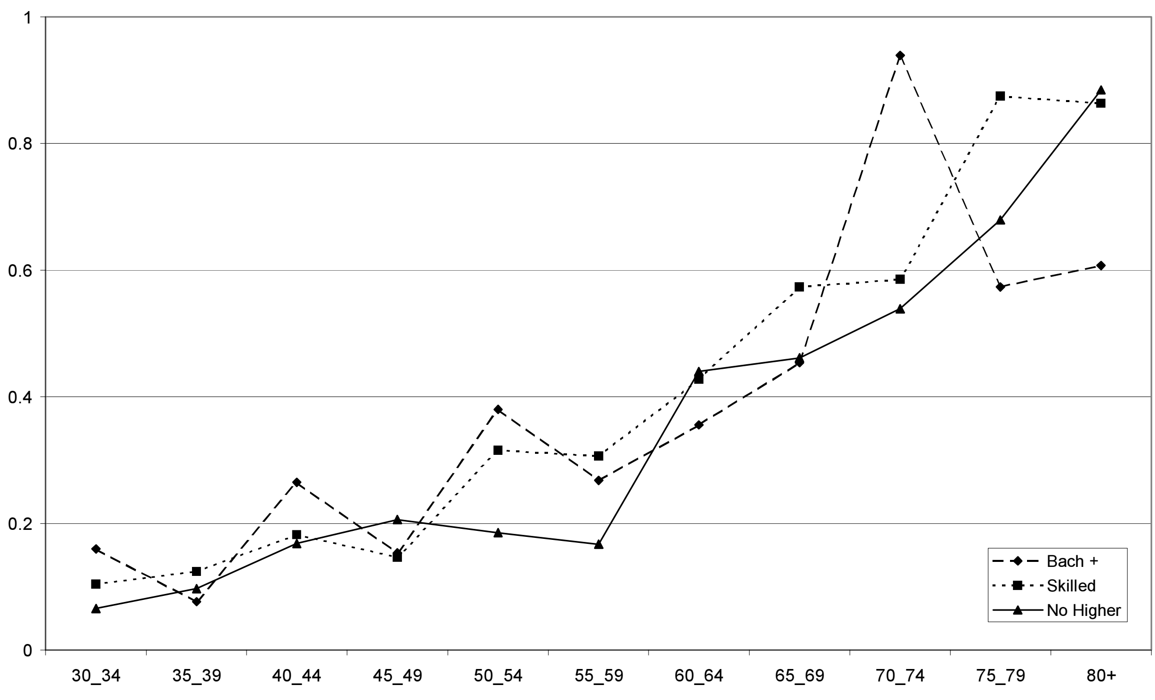


Figure 3d: Canadian Derived Health Investment Profiles



6 Conclusion

This paper has highlighted a number of interesting features of the education and health relationship. It has shown that the association between health and education in Australian and Canada is very similar. This is perhaps not surprising given similarities in the Canadian and Australian health care systems, and general economic conditions.

After clarifying the differences between technical and allocative efficiency and time preference explanations of the relationship between education and health, I presented some empirical evidence for each. In both Canadian and Australian data sets it was difficult to identify the underlying health production relationship given a lack of suitable instruments and data to identify preferences. However, I was able to show that the association of health to other important socio-economic variables does vary by education group and this may imply that the underlying production structure varies by education or that education groups interpret relative prices of inputs differently.

I attempted to isolate time preference heterogeneity by estimating regressions conditional on smoking status where smoking status was used as a time preference indicator. If the education and health relationship disappeared in these conditional regressions, this would be evidence that education is proxying for time preference. I found in one group (those who were smoking) that education coefficients did diminish in size and statistical significance. In other conditional regressions, the education effect remained at a similar level to the unconditional regressions. In the unconditional regressions smoking was included as an additional variable thus if smoking was working as a time preference indicator the education effect should have already been some what attenuated in these regressions.[29] This was in fact the case; the exclusion of smoking status from the unconditional regression did lead to the coefficients on the education dummy variables increasing. Thus, it appears that there is at least some time preference component in the education and health relationship.

Lastly, I examined the age-health profiles of different education groups and derived gross investment profiles. The most striking aspect of this exercise was that the differences in health between education groups were present at a young age and that the differences remained largely unchanged for all age groups. This resulted in investment profiles that were very similar across education groups. These results held for both the Canadian and Australian data. The lack of variation in investment profiles is suggestive of an efficiency effect as a time preference effect would probably see the less educated invest less at younger ages compared to older ages.

[29] In an unconditional regression, where smoking status was excluded the coefficients on bachelor or higher and skilled education categories increased to 0.285 and 0.135 respectively.

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