Understanding ‘Sheepskin Effects’ in the Returns to Education: The Role of Cognitive Skills*

PRELIMINARY

W. Craig Riddell
Department of Economics
University of British Columbia

November 2008

* Paper for presentation at the CLSRN Workshop, University of Toronto, November 18-19, 2008. I thank CLSRN for research support and Na Zhang for excellent research assistance.

Introduction

This paper investigates the role played by cognitive skills – specifically literacy, numeracy and problem-solving skills – as influences on the magnitudes of "sheepskin effects" in the returns to education. Sheepskin effects refer to gains in earnings associated with the completion of a diploma or degree, controlling for years of schooling. They can thus be interpreted as the value of program completion -- the difference in earnings between those with a diploma or degree and non-completers with the same years of schooling.

Why Sheepskin Effects Matter

Credential effects or "sheepskin effects" are important for understanding the returns to education. In their study of the returns to education for native born Canadians, Ferrer and Riddell (2002) find that both years of schooling and credentials are important determinants of earnings. The human capital earnings function in which earnings are assumed to depend only on years of schooling and the credentialist model in which earnings are assumed to be only a function of degrees received are clearly rejected in favour of a more general model that incorporates both years of completed schooling and certificates, diplomas and degrees received. There is therefore a rationale for including both dimensions of human capital in analyses of the returns to education, at least in situations in which the data contain measures of years of schooling and highest level of educational attainment.

The relevance of sheepskin effects for understanding the returns to education may be increasing over time. Ferrer and Riddell (2002) find that the relative importance of credentials rises with educational attainment, accounting for about 30% of the return to completing 16 years of schooling but more than half of returns above 16 years. As a greater proportion of the population enrolls in post-secondary education the importance of credential effects is thus likely to rise.

Sheepskin effects are also of research and policy interest because they provide estimates of the value of completing educational programs. Educational policy often focuses on program completion – whether at the secondary school level, trade and apprenticeship programs, or post-secondary education. If sheepskin effects were unimportant we would place as much emphasis on obtaining an additional year of secondary schooling for someone who would otherwise exit high school at the end of grade 10 as for someone who would exit at the end of grade 11. Similarly we would place as much emphasis on obtaining an additional year of university education, whether the individual has completed one, two or three years. Yet policies are often directed at program completion – reducing the number of high school dropouts or increasing the number of apprentices that complete their apprenticeship.

Sheepskin effects are also potentially important because they provide information about the way the labour market functions. Indeed, the existence and magnitude of sheepskin effects have been central to the debate over "human capital" versus "signaling/screening" theories of the role of education in the economy. In a widely cited paper Layard and Psacharopoulos (1974) dismissed the signaling hypothesis because their evidence did not support the "sheepskin prediction" that earnings of program completers exceed those of dropouts.[1] Subsequent studies generally find evidence of sheepskin effects, but have not fully resolved the debate between alternative theories of education. The finding (discussed below) that both years of schooling and degree receipt influence earnings does contradict simple learning models in which each year of schooling contributes equally and independently to productivity. This finding is, however, consistent with educational programs that consist of a package of complementary components, so that productivity and earnings should increase upon completion. Similarly, evidence of credential effects is also consistent with hybrid models of signaling and learning, such as Weiss (1983), in which employers use program completion as a predictor of unobserved characteristics such as motivation and perseverance that are difficult to measure directly. Sheepskin effects are also consistent with graduates having learned more in school than non-graduates with the same years of schooling. Such a finding accords with human capital theory if employers observe workers' skills but researchers do not observe these skills, and with signaling theory if employers do not observe workers' skills but use graduation as a predictor of skills. In this study I employ data containing direct measures of individuals' skills – information

[1] Note, however, that the Layard and Psacharopoulos estimates did not take account of years of schooling. Subsequent studies, discussed below, had access to better data.

that is generally not available to researchers -- which allows testing alternative explanations of the role of program completion.

Evidence on sheepskin effects

Much previous research has investigated the relationship between earnings and education.[2] Perhaps the most common measure of educational attainment – especially in U.S. studies – is years of completed schooling. Indeed, the simple "human capital earnings function" – in which the log of earnings is regressed on years of completed schooling, a quadratic in labour market experience, and other controls -- fits the U.S. data remarkably well (Card, 1999). Other studies measure educational attainment using dummies for highest level of education achieved. Most empirical research uses either years of completed schooling or highest level of educational attainment because both measures are typically not available in the data.

Early U.S. contributions to the literature on sheepskin effects such as Hungerford and Solon (1987) and Belman and Heywood (1991) looked for unusually large increases in earnings associated with years of schooling that correspond to educational milestones such as 12 years (high school graduation) and 16 years (university graduation). A shortcoming of such studies is that the data do not distinguish between graduates and dropouts. Since sheepskin effects are principally identified from earnings differences between completers and non-completers with the same years of schooling, this is an important limitation. Nonetheless, these studies do find evidence of sheepskin effects, especially associated with high school and university graduation. Subsequent U.S. studies such as Jaeger and Page (1996) and Park (1999) employ data that measures both years of completed schooling and receipt of diplomas and degrees.[3] These studies find stronger evidence of sheepskin effects that are non-trivial in size – earnings gains of 9-10 percent associated with high school graduation, 11 percent with an Associate's degree (two year college), and 20-30 percent associated with a Bachelor's degree (four year college).

---

[2] See Card (1999) for a survey of research in this area.

[3] In 1992 the educational attainment questions in the U.S. Current Population Survey changed from years of schooling to degree receipt. These studies utilize the fact that some respondents answered the old and new questions.

These studies also conclude that assuming that program completion occurs at “normal” times such as 12, 14 and 16 years results in substantial under-estimation of sheepskin effects.

Ferrer and Riddell (2002) take advantage of the richness of Canadian Census data which provides information on both years of schooling and all certificates, diplomas and degrees received. They conclude that sheepskin effects are also important in the Canadian labour market, with magnitudes for native born Canadians that are similar in size to those estimated for the U.S.: 4% to 6% for high school completion; 6% for completion of a community college or trade school program without a high school diploma; 3% to 5% for completion of a community college or trade school program with a high school diploma; and over 20% for a university Bachelor’s degree. This study provides clear evidence that program completion (degree receipt) is associated with higher earnings even after controlling for years of schooling and other influences.

Credential effects also appear to be quantitatively more important for some groups than others. Ferrer and Riddell (2008) conclude that degree completion has an impact on the earnings of immigrants to Canada that is at least as large as, and often larger than, that for native born Canadians. Understanding the role of program completion is thus important for understanding earnings differences among various groups, such as those between immigrants and the Canadian born.

Data and methodology

Although the presence and approximate magnitudes of sheepskin effects in the Canadian labour market are now well established, the behavioral mechanisms that give rise to these effects are not well understood. The principal objective of the paper is to determine the extent to which sheepskin effects reflect cognitive skills that are unobserved by the researcher, but that may be observed by the individual employee and/or the employer. To do so I use data that contains not only measures of years of completed schooling and levels of educational attainment but also direct measures of cognitive skills. The data source containing this rich information is the International Adult Literacy and Skills Survey (IALSS), a survey conducted by Statistics Canada in 2003. The IALSS includes standard questions on demographics and labour market behaviour, but importantly it also measures cognitive skills in four broad areas: Prose literacy, Document literacy, Numeracy and Problem Solving.

Perhaps of most importance for our discussion, the IALSS did not attempt to just measure abilities in math and reading but tried to assess capabilities in applying skills to situations encountered in everyday life. Thus, the Prose literacy questions in the survey assess skills ranging from items such as identifying recommended dosages of aspirin from the instructions on an aspirin bottle to using an announcement from a personnel department to answer a question that uses different phrasing from that used in the text of the announcement. The Document literacy questions, which are intended to assess capabilities to locate and use information in various forms, range from identifying percentages in categories in a pictorial graph to assessing an average price by combining several pieces of information. The Numeracy component ranges from simple addition of pieces of information on an order form to calculating the percentage of calories coming from fat in a Big Mac based on a nutritional table.

The 2003 IALSS contains information on 23038 individuals aged 16 and over. The goal of this paper is to focus on cognitive skills generation (and their labour market consequences) in Canada, including such influences as the Canadian educational system. As a result, I focus the analysis on those born in Canada. The IALSS survey over-sampled certain aboriginal groups, thus providing sufficient numbers of observations to report separate results for aboriginals.[4] Because the educational attainment and skills of aboriginals are very different from those of other Canadian born, aboriginals are omitted from the analysis in this paper and will be examined separately. In order to highlight the complete effects of schooling and what happens to cognitive skills afterwards, individuals who list their main activity as “student” are also excluded from the sample. Finally, because of the importance of accurate measures of educational attainment for analysing credential effects, those who did not report their highest level of education are also excluded. The result is a Canadian born non-aboriginal sample of size 14,637. This sample is used to investigate the role of program completion in generating literacy, numeracy and problem-solving skills in Canada. However, when attention turns to the

[4] The IALSS over-sampled aboriginals living in urban areas in Manitoba and Saskatchewan and Inuit living in Nunavut.

determinants of earnings, the sample is further restricted to paid workers with weekly earnings that are over $50 and less than $20,000. The self-employed are excluded because the study focuses on the labour market returns to cognitive skills, and self-employment earnings reflect both that remuneration and returns to capital. Dropping those with extremely low or high reported earnings eliminates a small number of individuals with weekly earnings that are substantial outliers relative to the rest of the sample. After these exclusions the worker sample consists of 7,766 individuals. The sample survey weights are used to generate all summary statistics and regression estimates, so the results are nationally representative.[5]

Cognitive skill scores within each of the four domains are reported as 5 “plausible values” for each person. While documentation associated with the IALSS data recommends first calculating a given statistic for each plausible value and then averaging across the statistics, this extra step is unnecessary here because the analysis focuses on averages and mean regressions. In these circumstances the results are identical whether one first estimates the relevant statistics for each plausible value separately and then calculates averages, or first averages the scores and then estimates the relevant statistics. Thus I use the average of the five plausible values for each cognitive skill throughout.

One defining feature of the IALSS data is the strong correlation among the various cognitive skill scores. In the sample used here the correlation between the Prose literacy and Document literacy scores is .94, the correlation between Prose literacy and Numeracy is .85, and the correlation between the Prose literacy and Problem Solving scores is .89. Further, a principal components analysis indicated only two principal components with the first being vastly more important and placing equal weight on all four scores. Thus, a simple average of the scores captures much of the information available in the four scores, and is the cognitive skill measure that is employed in this paper. Some results for the individual cognitive skill measures are reported in the Appendix.

There are two distinct parts to this investigation. The next section analyses the role of sheepskin effects in the generation of cognitive skills. This part addresses the

[5] The use of the survey weights is particularly important in this study because the IALSS over-sampled a number of groups. These over-sampled groups thus receive greater representation in the unweighted data than is appropriate given their representation in the population.

question: are graduates of educational programs more skilled than dropouts with the same years of schooling? The second part of the analysis examines the contribution of cognitive skills to sheepskin effects in the economic returns to education. The part addresses the question: to what extent are the sheepskin effects estimated in earlier studies due to unobserved cognitive skills?

Are graduates more skilled?

The IALSS data contains rich information on educational attainment. Of particular importance to this study, the survey asked about years of completed schooling and the highest level of education ever attained. In addition there is a separate question on high school graduation.[6] This latter question is especially valuable because a significant number of Canadians who report that they have completed some form of post-secondary education have not graduated from high school.[7]

Based on the responses to the education questions, six main categories of educational attainment are defined: less than high school, high school graduate, non-university post-secondary graduate without completed high school, non-university post-secondary graduate with completed high school, university bachelor's degree, and university postgraduate degree (includes Master's, professional degrees such as Law and Medicine, and PhD degrees).

Table 1 reports summary statistics for the full sample of 14,637 non-aboriginal native born Canadians (workers and non-workers), as well as separately by gender. Average age is 45 years, with the females in our sample being almost 2 years older than the males. We measure work experience in the usual Mincer fashion: Age – Years of schooling – 6. Because it assumes that individuals enter the labour force immediately

---

[6] The respective questions are:
A3 "During your lifetime, how many years of formal education have you completed beginning with grade one and not counting repeated years at the same level? Convert any part-time schooling to its full-time equivalent."
A4A "Have you graduated from high school (including high school equivalency)?"
A4C "What is the highest level of schooling that you have <u>ever</u> completed?"
Those who answered "No" to the high school graduation question were also asked A4B "What is the highest grade of elementary or high school that you have ever completed?" prior to the question on highest level of education ever completed.

[7] According to the 1996 census, almost 30% of FYFT workers are in this category (Ferrer and Riddell, 2002).

after completing their formal schooling and work continuously until the date of the survey, this measure generally overstates actual experience more for females than for males. Mean years of schooling is 13 years, and is about the same for men and women. Given the gender differences in age, Mincer experience is approximately two years greater for females than for males.

Although average years of schooling are approximately the same for males and females, there are some noteworthy gender differences in the distribution of highest level of education. Approximately one-quarter of the sample have less than completed high school, and a further 2.5% are high school dropouts who subsequently obtained a post-secondary diploma or certificate. Males are more likely to be members of both these groups, whereas females are more prevalent among the high school graduates, a group that constitutes close to one-third of the sample. Less than 20% of the sample has a university degree, and almost one-quarter completed both high school and a non-university post-secondary education program.

The educational attainment of the parents of IALSS respondents is much lower, reflecting the rise in education over time in Canada. Almost one-half of the sample report that their mother did not graduate from high school, and about 45% report that their father was a high school dropout. About 11% had a father with a university degree, and 7.5% report that their mother had graduated from university. The more rapid rise in educational attainment among women than among men is also evident in the parental education data, with the current generation of women being much more well educated than their male counterparts compared to the previous generation. Second generation immigrants constitute 15% - 20% of our Canadian born non-aboriginal sample. Having an immigrant father is more likely than having an immigrant mother.

The survey includes some questions about the ease or difficulty that respondents experienced with learning mathematics while in high school. These are used in the empirical analysis as proxies for innate ability. More than two-thirds report that they “got good grades” in math, whereas about one-quarter report that they found that “teachers went too fast and I often got lost.” There is a large gender difference in these responses, with females less likely to state that they got good grades in math and substantially more likely to report that teachers went too fast.

The cognitive skill scores are measured on a scale that runs from 0 to 500. Looking first at the average of the four cognitive skills, the mean score is 275, and is about 4.5 points higher for males than females. Gender differences are most pronounced in the numeracy scores, and least pronounced in problem solving. Females obtain higher average scores on prose literacy, while males obtain higher average scores on the other three skills.

Figure 1 plots mean cognitive skills by mean years of schooling.[8] Skills increase with schooling but at a decreasing rate, suggesting that there may be diminishing returns to formal schooling in producing cognitive skills. This is not surprising because the skills that are being assessed are not high level skills. A good high school graduate should do well on the IALSS skill tests; a good university graduate should do better, but perhaps not in proportion to the additional amount of formal education. Also shown in Figure 1 is a regression line fitted to the bivariate relationship between cognitive skills and years of schooling using a quadratic specification. This fitted regression line uses all of the individual observations so does not place equal weights on each of the cell means shown in the figure. The simple quadratic fits the data well – the only noteworthy deviation occurs at high levels of schooling (25 and 26 years) where there are relatively few observations. Similar figures for each of the four skill domains assessed in IALSS are shown in the Appendix. The shape of the distribution is very similar for each of these skills.

Inspection of Figure 1 does not reveal much evidence of sheepskin effects. The average skills at 12 years of schooling-- the number of years normally associated with high school completion-- lies slightly above the fitted regression line, but the comparable mean skill level associated with 16 years of schooling (normal for university graduates) is on the regression line. However, it is worth keeping in mind one of the lessons of earlier research – years of schooling is an imperfect indicator of program completion. The 12 years of schooling group, for example, includes both high school graduates and high school dropouts with some (perhaps incomplete) post secondary education.

[8] For the purposes of this figure we treat years of schooling less than or equal to 6 years as being equal to 6 years, and years of schooling equal to or greater than 26 years as equal to 26. There are only a few observations at these tails of the schooling distribution.

Figure 2 plots mean cognitive skills by highest level of education, using our six main educational categories. Also shown is the regression line fitted to the individual observations using the quadratic specification. The simple quadratic fits the data remarkably well. The average skills of high school graduates are slightly above the fitted line, while those for non-university post-secondary graduates are a bit below.

As Figure 2 makes clear, it is important to be able to distinguish between non-university post-secondary graduates who did not complete high school and those that did graduate from high school. In most data sets it is not possible to identify these two groups, which are therefore treated as a single "post-secondary" educational category. In fact the two groups differ substantially in their years of completed schooling and in their cognitive skills. Indeed, on both measures post-secondary graduates that did not complete high school are substantially below not only their counterparts who completed high school, but also high school graduates without post-secondary education.

In order to assess whether the correlations observed in the raw data continue to hold when we control for other influences, Table 2 reports a series of regressions designed to analyse the factors that influence cognitive skills. The dependent variable is the log of the skill score, so the estimated coefficients can be interpreted easily as showing the percentage change in the skill score associated with a unit change in the relevant explanatory variable. The first column presents the simplest specification in which the explanatory variables are age, age squared, years of schooling, years of schooling squared, and a gender dummy. The non-linear specification of the age and education variables allows for the relationship between cognitive skills and both age and years of schooling to be concave.

The estimates indicate that women have lower skill levels than men (conditional on education and age) but the gender difference is very small – less than 2%. Similarly, the age and age squared coefficients are small in magnitude, although they are statistically significant.[9] The finding that there is essentially no relationship between literacy skills and either age or experience is a key part of the discussion in Green and Riddell (2003). The one relationship that is economically substantial is the one between

[9] For example, an additional year at age 20 raises skills by less than .3% and an additional year at age 30 by less than .2%.

cognitive skills and schooling. At low levels of education, an additional year of schooling is associated with an increase in skills of more than 6%. This finding of a quantitatively large and statistically significant relationship between skills and educational attainment is similar to what Green and Riddell (2003) obtained using the 1994 IALS data. The negative coefficient on the schooling squared variable implies that the partial relationship between literacy skills and years of schooling is concave, as was suggested by Figure 1. One extra year of schooling, evaluated when the individual already has 12 years of education, increases skills by 3.2%.[10] For those with 16 years of schooling, an additional year of education raises cognitive skills by 2.1%.

The second column of Table 2 replaces years of schooling (and its square) with dummies for highest level of education. Relative to high school dropouts without additional education, dropouts who completed a non-university post-secondary program have skills that are 11% higher, after controlling for age and gender. Skills of high school graduates are 15% higher than those of dropouts, and higher levels of educational attainment are, as expected, associated with higher levels of cognitive skills.

Column 3 presents the estimates of sheepskin effects. Note that the sheepskin dummies are specified in a cumulative fashion; for example, the dummy for high school completion equals one for all those who graduated from secondary school, including those that proceeded to college and university. Similarly, the sheepskin dummy for a university bachelor's degree equals one for all university graduates, including those that also completed a postgraduate program.

The estimates in column 3 provide clear evidence of sheepskin effects in the generation of cognitive skills. The largest individual sheepskin effect is that associated with high school completion. High school graduates have 6.7% higher skills than high school dropouts with the same years of schooling. There is also a moderately large sheepskin effect associated with completing a post-secondary program among those that did not graduate from high school. Among high school graduates, completing a post-secondary diploma or certificate adds an additional 1.1% to skills, over and above the

[10] This number is obtained by taking the first derivative of the schooling profile and evaluating it at years of schooling equal to 12.

impact of high school graduation. Similarly, university graduates have higher skill levels than non-graduates with the same years of schooling.

Note that adding the sheepskin dummies to the basic specification in column 1 reduces the estimated effects of years of schooling by approximately 1/6th. The estimated impact of age on skills also declines, though it remains statistically significant.

Column 4 adds controls for parental education and parental immigrant status. Doing so results in somewhat smaller estimated effects of years of schooling and completion of educational programs. Nonetheless, the estimated sheepskin effects remain similar in size to those reported in column 3. Perhaps the most substantial change is that to the coefficients on the age variables, which approximately double in size. However, despite this increase the net effect of age on cognitive skills remains quite small. For example, at age 30 an additional year of age is associated with a decline in cognitive skills of 0.3%. The corresponding changes evaluated at ages 40 and 60 are 0.5% and 0.9% respectively. These estimates imply that skills decline by about 10% between age 60 and age 70, after controlling for gender, educational attainment, parental education and parental immigrant status.

The parental education variables are jointly highly significantly different from zero. Interestingly, the effect is found almost entirely at low levels of parental education. Relative to the base category (parent who is a high school graduate), having a parent who is a high school dropout is associated with skills that are approximately 3 ½% lower in the case of the mother and 2 ½% lower in the case of the father. However, parental education beyond high school graduation has little or no further impact on cognitive skills at conventional significance levels. Interestingly, non-response to the question about parent’s education (which is the case for approximately 6% to 7% of the sample) has a strong effect, being associated with approximately 5% to 6% lower skill levels. While this variable was included in order to allow us to retain the observations for which parental education is missing, it seems possible it actually represents something real. One category of non-response is “not applicable” which may refer to individuals who grew up without a female or male parent or guardian. Another sizeable category is “don’t know.” Children who do not know a parent’s education may not have had a close relationship with that parent. Thus, for both the “not applicable” and “don’t know” responses the estimated coefficient may reflect the extent to which skills are generated through direct parental involvement.[11] Finally, having a mother or father who is an immigrant has no impact on cognitive skills. Overall, the results point to a surprisingly limited role of parental background as a determinant of skills. Having an immigrant parent has no significant impact on skills. Parental education matters, but the impact is limited to having a parent with high school education or higher. Having a mother or father with post-secondary education exerts little or no additional impact. The individual's own schooling, however, does appear to have a substantial impact on skill generation, one that continues – albeit at a diminished rate – into the post-secondary range of educational attainment. Further, there is clear evidence that those who complete educational programs are more skilled than their non-completing counterparts, controlling for years of schooling and other influences, including parental education.

Cognitive skills and educational attainment – whether captured by years of schooling or program completion -- are likely to be jointly determined. In particular, there may be a correlation between cognitive skills and schooling arising from unobserved ability. If high ability people are more likely to acquire skills as well as continue in school then we could observe a positive regression coefficient on schooling because schooling is correlated with ability rather than because of a causal impact of schooling on skills. In these circumstances the OLS estimates will be biased. Unfortunately, it is not possible to employ an instrumental variables (IV) strategy in this setting because any suitable instruments for years of schooling are also likely to influence completion of educational programs. This problem could be addressed if a measure of ability were available. Ideally this would require a test score such as IQ from a very young age - before the skill generation process really begins. In the absence of such a measure, I instead try to proxy for ability using two variables that are plausibly related to it. In particular, the regression in column 5 includes a dummy variable equalling one if the person agreed or strongly agreed with the statement that they got good grades in math when they were in high school and another dummy variable equalling one if the respondent agreed or strongly agreed with the statement that teachers often went too fast and the person often got lost. Either of these could plausibly be seen as proxies for innate

[11] A third non-response category is "refused to answer."

ability. Both of these variables enter significantly, with people who claimed to have gotten good grades in math having 2.2% higher skill levels and those who thought teachers went too fast having 2.6% lower skills. Including these variables does reduce the estimated impact of years of schooling on cognitive skills by about 15%. This modest decline in the estimated impact of years of education is consistent with the OLS estimates in columns 1 to 4 being upward biased because of unobserved factors such as ability that are correlated with both educational attainment and skills. However, the estimated sheepskin effects change relatively little when these proxies for unobserved ability are included. Thus the principal finding of this section is not altered by this attempt to control for the influence of unobserved ability. There is clear evidence of sheepskin effects in skills generation: graduates are more skilled than non-graduates, controlling for years of completed schooling and other influences on cognitive skills.

Earnings, education and cognitive skills

Previous studies of the economic returns to education find evidence of sheepskin effects. However, as discussed earlier in the paper, it is not clear how to interpret these estimates. One interpretation is that they can be attributed to omitted variables that are typically unobserved by researchers, such as cognitive and non-cognitive skills. For example, if graduates exhibit greater perseverance, or possess greater numeracy skills, than do non-graduates, the higher earnings of those with credentials could reflect the labour market consequences of their greater skills.

The IALSS data allows us to assess this interpretation by examining the contribution to earnings of an important set of cognitive skills – literacy, numeracy and problem solving. To do so I first estimate several earnings regressions similar to those reported in previous studies. Cognitive skills are then added as an additional control. If sheepskin effects reflect variables that are omitted in earlier studies, inclusion of direct measures of skills should substantially reduce (perhaps to zero) the magnitudes of estimated credential effects.

Column 1 reports a standard log earnings regression similar to those reported in many previous studies of the relationship between education and earnings.[12] The results

[12] See Card (1999) for a survey of this literature.

are also very similar to those reported elsewhere. Thus there appears to be nothing unusual about the measurement or behaviour of education, experience and earnings in the IALSS data. Labour market experience exerts a strong effect on earnings, with the familiar concave shape reflecting diminishing returns to experience. Early in the career an additional year of experience is associated with an increase in earnings of about 6.6%. This return to experience diminishes to about 5.4% after 5 years of experience, to 4.3% after 10 years, and to 2.1% after 20 years. Females earn weekly wages that are approximately 40% below those of males after controlling for work experience and education. The partial relationship between earnings and years of schooling is approximately linear.[13] Each additional year of schooling is associated with weekly earnings that are 8.9% higher. Under certain assumptions this estimate implies that the real rate of return to formal education is about 9%.

Column 2 reports estimates of the same log earnings equation, except that highest level of education rather than years of schooling is used to measure educational attainment. The fit of this equation is a bit better, and the impact of experience on earnings is somewhat lower than in the relationship estimated in column 1. Nonetheless the results are broadly similar. Relative to high school dropouts, those with a high school diploma and no further completed education have earnings that are 29% higher. Among those who did not graduate from secondary school, the estimated impact on earnings of a non-university post-secondary certificate or diploma is very similar to that of high school completion – 29%. High school graduates who also complete a non-university post-secondary education program earn more than 50% more than high school dropouts, while those with university bachelor's degrees and postgraduate degrees earn, respectively, 85% and 100% more than dropouts.

The results in column 2 also confirm the importance of distinguishing between non-university post-secondary graduates who completed high school and those who did not. The earnings of the latter group are very similar to high school graduates without any post-secondary education than to college and trade school graduates who finished high school.

[13] All of the regressions reported in Tables 4 and 5 were also estimated including years of schooling squared. The quadratic term was insignificant in all cases.

Column 3 reports the estimated sheepskin effects. Addition of the sheepskin variables results in little change in the coefficients on gender and age. However, as expected, the coefficient on years of schooling is much lower than in column 1. Nonetheless, years of schooling remains an important predictor of earnings, even after we control for credentials received. The pattern of credential effects is similar to that obtained with census data in Ferrer and Riddell (2002). However, the magnitudes of the estimated sheepskin effects are larger.[14] High school completion is associated with an increase in wages of about 21%, controlling for years of completed schooling. Among those who did not finish secondary school, obtaining a trade certificate or college diploma is associated with a similar increase in wages of about 23%. Those who obtain a post-secondary diploma after high school have earnings that are 38% higher than dropouts with the same years of schooling (21% for high school completion plus 17% associated with completing a college or trade school program). University bachelor's graduates earn 43% more than high school graduates with the same years of schooling. There is an additional sheepskin effect of 7% associated with a postgraduate degree; however, this estimated coefficient is not significantly different from zero.

The next three columns of Table 4 add controls for cognitive skills to the equations estimated in columns 1 to 3. The estimates of the gender and age coefficients change very little as a consequence of controlling for skills. However, the estimated coefficients on years of schooling and on the highest level of education decline by about 20%. For example, the coefficient on years of schooling falls from 8.9% in column 1 to 7.1% in column 4, and the magnitudes of the decline in the education coefficients in column 5 are similar. As discussed in Green and Riddell (2003), this decline indicates that education plays an important role in generating cognitive skills, but that formal education also has a large impact on earnings over and above its impact on the production of cognitive skills. The decline of 20% in the estimated impact of schooling is, however, smaller than that obtained by Green and Riddell (2003) with IALS data.[15]

---

[14] This difference may reflect the much better measure of weekly wages in the IALSS data. Census data provides information on annual earnings and weeks worked in the previous year, both subject to recall bias because the census is taken in June. The weekly earnings measure used in census studies is obtained by dividing annual earnings by weeks worked.

[15] The difference may reflect a more flawed measure of earnings in the 1994 IALS data.

The key results for this study are reported in column 6. The addition of controls for cognitive skills does result in a decline in the size of the estimated sheepskin effects. The decline is largest for the impact of high school completion – a drop of 4.2 percentage points or about 22%. The decline in the estimated sheepskin effect associated with completion of a non-university post-secondary program by high school dropouts is half that size – about 11%, while the declines in the estimated credential effects associated with a college diploma or university degree (among high school graduates) are relatively modest in size – about 6% to 8%.

These results suggest that estimated sheepskin effects reported in previous studies do reflect, in part, the omission of controls for cognitive skills. When direct measures of these skills are available, estimated credential effects decline, with the largest decline being at the lower end of the education distribution. In other words, an important part of estimated sheepskin effects associated with high school completion that have previously been reported in the literature can be attributed to the fact that high school graduates are more skilled than dropouts with the same years of formal education. At the same time, moderately large sheepskin effects remain even after conditioning on directly measured cognitive skills. Thus the fact that literacy, numeracy and problem solving skills are omitted variables in most studies of the determinants of earnings cannot fully account for the presence of credential effects in the labour market. The sheepskin effects that remain after we control for the cognitive skills measured in IALSS could reflect the role of non-cognitive skills such as perseverance, determination and ambition – each of which could be correlated with the probability of completing an educational program. Alternatively they could reflect cognitive skills other than those measured in the IALSS survey.

Both education and cognitive skills may be correlated with innate ability, producing omitted variables bias in the estimates reported in Table 4. A common way of dealing with this situation is to use an instrumental variables (IV) strategy. However, it is difficult to implement this approach in this setting because any IV that influences educational attainment is likely to affect both years of schooling and completion of educational programs. An alternative strategy employed here is to attempt to control for the omitted ability variable by including proxies for innate ability. The proxies used are those employed previously: the responses to questions about the ease or difficulty that respondents experience when learning mathematics in high school. These results are reported in table 5. Columns 1, 3 and 5 add the proxies for unobserved ability to the equations in columns 1, 2 and 3 in table 4 – i.e. to the equations that did not include controls for cognitive skills. Columns 2, 4 and 6 in Table 5 add the ability proxies to the regressions in Table 4 that include controls for skills – i.e. those in columns 4, 5 and 6 in Table 4.

Looking first at the estimated equations that do not include controls for skills, the controls for unobserved ability do predict earnings. For example, in column 1 the coefficient on “good grades” is + 5.8% and that on “teachers too fast” is – 7.8%, a combined effect of almost 14%. Including these controls results in a decline in the female coefficient of 1.4 percentage points; thus a small amount of the male-female earnings gap appears to be associated with females having greater difficulty in learning mathematics than males, a difference that is also consistent with women having lower numeracy skills than men in the IALSS sample. Inclusion of the ability proxies also results in a small drop in the coefficient on years of schooling – which declines from 8.9% to 8.7% -- which is consistent with some of the estimated return to schooling in fact being due to innate ability that is correlated with both schooling and earnings. However, perhaps what is most remarkable about the decline in the estimated returns to schooling is how small it is.

Column 2 in Table 5 adds the innate ability proxies to the specification that includes cognitive skills. Comparing column 4 in Table 4 to these estimates reveals that the coefficient on cognitive skills changes very little and remains highly significant. In contrast, the proxies for ability are now either not significantly different from zero or marginally significant at the 10% level. Their magnitudes are also smaller than those in column 1 that did not control for skills. These results suggest that once we include controls for directly observed cognitive skills there is little additional role for innate ability. The contribution of innate ability to earnings is its contribution to the generation of cognitive skills, so that when cognitive skills are observed there is no additional impact of ability.

The remaining estimates reported in Table 5 tell a very similar story. Proxies for ability have large estimated effects when controls for cognitive skills are not included, but smaller and insignificant or marginally significant estimated impacts when the skill variable is included. The estimated impact of cognitive skills on earnings remains large and statistically significant, and its magnitude does not change much when proxies for innate ability are included. The size of the estimated sheepskin effect reported in column 6 of Table 5 is very similar to those obtained without including controls for innate ability. Thus the conclusions about the pattern and magnitudes of credential effects are not affected in any significant way by this method of dealing with omitted variables bias.

Conclusions

This paper investigates the role played by cognitive skills – specifically literacy, numeracy and problem-solving skills – as influences on the magnitudes of "sheepskin effects" in the returns to education. Sheepskin effects refer to gains in earnings associated with the completion of a diploma or degree, controlling for years of schooling. They can thus be interpreted as the value of program completion -- the difference in earnings between those with a diploma or degree and non-completers with the same years of schooling.

The analysis leads to three principal conclusions. First, I find evidence of sheepskin effects in the generation of cognitive skills. Those who complete educational programs are more skilled than those who drop out of programs, after controlling for years of completed education. To my knowledge this is the first evidence that graduates are more skilled than non-graduates with the same years of schooling.

The second finding is that sheepskin effects in the returns to education do in part reflect the fact that program completers are more skilled than non-completers, controlling for years of schooling. The addition of directly observed measures of literacy, numeracy and problem solving skills to the earnings equation results in a decline in estimated sheepskin effects in the order of 20%. The fact that the estimated impacts of credentials do not decline by a greater amount leads to the third principal conclusion. Estimated sheepskin effects remain large even when directly observed skill measures are included in the earnings equation. These credential effects may reflect other, perhaps non-cognitive, skills such as perseverance that are correlated with program completion and productivity, and thus reflected in higher earnings.

References

Belman, Dale and John S. Heywood. "Sheepskin Effects in the Returns to Education: An Examination of Women and Minorities" *Review of Economics and Statistics* 73 (November 1991), pp. 720-24.

Card, David. "The Causal Effect of Education on Earnings" in Orley Ashenfelter and David Card (eds.), *Handbook of Labor Economics,* vol.3. NewYork: Elsevier, 1999.

Ferrer, Ana M., David A. Green and W. Craig Riddell. “The Effect of Literacy on Immigrant Earnings,” *Journal of Human Resources,* Spring 2006, pp. 380-410.

Ferrer, Ana M. and W. Craig Riddell (2002) "The Role of Credentials in the Canadian Labour Market" *Canadian Journal of Economics* 35, 879-905.

Ferrer, Ana M. and W. Craig Riddell (2008) “Education, Credentials and Immigrant Earnings” *Canadian Journal of Economics* 41, 186-216.

Green, David A. and W. Craig Riddell. “Literacy and Earnings: An Investigation of the Interaction of Cognitive and Non-Cognitive Attributes in Earnings Generation” *Labour Economics*, Vol. 10, No. 2, April 2003, pp. 165-184.

Green, David A. and W. Craig Riddell. “Literacy and the Labour Market: The Generation of Literacy and Its Impact on Earnings.” Ottawa: Statistics Canada, November 2007.

Hungerford, Thomas and Gary Solon. "Sheepskin Effects in the Returns to Education" *Review of Economics and Statistics* 69 (1987) pp. 175-77.

Jaeger, David A. and Marianne E. Page. "Degrees Matter: New Evidence on Sheepskin Effects in the Returns to Education" *Review of Economics and Statistics* 78 (1996) pp. 733-740.

Kane, Thomas J. and Cecilia Elena Rouse. "Labor-Market Returns to Two- and Four-Year College" *American Economic Review* 85 (June 1995) pp. 600-14.

Layard, Richard and George Psacharopoulos. "The Screening Hypothesis and the Returns to Education" *Journal of Political Economy* 82 (September/October, 1974) pp. 985-98.

Park, Jin Heum. "Estimation of Sheepskin Effects Using the Old and the New Measures of Educational Attainment in the Current Population Survey" *Economic Letters* 62 (1999), pp 237-240.

Tyler, John H., Richard J. Murnane and John B. Willett. "Estimating the Labor Market Signaling Value of the GED" *Quarterly Journal of Economics* 115 (May 2000) pp. 431-468.

Weiss, Andrew. "Human Capital vs. Signalling Explanations of Wages" *Journal of Economic Perspectives* 9 (Fall 1995) pp.133-54.

Table 1 Summary Statistics for the Full Sample

	Males	Females	Both Genders
Age	44	45.8	44.9
Experience	25.1	26.9	26
Years of Schooling	12.9	13	12.9
Educational Attainment			
% Less than High School	26.5	23.1	24.7
% High School	30.5	33.7	32.1
% Non Univ PS w/o HS	3.1	1.9	2.5
% Non Univ PS with HS	21.9	24	23
% University BA	12.7	13.6	13.2
% Univ Postgrad	5.3	3.7	4.5
Mother's education			
% Less than High School	41.2	48.3	44.8
% High School	29	23.4	26.1
% Some Post Secondary	12.7	15.2	14
% BA or higher	8.2	6.8	7.5
% None reported	8.9	6.3	7.6
Father's education			
% Less than High School	47	50.6	48.8
% High School	20.3	18.9	19.6
% Some Post Secondary	12	11.2	11.6
% BA or higher	11.7	10.5	11.1
% None reported	9	8.8	8.9
Immigrant Parents			
% Immigrant mother	16.4	15.6	16
% Immigrant father	19.4	17.9	18.6
Math in high school			
% Good math grades	70.8	66	68.3
% Teachers went too fast	21.4	30.8	26.2
Prose Literacy	278.1	282.9	280.6
Document Literacy	280.6	275.8	278.2
Numeracy	277.4	261.2	269.2
Problem Solving	273.8	273	273.4
Average Skill Score	277.5	273.2	275.3
Number of Observations	6693	7944	14637

Table 2 Sheepskin effects in the determinants of skills

	OLS 1	OLS 2	OLS 3	OLS 4	OLS 5
Female	-0.0137*** (0.0042)	-0.0125*** (0.0043)	-0.0148*** (0.0041)	-0.0131*** (0.0041)	-0.0097** (0.0041)
Years of schooling	0.0660*** (0.0045)	-	0.0556*** (0.0053)	0.0524*** (0.0050)	0.0425*** (0.0055)
Schooling squared	-0.0014*** (0.0002)	-	-0.0013*** (0.0002)	-0.0013*** (0.0002)	-0.0010*** (0.0002)
Age	0.0033*** (0.0007)	0.0025*** (0.0007)	0.0025*** (0.0007)	0.0052*** (0.0007)	0.0052*** (0.0007)
Age squared (/100)	-0.0001*** (0.0000)	-0.0001*** (0.0000)	-0.0001*** (0.0000)	-0.0001*** (0.0000)	-0.0001*** (0.0000)
Educational Attainment					
High School	-	0.1545*** (0.0069)	-	-	-
Non Univ PS w/o HS	-	0.1072*** (0.0138)	-	-	-
Non Univ PS with HS		0.1998*** (0.0072)			
University BA	-	0.2682*** (0.0077)	-	-	-
Univ Postgrad	-	0.3224*** (0.0102)	-	-	-
Sheepskin effects					
HS grad	-	-	0.0673*** (0.0082)	0.0602*** (0.0079)	0.0617*** (0.0077)
Non Univ PS w/o HS	-	-	0.0525*** (0.0135)	0.0414*** (0.0135)	0.0412*** (0.0134)
Non Univ PS with HS	-	-	0.0107** (0.0054)	0.0079 (0.0053)	0.0099* (0.0053)
Univ BA	-	-	0.0429*** (0.0076)	0.0346*** (0.0073)	0.0338*** (0.0072)
Univ Postgrad	-	-	0.0394*** (0.0099)	0.0359*** (0.0097)	0.0306*** (0.0095)
Mother's education					
Less than High School	-	-	-	-0.0344*** (0.0052)	-0.0358*** (0.0051)
Some Post Secondary	-	-	-	-0.0009 (0.0061)	-0.0017 (0.0059)
BA or higher	-	-	-	0.0158* (0.0095)	0.0134 (0.0091)
None reported	-	-	-	-0.0556*** (0.0105)	-0.0567*** (0.0102)
Father's education					
Less than High School	-	-	-	-0.0244*** (0.0062)	-0.0234*** (0.0062)
Some Post Secondary	-	-	-	0.0017 (0.0068)	0.0026 (0.0066)
BA or higher	-	-	-	0.0065 (0.0078)	0.0100 (0.0076)
None reported	-	-	-	-0.0465*** (0.0104)	-0.0450*** (0.0104)
Immigrant Parents					
Immigrant mother	-	-	-	0.0066	0.0061

				(0.0071)	(0.0069)
Immigrant father	-	-	-	0.0065 (0.0064)	0.0076 (0.0062)
Math in high school					
Good math grades	-	-	-	-	0.0224*** (0.0051)
Teachers went too fast	-	-	-	-	-0.0264*** (0.0053)
Constant	5.0103*** (0.0351)	5.5061*** (0.0165)	5.0952*** (0.0389)	5.0962*** (0.0380)	5.1633*** (0.0425)
Observations	14,637	14,637	14,637	14,637	14,637
R-squared	0.5084	0.4767	0.5224	0.5403	0.5506

Standard errors in parenthesis. *, **, *** statistically significant at 10%, 5%, 1% level.

Table 3 Summary Statistics for the Worker Sample

	Males	Females	Both Genders
Age	37.7	38.5	38.1
Experience	18.2	18.7	18.4
Years of Schooling	13.5	13.9	13.7
Educational Attainment			
% Less than High School	17.8	11.6	14.8
% High School	35	36.8	35.9
% Non Univ PS w/o HS	2.7	1.7	2.2
% Non Univ PS with HS	26.2	27.6	26.9
% University BA	13.1	17.4	15.1
% Univ Postgrad	5.2	4.9	5.1
Mother's education			
% Less than High School	36.9	41.2	39
% High School	32.9	28.1	30.6
% Some Post Secondary	13.9	18.2	16
% BA or higher	10	8.6	9.3
% None reported	6.3	3.9	5.1
Father's education			
% Less than High School	42.8	45.9	44.3
% High School	22.7	21.7	22.2
% Some Post Secondary	14.4	13.9	14.1
% BA or higher	13.9	12.3	13.1
% None reported	6.2	6.2	6.3
Immigrant Parents			
% Immigrant mother	15.5	15.6	15.6
% Immigrant father	19.4	17.7	18.5
Math in high school			
% Good math grades	73.1	67.7	70.5
% Teachers went too fast	22.7	32.9	27.6
Prose Literacy	289.1	299.6	294.2
Document Literacy	293.4	294.3	293.8
Numeracy	289.4	278.2	284
Problem Solving	285	288.6	286.7
Average Skill Score	289.2	290.2	289.7
Weekly wage	894.7	640.9	772.2
Number of Observations	3633	4133	7766

Table 4 Earnings regressions, Worker sample

	OLS 1	**OLS 2**	**OLS 3**	**OLS 4**	**OLS 5**	**OLS 6**
Female	-0.4106*** (0.0242)	-0.4178*** (0.0234)	-0.4201*** (0.0235)	-0.4064*** (0.0236)	-0.4124*** (0.0231)	-0.4146*** (0.0232)
Experience	0.0656*** (0.0036)	0.0635*** (0.0036)	0.0637*** (0.0037)	0.0659*** (0.0035)	0.0642*** (0.0036)	0.0643*** (0.0037)
Experience squared (/100)	-0.1127*** (0.0080)	-0.1138*** (0.0084)	-0.1110*** (0.0085)	-0.1106*** (0.0079)	-0.1117*** (0.0082)	-0.1099*** (0.0083)
Years of schooling	0.0890*** (0.0042)	-	0.0331*** (0.0066)	0.0706*** (0.0047)	-	0.0243*** (0.0065)
Educational Attainment						
High School	-	0.2935*** (0.0384)	-	-	0.2178*** (0.0398)	-
Non Univ PS w/o HS	-	0.2858*** (0.0962)	-	-	0.2429*** (0.0911)	-
Non Univ PS with HS	-	0.5229*** (0.0428)	-	-	0.4201*** (0.0462)	-
University BA	-	0.8585*** (0.0424)	-	-	0.7070*** (0.0469)	-
Univ Postgrad	-	1.0124*** (0.0606)	-	-	0.8264*** (0.0677)	-
Sheepskin effects						
HS grad	-	-	0.2062*** (0.0409)	-	-	0.1600*** (0.0413)
Non Univ PS w/o HS	-	-	0.2329** (0.0961)	-	-	0.2075** (0.0913)
Non Univ PS with HS	-	-	0.1719*** (0.0336)	-	-	0.1624*** (0.0333)
Univ BA	-	-	0.4253*** (0.0415)	-	-	0.3931*** (0.0409)
Univ Postgrad	-	-	0.0738 (0.0634)	-	-	0.0635 (0.0628)
Average Skill Score	-	-	-	0.0028*** (0.0003)	0.0025*** (0.0003)	0.0023*** (0.0003)
Constant	4.7416*** (0.0679)	5.5715*** (0.0422)	5.2250*** (0.0809)	4.1507*** (0.0971)	4.8998*** (0.1005)	4.7036*** (0.1143)
Observations	7,766	7,766	7,766	7,766	7,766	7,766
R-squared	0.3718	0.3949	0.4003	0.3887	0.4083	0.4111

Standard errors in parenthesis. *, **, *** statistically significant at 10%, 5%, 1% level.

Table 5 Earnings regressions with proxies for ability, Worker sample

	OLS 1	**OLS 2**	**OLS 3**	**OLS 4**	**OLS 5**	**OLS 6**
Female	-0.3968*** (0.0245)	-0.3961*** (0.0241)	-0.4062*** (0.0238)	-0.4040*** (0.0236)	-0.4086*** (0.0239)	-0.4060*** (0.0237)
Experience	0.0661*** (0.0036)	0.0665*** (0.0035)	0.0636*** (0.0036)	0.0644*** (0.0036)	0.0640*** (0.0037)	0.0646*** (0.0037)
Experience squared (/100)	-0.1149*** (0.0081)	-0.1131*** (0.0080)	-0.1144*** (0.0084)	-0.1129*** (0.0082)	-0.1122*** (0.0085)	-0.1114*** (0.0083)
Years of schooling	0.0874*** (0.0043)	0.0709*** (0.0048)	-	-	0.0332*** (0.0067)	0.0255*** (0.0066)
Educational Attainment						
High School	-	-	0.2892*** (0.0391)	0.2225*** (0.0403)	-	-
Non Univ PS w/o HS	-	-	0.2939*** (0.0961)	0.2547*** (0.0911)	-	-
Non Univ PS with HS	-	-	0.5173*** (0.0431)	0.4252*** (0.0465)	-	-
University BA	-	-	0.8389*** (0.0432)	0.7045*** (0.0472)	-	-
Univ Postgrad	-	-	0.9869*** (0.0615)	0.8211*** (0.0681)	-	-
Sheepskin effects						
HS grad	-	-	-	-	0.2033*** (0.0413)	0.1618*** (0.0417)
Non Univ PS w/o HS	-	-	-	-	0.2423** (0.0960)	0.2181** (0.0913)
Non Univ PS with HS	-	-	-	-	0.1709*** (0.0335)	0.1611*** (0.0333)
Univ BA	-	-	-	-	0.4107*** (0.0417)	0.3812*** (0.0413)
Univ Postgrad	-	-	-	-	0.0679 (0.0634)	0.0578 (0.0631)
Average Skill Score	-	0.0027*** (0.0004)	-	0.0024*** (0.0004)	-	0.0022*** (0.0004)
Math in high school						
Good math grades	0.0576* (0.0300)	0.0377 (0.0291)	0.0488* (0.0290)	0.0330 (0.0283)	0.0448 (0.0290)	0.0312 (0.0284)
Teachers went too fast	-0.0777*** (0.0296)	-0.0554* (0.0299)	-0.0727** (0.0288)	-0.0519* (0.0292)	-0.0699** (0.0288)	-0.0516* (0.0292)
Constant	4.7374*** (0.0746)	4.1665*** (0.1066)	5.5595*** (0.0470)	4.9230*** (0.1090)	5.2119*** (0.0870)	4.7119*** (0.1240)
Observations	7,766	7,766	7,766	7,766	7,766	7,766
R-squared	0.3773	0.3922	0.3989	0.4105	0.4040	0.4134

Standard errors in parenthesis. *, **, *** statistically significant at 10%, 5%, 1% level.

Figure 1 Cognitive skills by years of schooling

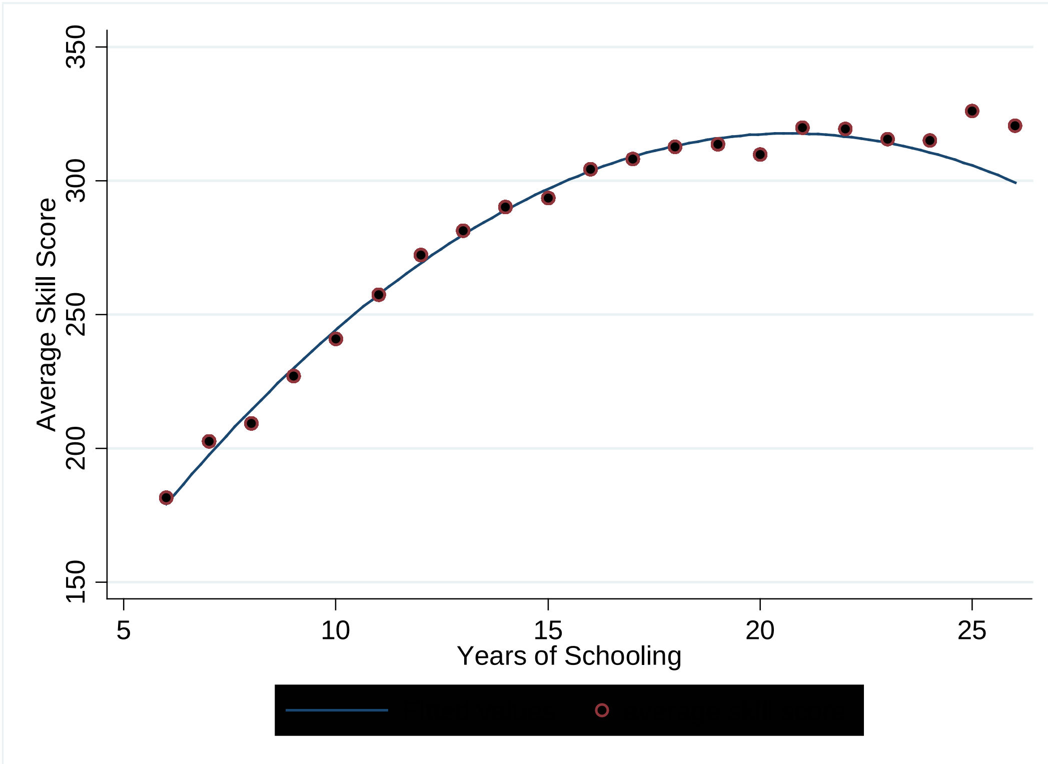

Figure 2 Average skill score by average years of schooling