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Literacy, Numeracy and Labour Market Outcomes in Canada

INTERNATIONAL ADULT LITERACY SURVEY

IALS

EIAA

ENQUÊTE INTERNATIONALE SUR L'ALPHABÉTISATION DES ADULTES

David A. Green
and
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International Adult Literacy Survey

Literacy, Numeracy and Labour Market Outcomes in Canada

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Introduction

Developing the skills and knowledge of the labour force is seen more and more as a central ingredient in national economic policy. The prominence given to the quality of human resources reflects several developments. Modern views about the determinants of long-term economic growth place considerable emphasis on the contribution made by people (human capital). The skills and competencies of the work force are also seen as an important influence on the distribution of economic rewards. In many industrialized countries, a trend toward widening inequality in employment and earnings between the more- and less-skilled has generated considerable concern and has focussed attention on national education and training systems.

Most research on the contribution of human capital to economic growth and its role in the distribution of income uses only relatively crude indicators such as educational attainment and years of labour market experience. Educational attainment is generally measured by years of schooling or highest level of education reached. Labour market experience is unobserved in most data sets and is often proxied by 'potential experience,' measured as age minus years of schooling minus six. However, individuals with the same number of years of education and potential labour market experience may have substantially different skills—depending on their family environment, their fields of study, their work experience and on-the-job training, and other factors. More generally, education and work experience are 'inputs' into the production of human capital, not direct measures of the 'outcomes'—a set of skills, competencies and knowledge. Although the relationships between inputs such as education and experience and outcomes such as employment and earnings have been extensively investigated, relatively little is known about the relationship between direct measures of skills and labour market outcomes.[1]

This study uses Canadian data from the International Adult Literacy Survey (IALS) to investigate the relationship between labour market success and literacy skills, specifically prose literacy, document literacy and quantitative literacy or numeracy. Earnings is the most commonly used and widely accepted measure of labour market success. It has the advantage of incorporating the dimensions of both 'price'—that is, the wage rate—and 'quantity'—the number of hours worked per week or the number of weeks worked per year. Accordingly, this paper focusses on the relationship between literacy and annual, weekly and hourly earnings. Important labour market outcomes not examined in this paper are labour force participation and unemployment (or employment conditional on participation). We plan to investigate the impact of literacy skills on these outcomes in subsequent research. A multivariate framework is employed in this paper to take account of other factors that influence labour market outcomes, such as educational attainment, gender and experience.


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Section 1

Analytical framework

The starting point for most empirical research into the relationship between education and earnings is the human capital earnings function associated with the work of Mincer (1974). According to this model, the logarithm of individual earnings can be expressed as a linear function of years of completed schooling, a quadratic function of labour market experience, and a function of other influences on earnings such as gender and union status. This simple empirical model of the influence of human capital inputs (education and experience) has been remarkably successful (Card 1999).

In this section, we amend the human capital earnings function to account for a situation when some skills are observable to the researcher and some are not. Both observable and unobservable skills have potential value in the labour market. According to the human capital framework, an individual's earnings (or other measures of labour market outcomes) depend on the set of skills possessed by the individual, the value or 'implicit price' placed on each of these skills in the labour market, and other factors besides skills that influence earnings, such as union status, differences across regions in amenities and the cost of living. That is,

$$log\ y_i = S_i\ p\ +\ Z_i\ \delta\ +\ \varepsilon_i \qquad (1)$$

where:

y_i is the earnings of individual *i*,

S_i is a vector of skills and knowledge possessed by individual *i*,

p is a vector of implicit market prices associated with each skill,

Z_i is a vector of variables that affect earnings in addition to skills,

δ is a vector of parameters, and

ε_i is a random error term.[2]

If all relevant skills are observable and measured, we could estimate equation (1) and obtain estimates of the vector of 'implicit prices' p, and thus estimates of the economic return placed on each skill in the labour market.[3]

However, because the skills of each individual are generally not observed, we posit a second relationship between 'inputs' into the production of human capital and the competencies possessed by the individual:

$$S_i = X_i B\ +\ v_i \qquad (2)$$

where X_i is a vector of variables—such as education, experience, and health status—that influence the human capital of individual *i*, B is a matrix of 'input–output coefficients' that map inputs (such as years of education or field of study) into skills (such as literacy or problem-solving ability), and v_i is a random error term. Substituting (2) into (1) yields the human capital earnings function that is typically estimated:

$$log\ y_i = X_i B\ p\ +\ Z_i\ \delta\ +\ u_i\ =\ X_i\ \beta\ +\ Z_i\ \delta\ +\ u_i \qquad (3)$$

where $\beta = Bp$ is a vector of parameters that indicates the magnitude of the influence of each human capital input on earnings. Note that these parameters confound two influences: (1) the effects of inputs such as educational attainment on skills formation, captured by the matrix of input–output coefficients B; and, (2) the implicit price placed on each skill in the labour market, the vector of parameters p. In the absence of direct measures of skills, it is not possible to separate these two influences on labour market outcomes.

Now suppose that it is possible to directly measure some skills but not others. Thus the vector of skills S_i can be written as consisting of two components:

$$S_i = (S^o_i \;\; S^u_i) = (X^o_i B^o \;\; X^u_i B^u) + v_i \qquad (4)$$

where S^o_i are the observed skills and S^u_i the unobserved. Associated with these components are the implicit price vectors p^o and p^u. Substituting equation (4) into equation (1) yields:

$$log\ y_i = S^o_i p^o + X^u_i B^u p^u + Z_i d + u_i = S^o_i p^o + X^u_i \beta^u + Z_i d + u_i \qquad (5)$$

This equation will yield estimates of the parameters p^o, the 'implicit prices' associated with observed skills. Note that the inputs into human capital formation, the variables in the vector X^u_i, are included in the equation to account for the influence of unobserved skills. However, the parameters β^u associated with these input measures will now differ from those in equation (3). In equation (3), where observed skills are not included as controls, the vector of coefficients β shows the influence of each input on all skills and, via the implicit prices for skills, the impact on earnings. However, in equation (5), where observed skills are included, the β^u coefficients show the magnitude of the inputs' influence on unobserved skills and on earnings. Thus we would anticipate a variable such as educational attainment, which can be expected to increase the level of many skills, to have a smaller associated coefficient in the β^u vector than in the β vector. The reason is that the β vector incorporates the influence of educational attainment on both observed and unobserved skills, whereas the β^u vector incorporates the influence of education on unobserved skills alone.

In order to illustrate this framework, suppose there are three skills: literacy (S_1), problem-solving (S_2), and communications (S_3). Each of these skills is 'produced' by education (E) and experience (EXP):

$$S_1 = b_{11} E + b_{12} EXP$$
$$S_2 = b_{21} E + b_{22} EXP$$
$$S_3 = b_{31} E + b_{32} EXP$$

Individual earnings are given by:

$$ln\ y = p_1 S_1 + p_2 S_2 + p_3 S_3 + Zd + e$$
$$= (p_1 b_{11} + p_2 b_{21} + p_3 b_{31}) E + (p_1 b_{12} + p_2 b_{22} + p_3 b_{32}) EXP + Zd + e$$

Thus if all three skills are unobserved, the impact of education E on earnings will be estimated as:

$$b^* = p_1 b_{11} + p_2 b_{21} + p_3 b_{31}$$

However, if S_1 is observed and S_2 and S_3 are unobserved, the equation for individual earnings becomes:

$$ln\ y = p_1 S_1 + (p_2 b_{21} + p_3 b_{31}) E + (p_2 b_{22} + p_3 b_{32}) EXP + Zd + e$$

and the effect of education on earnings, controlling for the observed skill S_1, is given by:

$$b^{**} = p_2 b_{21} + p_3 b_{32}$$

The difference between the two coefficients is:

$$b^* - b^{**} = p_1 b_{11}$$

which reflects both the implicit price of literacy in the labour market p_1 and the marginal impact of education on literacy skills b_{11}.

Similarly the difference between comparable coefficients associated with experience is:

$$c^* - c^{**} = p_1 b_{12}$$

which reflects both the implicit price of literacy p_1 and the marginal impact of experience on literacy skills b_{12}.

In summary, in the context of the human capital earnings function, it is appropriate to include direct measures of skills in an equation explaining earnings or other labour market outcomes. However, it is also appropriate to include traditional human capital variables such as educational attainment and labour market experience, because these control for the influence of unobserved skills. This method provides estimates of the implicit prices or economic return to observed skills. It also provides a natural measure of the extent to which the rate of return to education (or other forms of human capital investment) is due to the influence of education on observed and unobserved skills. This measure is simply the difference between the element of the vector β associated with education, or the estimates obtained when observed skills are omitted as variables, and the element of the vector β^u associated with education—that is, the estimates obtained when observed skills are included.

Of course, we need to be cautious when giving a causal interpretation to the ordinary least squares (OLS) estimates of equation (5). There might be unobserved factors such as ability or ambition, which influence both literacy skills and earnings—and perhaps also educational attainment—that we have been unable to account for in this analysis. This potential bias that arises from the correlation between the error term and one or more right-hand side variables is a familiar issue in the extensive literature on the relationship between education and earnings.[4]

It is often posited that the positive relationship between these variables could be due to 'unobserved ability' that may be correlated with both education and earnings. In signaling models of educational choice, such as those of Arrow (1973) and Spence (1973), the more productive (higher ability) workers choose to obtain more education and earn more in equilibrium (owing to their higher productivity), but education has by assumption no direct impact on worker productivity. In recent years, a number of studies have used instrumental variable (IV) and related econometric methods to estimate the causal impact of education on earnings. Card (1999) provides a valuable survey of this literature. In this study, we employ IV methods to take account of possible correlation between the error term and two right-hand side control variables—education and literacy.


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Section 2

The International Adult Literacy Survey—data

The data we use come from the Canadian component of the International Adult Literacy Survey (IALS) that was carried out in the fall of 1994. The survey marked a breakthrough in international data collection, providing for the first time data on literacy skills that were comparable across countries and language groups.[5] The first round was carried out in 7 countries, and the survey has now been carried out in 22 countries. Like two earlier national studies in North America (Kirsh et al 1993; Statistics Canada 1991), the IALS combined the techniques of household-based surveys with those of educational testing. Respondents first completed a 20-minute background interview and then took about 45 minutes to work on a set of pre-selected tasks from the test matrix.[6]

The sampling frame for the Canadian component was the Labour Force Survey (LFS), so our data are representative of the civilian non-institutionalized population excluding those living in the Northwest Territories (included Nunavut at the time of the IALS), the Yukon and on reserves. Because certain groups were oversampled, we use the LFS weights throughout in order to present results that are nationally representative.

The Canadian sample size was 5,660. For each individual, the survey provided three measures of literacy: prose literacy, document literacy and quantitative literacy (also referred to here as numeracy). These correspond to the following set of information-processing skills needed to perform everyday tasks at home, at work and in the community:

- **Prose literacy**: the ability to understand and use information from texts such as editorials, news stories, poems and fiction.
- **Document literacy**: the ability to find and use information from documents such as job applications, payroll forms, transportation schedules, maps, tables and graphs.
- **Quantitative literacy**: the ability to perform arithmetic functions such as balancing a chequebook, calculating a tip or completing an order form.

The Organisation for Economic Co-operation and Development and Statistics Canada (1995) provide information on the types of tasks used to assess prose, document and quantitative literacy and the levels of task difficulty associated with the five levels of difficulty used in the survey instruments. The main point is that these are tasks used in everyday activities. For each individual, the survey measures prose, document and quantitative literacy on a scale from 0 to 500. These numerical literacy scores are also grouped into five main levels of competency, with level 1 being the lowest and level 5 the highest.[7] According to Statistics Canada, individuals with only level 1 or level 2 literacy skills—more than one-third of the Canadian work force—have marginal or quite limited capabilities (Crompton 1996).

In addition to the assessments of prose, document and quantitative literacy, the survey provides information on current labour force activity (as of the date of the survey) and activity over the previous year. The income information that we use corresponds to wages, salaries and self-employment income during the calendar year 1993. We also construct measures of the weekly wage (annual employment earnings in 1993 divided by weeks worked in the last 12 months) and hourly wage (weekly wage divided by usual hours in the main job held during the last 12 months). Because the earnings information refers to the calendar year 1993, while the retrospective labour force activity refers to the last 12 months, there is more potential for measurement error in our measures of weekly and hourly wages than is usually the case in studies of the determinants of earnings. For this reason, as well as the comprehensive nature of annual earnings—it incorporates both weekly or hourly wages and hours and weeks worked during the year—we focus on annual earnings.


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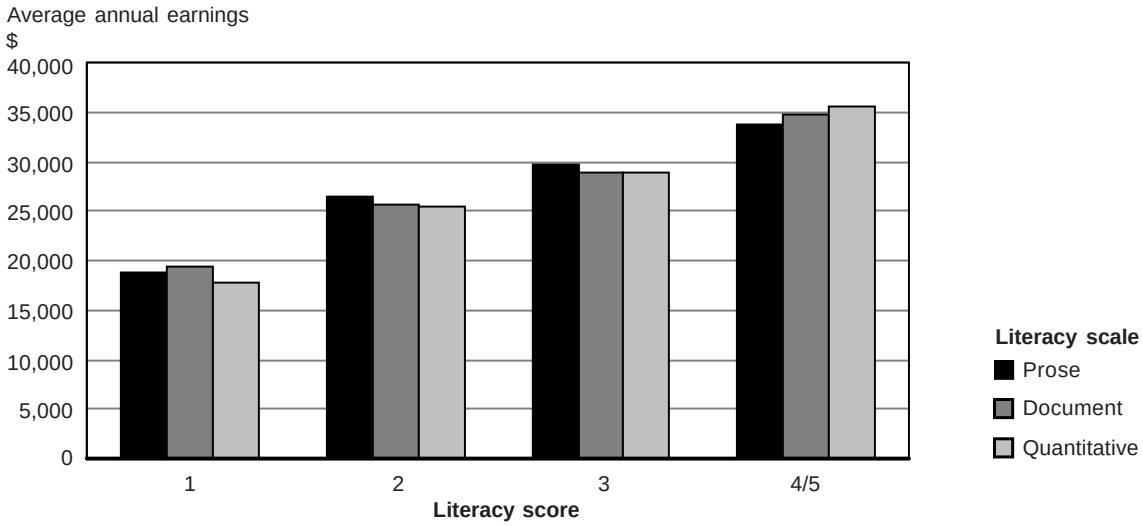
Section 3.1

Literacy and earnings

All three parts of the figure below suggest a positive relationship between literacy and annual earnings. Of course, this positive correlation might simply arise because both literacy and earnings are positively related to some third observable variable such as educational attainment. Or it might arise because both are related to some unobservable variable such as 'ability.'

Figure 1 Annual earnings by literacy level



In this section, we analyse the relationship between literacy and earnings, taking account of other factors that influence earnings—the variables *Z* in equation (5) above—and the influence of unobserved skills, denoted by the variables *X* in equation (5). We exclude students, retirees and individuals who reported they did not work during the 12 previous months.[8] After also excluding those for whom earnings and years of education were not reported, we are left with a sample of 2,190 for our analysis of annual earnings.

Two measures of educational attainment are available in the survey: years of education, defined as years of formal education completed beginning at grade one and not counting repeated years at the same level; and highest level of schooling completed, categorized as follows:

1. primary not completed
2. completed primary
3. some high school
4. high school graduate
5. postsecondary graduate (not university)
6. university graduate.

In most of the analysis, we report results using years of education, thus providing an easily interpreted estimate of the impact of education on earnings, as well as a way to draw comparisons with the large literature on education and earnings, most of which uses years of education to measure educational attainment. However, we also report results using the highest level of schooling achieved; when this is done we combine 'primary not completed' and 'completed primary' as the omitted category and employ dummy variables for the categories 'some high school,' 'high school graduate,' 'postsecondary graduate' and 'university graduate.'[9]

The other control variables are as follows [for dummy variables, the omitted category is in square brackets]:

- sex: female [male]
- marital status: married, includes separated/divorced and widowed [single, never married]
- province of residence: Newfoundland to British Columbia [Ontario]
- rural [urban]
- experience, calculated as age minus years of education minus six
- experience squared[10]

Table 1 shows mean literacy scores by various individual and demographic characteristics. For our sample of those with labour market earnings, on a 0 to 500 scale, the average scores on prose, document and quantitative literacy range between 288 and 293. On average, women perform better than do men on all three literacy measures, with the widest gender gap occurring for prose literacy. Average literacy scores increase with age up to ages 35 to 44, after which average scores decline.[11] For all three types of literacy, there is a positive association between literacy and educational attainment. The gap between those with primary education and some high school is especially large. Substantial gaps also exist between college and university graduates in both prose and quantitative literacy.

Table 1 Mean literacy scores by individual characteristics

	Observations	Mean literacy score[1]		
		Prose	Quantitative	Document
All individuals	2,190	288	293	291
		(1.30)	(1.29)	(1.35)
Males	1,118	281	290	289
		(1.81)	(1.86)	(1.99)
Females	1,072	298	298	294
		(1.82)	(1.77)	(1.79)
Age 16–24	375	282	274	287
		(2.82)	(2.82)	(3.23)
Age 25–34	620	294	303	306
		(2.14)	(2.29)	(2.28)
Age 35–44	672	298	303	298
		(2.34)	(2.03)	(2.40)
Age 45–54	351	285	290	282
		(3.40)	(3.62)	(3.08)
Age 55–69	161	251	258	243
		(5.48)	(5.17)	(6.16)
Age 70+	11	262	276	275
		(12.31)	(16.34)	(15.90)
Primary only	180	180	195	179
		(5.25)	(4.51)	(5.22)
Some high school	398	265	263	264
		(2.49)	(2.36)	(2.31)
High school graduate	741	288	291	294
		(1.60)	(1.47)	(1.74)
Postsecondary graduate (not university)	498	302	303	311
		(1.91)	(2.04)	(2.01)
University graduate	336	337	351	334
		(2.00)	(2.47)	(2.52)
Newfoundland	63	276	272	269
		(6.20)	(6.12)	(6.05)
Prince Edward Island	46	259	267	264
		(9.45)	(8.14)	(9.22)
Nova Scotia	95	298	299	291
		(5.19)	(5.85)	(5.49)
New Brunswick	419	282	285	285
		(2.60)	(2.51)	(2.91)
Quebec	279	272	278	280
		(3.33)	(3.26)	(3.69)
Ontario	726	291	299	293
		(2.58)	(2.62)	(2.67)
Manitoba	101	301	300	302
		(4.52)	(4.67)	(4.50)
Saskatchewan	140	305	308	306
		(4.62)	(4.52)	(4.53)
Alberta	199	308	307	307
		(3.27)	(3.06)	(3.38)
British Columbia	122	292	297	295
		(5.12)	(5.02)	(5.29)
Urban	1,486	290	296	294
		(1.57)	(1.58)	(1.65)
Rural	704	281	283	279
		(2.30)	(2.16)	(2.28)
Non-immigrant or immigrated before age 15	2,102	295	298	298
		(1.13)	(1.18)	(1.17)
Immigrant	88	232	255	239
		(9.89)	(9.51)	(10.82)

1. Standard errors are reported in parentheses.
Source: Authors' calculations using International Adult Literacy Survey data for Canada.

Variation by province is evident for all three measures of literacy. Average scores are highest in the Prairie provinces (Manitoba, Saskatchewan and Alberta) followed by Nova Scotia, Ontario and British Columbia. Average literacy scores are lowest in Quebec, New Brunswick, Prince Edward Island and Newfoundland. Residents of urban areas perform better in literacy proficiency than residents of rural regions, with the largest gap occurring for document literacy. Immigrants perform at a lower level on all three measures of literacy than do native-born Canadians: the differences are largest for prose and document literacy.

We attempted to estimate the effects of prose, document and quantitative literacy on earnings, as well as to allow for possible interactions among these three skills. Unfortunately, in Canada, the three types of literacy are so highly correlated that it is not possible to identify the separate effects of the three types of literacy on earnings, at least with a sample of this size. The pair-wise correlations are 0.894 between prose and quantitative literacy, 0.897 between prose and document literacy and 0.904 between document and quantitative literacy. So we carried out a principal components analysis to assess how best to aggregate the three individual literacy measures. The results of this analysis were clear: the first principal component places almost equal weights on the three literacy scores and accounts for more than 93% of the variance.[12] The second principal component, which accounts for about 3.5% of the variance, is never statistically significant when added to the estimated log earnings equation. This analysis indicates it is appropriate to use the simple average of the three literacy scores; therefore, this is the method we use in what follows.

The results of using this simple average versus the first principal component are almost identical. Moreover, the results based on the average literacy score are easier to interpret. The data are telling us that, in Canada, it is not possible to identify the separate effects—if any—of the three types of literacy on earnings, and that the average literacy score is the best overall measure of literacy skills.

Section 3.2

Ordinary least squares estimates of the impact of education and literacy on earnings

Table 2 reports estimated annual earnings equations (logarithmic) with and without the literacy score variable. The first three columns use years of education as the measure of educational attainment, while the last three columns show comparable estimates using highest level of schooling completed. Column 1 reports an estimate of 0.083 associated with years of education, indicating that each additional year of education raises earnings by approximately 8.3%. This estimate of the 'return to education' is similar to those obtained with larger nationally representative data sets such as the Census of Canada. Labour market experience also has a large and statistically significant impact on earnings, boosting earnings approximately 4.5% a year early in the career and by progressively smaller amounts with accumulated experience.

Table 2 Determinants of annual earnings

Variable	1	2	3	4	5	6
Female	-0.6445***	-0.6581***	-0.6608***	-0.6687***	-0.6750***	-0.6785***
	(0.0372)	(0.0368)	(0.0369)	(0.0375)	(0.0371)	(0.0372)
Married	0.3297***	0.3098***	0.3026***	0.3299***	0.3054***	0.3032***
	(0.0599)	(0.0592)	(0.0594)	(0.0601)	(0.0594)	(0.0596)
Rural	-0.1230**	-0.1336***	-0.1274**	-0.1423***	-0.1544***	-0.1489***
	(0.0508)	(0.0502)	(0.0503)	(0.0511)	(0.0505)	(0.0506)
Years of education	0.0827***	0.0519***	0.0572***	—	—	—
	(0.0058)	(0.0070)	(0.0068)			
Some high school	—	—	—	0.3713***	0.1246	0.2513***
				(0.0836)	(0.0887)	(0.0846)
High school graduate	—	—	—	0.5076***	0.1814**	0.3060***
				(0.0769)	(0.0871)	(0.0817)
Postsecondary graduate (not university)	—	—	—	0.7532***	0.3822***	0.5150***
				(0.0817)	(0.0942)	(0.0881)
University graduate	—	—	—	1.0065***	0.5189***	0.6493***
				(0.0834)	(0.1042)	(0.0978)
Experience	0.0454***	0.0454***	0.0461***	0.0447***	0.0462***	0.0459***
	(0.0054)	(0.0054)	(0.0054)	(0.0055)	(0.0054)	(0.0054)
Experience^2	-0.0007***	-0.0007***	-0.0007***	-0.0007***	-0.0007***	-0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Raw average IALS score	—	0.0031***	—	—	0.0033***	—
		(0.0004)			(0.0004)	
Percentile IALS score	—	—	0.0055***	—	—	0.0055***
			(0.0008)			(0.0008)
Constant	8.4519***	7.9520***	8.4882***	8.9970***	8.3521***	8.8966***
	(0.1081)	(0.1254)	(0.1071)	(0.0958)	(0.1269)	(0.0959)
Sample size	2,190	2,190	2,190	2,190	2,190	2,190
R-squared	0.2588	0.2780	0.2754	0.2573	0.2766	0.2728

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Results for the provincial controls have been suppressed in the interest of readability.
— variable was not included in the estimated equation

The average literacy score is statistically significant and its estimated impact is large: an increase of 10 points on the literacy scale raises earnings about 3.1%, holding constant educational attainment, labour market experience and other influences controlled for in column 1 of Table 2. It is also worth noting that, when the average literacy score is included, the estimated coefficient on years of education falls from 0.083 to 0.052. This suggests that a substantial part of the 'return to education,' approximately 3.1 percentage points of the total 8.3 percentage points—or more than one-third of the total—results from the combined influences of education on literacy and of literacy skills on earnings. In contrast to its effect on the estimated education coefficient, the addition of literacy has little impact on the coefficients associated with labour market experience, suggesting that educational attainment has a much larger impact than work experience on literacy.

Column 3 reports the results of an alternative specification in which the individual's percentile in the distribution of literacy scores is used as a control for literacy, rather than the individual's raw score. The percentile measure is more straightforward to interpret than the arbitrary 0 to 500 score, and it has the advantage of being ordinal rather than cardinal.[13] Again, the estimated impact of literacy is significant and quantitatively large. An increase of 10 percentiles in the literacy distribution—for example, from the median to the 60th percentile—other factors being held constant, raises annual earnings by about 5.5%.

The results are very similar when highest level of schooling is used as a control for educational attainment, rather than years of education. Without controlling for literacy skills, high school graduates earn approximately 50% more than those with an elementary education after controlling for other influences, while university graduation raises earnings by more than 100%. The addition of the literacy level brings about substantial declines in these estimated coefficients. For example, comparing columns 4 and 5, the coefficient on high school graduation falls by 0.33—or over 60% of its original value (0.508)—with the addition of the literacy controls. The coefficients on postsecondary graduates and university graduates drop by 0.37 and 0.49, respectively—or by about half their original values. The general finding continues to hold: including literacy skills in the earnings equation results in a substantial decline in the estimated return to schooling but relatively little change in the estimated return to experience. As discussed previously, we expect that including a directly observed skill such as literacy will reduce the estimated return to education because the impact of education on earnings via its impact on literacy skills has been netted out. What remains is the impact of education on earnings via its impact on unobserved skills, plus any independent direct effect of education (such as acting as a signal of worker productivity).

The direct effect of literacy on earnings is similar to that obtained with years of education. Moreover, it is equal to approximately a 3.3% increase in earnings being associated with an increase of 10 points in the average literacy score, holding constant other influences. The estimated impact of a change in the position in the literacy skill distribution is identical to that obtained when educational attainment is measured using years of education.

Tables 3 and 4 report similar sets of ordinary least squares (OLS) estimates using the log of weekly and hourly earnings as dependent variables. Because weekly earnings results are an intermediate case, we focus the discussion here on hourly earnings. Without literacy controls, the estimated return to education is 6.2% per year (Table 4, column 1) versus 8.3% (Table 2, column 1). Thus, about three-quarters of the estimated return to education is reflected in the hourly wage rate—the 'price' of labour—and the rest is due to the fact that more highly educated workers work more hours per week and more weeks per year.[14]

Table 3 Determinants of weekly earnings

Variable	1	2	3	4	5	6
Female	-0.5751***	-0.5806***	-0.5856***	-0.5871***	-0.5897***	-0.5930***
	(0.0333)	(0.0332)	(0.0332)	(0.0335)	(0.0334)	(0.0334)
Married	0.2620***	0.2533***	0.2433***	0.2564***	0.2454***	0.2387***
	(0.0537)	(0.0536)	(0.0535)	(0.0537)	(0.0537)	(0.0536)
Rural	-0.0608	-0.0650	-0.0635	-0.0666	-0.0717	-0.0706
	(0.0454)	(0.0453)	(0.0452)	(0.0456)	(0.0455)	(0.0454)
Years of education	0.0544***	0.0417***	0.0377***	—	—	—
	(0.0052)	(0.0064)	(0.0061)			
Some high school	—	—	—	0.1061	0.0012	0.0307
				(0.0746)	(0.0799)	(0.0759)
High school graduate	—	—	—	0.2479***	0.1090	0.1208*
				(0.0685)	(0.0785)	(0.0732)
Postsecondary graduate (not university)	—	—	—	0.3498***	0.1923**	0.2004**
				(0.0728)	(0.0848)	(0.0790)
University graduate	—	—	—	0.6283***	0.4211***	0.4040***
				(0.0743)	(0.0939)	(0.0877)
Experience	0.0345***	0.0345***	0.0350***	0.0347***	0.0354***	0.0355***
	(0.0049)	(0.0048)	(0.0048)	(0.0049)	(0.0049)	(0.0049)
Experience^2	-0.0005***	-0.0004***	-0.0004***	-0.0005***	-0.0005***	-0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Raw average IALS score	—	0.0013***	—	—	0.0014***	—
		(0.0004)			(0.0004)	
Percentile IALS score	—	—	0.0036***	—	—	0.0035***
			(0.0007)			(0.0007)
Constant	5.1464***	4.9393***	5.1695***	5.5918***	5.3175***	5.5285***
	(0.0967)	(0.1134)	(0.0963)	(0.0854)	(0.1144)	(0.0860)
Sample size	2,185	2,185	2,185	2,185	2,185	2,185
R-squared	0.2178	0.2222	0.2274	0.2201	0.2247	0.2181

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Results for the provincial controls have been suppressed in the interest of readability.
— variable was not included in the estimated equation

Table 4 Determinants of hourly earnings

Variable	1	2	3	4	5	6
Female	-0.2231***	-0.2308***	-0.2365***	-0.2302***	-0.2338***	-0.2378***
	(0.0313)	(0.0312)	(0.0311)	(0.0315)	(0.0313)	(0.0312)
Married	0.2694***	0.2572***	0.2455***	0.2636***	0.2484***	0.2412***
	(0.0505)	(0.0503)	(0.0501)	(0.0504)	(0.0502)	(0.0501)
Rural	-0.0977**	-0.1037**	-0.1011**	-0.0950**	-0.1023**	-0.1004**
	(0.0429)	(0.0427)	(0.0425)	(0.0429)	(0.0427)	(0.0426)
Years of education	0.0620***	0.0442***	0.0407***	—	—	—
	(0.0049)	(0.0060)	(0.0057)			
Some high school	—	—	—	0.1191*	-0.0252	0.0239
				(0.0700)	(0.0747)	(0.0709)
High school graduate	—	—	—	0.3180***	0.1269*	0.1576**
				(0.0643)	(0.0734)	(0.0684)
Postsecondary graduate (not university)	—	—	—	0.3358***	0.1188	0.1469**
				(0.0683)	(0.0793)	(0.0738)
University graduate	—	—	—	0.7455***	0.4602***	0.4621***
				(0.0698)	(0.0878)	(0.0820)
Experience	0.0333***	0.0334***	0.0340***	0.0328***	0.0337***	0.0338***
	(0.0046)	(0.0045)	(0.0045)	(0.0046)	(0.0046)	(0.0046)
Experience^2	-0.0003***	-0.0003***	-0.0003***	-0.0004***	-0.0004***	-0.0004***
	(8.95E-05)	(8.90E-05)	(8.85E-05)	(9.10E-05)	(9.04E-05)	(9.02E-05)
Raw average IALS score	—	0.0018***	—	—	0.0019***	—
		(0.0003)			(0.0004)	
Percentile IALS score	—	—	0.0046***	—	—	0.0044***
			(0.0007)			(0.0007)
Constant	1.2869***	0.9970***	1.3163***	1.7900***	1.4126***	1.7101***
	(0.0910)	(0.1063)	(0.0901)	(0.0801)	(0.1069)	(0.0804)
Sample size	2,181	2,181	2,181	2,181	2,181	2,181
R-squared	0.1824	0.1924	0.2007	0.1894	0.1997	0.2046

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Results for the provincial controls have been suppressed in the interest of readability.
— variable was not included in the estimated equation

When controls are added for literacy (columns 2 and 3 of Table 4) the coefficients are significant and large in magnitude. The coefficient on the average literacy score implies an increase in hourly earnings of 1.8% for a 10-point increase in the literacy score, versus an impact of 3.1% on annual earnings. Thus, the estimates in column 2 imply that about 60% of the return to literacy affects the hourly wage and the remaining 40% reflects the impact of literacy on hours and weeks of work. This result—that most of the impact of literacy operates through its effect on the hourly wage or the 'price' of labour—is even stronger when the percentile in the distribution of literacy skills is employed as a control variable. The coefficients in column 3 of Table 4 indicate an impact of 4.6% on hourly earnings, or about 85% of the estimated impact of 5.5% on annual earnings reported in column 3 of Table 2.

In contrast to the impacts on the educational attainment coefficients, adding controls for literacy has little effect on the coefficients associated with the experience variables. Thus the results from Tables 2, 3 and 4 suggest that labour market experience exerts little net effect on literacy skills.[15, 16]

The estimated impact of literacy on hourly earnings is very similar when levels of educational attainment are used as explanatory variables rather than years of education (columns 5 and 6). It is also worth noting that adding the literacy controls results in substantial declines in the coefficients associated with various educational levels. For 'some high school,' 'high school graduate,' and 'postsecondary graduate' the coefficient declines by more than half its original value (compare columns 4 and 5 and columns 4 and 6), while for 'university graduates' the coefficient declines by about one-third. These results suggest that a substantial amount of the overall impact of education on skills—especially at the secondary level—is its effect on literacy.

In the remainder of this paper, we will limit the reported results to those using years of education for educational attainment and the percentile literacy score for literacy skills. Years of education has the advantages of ease of interpretation, as well as comparability with the large literature on the relationship between education and earnings. Because the 0 to 500 IALS literacy scale is essentially arbitrary, we also prefer the percentile literacy score for reasons of interpretation. As previously noted, this measure also has the advantage of being ordinal rather than cardinal.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Section 3.3

Roles of immigrant status and parents' education

Tables 5 and 6 report the sensitivity of these OLS results to two changes in specification. Table 5 adds controls for immigrant status to the equations for annual and hourly earnings. The earnings pattern of immigrants differs considerably from that of native-born Canadians, especially during the first decade or so following arrival in Canada. In order to focus on those who completed their secondary schooling prior to arrival in Canada, we define immigrants as those not born in Canada who immigrated here at age 16 or older. According to this definition, there are 95 immigrants in our earnings sample of 2,190. Our small sample size precludes a detailed assessment of the impact of literacy skills on the earnings of immigrants relative to the native-born. Instead, we simply include dummy variables for immigrant cohorts that arrived during the 15-year intervals 1980 to 1994, 1965 to 1979, 1950 to 1964 and before 1950. These controls allow, in a crude fashion, for the fact that immigrants' earnings on arrival in Canada are in general substantially below the earnings of otherwise comparable native-born Canadians. The controls also allow for the fact that, with the passage of time in the Canadian labour market, immigrants' earnings converge to—and may eventually exceed—those of the native-born.[17]

The annual earnings estimates in column 1 indicate that immigrants who arrived between 1980 and 1994 earned 35% less than comparable native-born Canadians did.[18] The earnings of those who arrived between 1965 and 1979 did not differ significantly from the earnings of the native-born. Those who immigrated to Canada prior to 1965 earned about 20% more than their native-born counterparts, though the estimated differences were borderline in terms of statistical significance.

Adding controls for literacy (column 2) results in a decline (from 35% to 30%) in the estimated entry effect associated with the recent cohort of immigrants, suggesting that literacy skills may play an important role in the adjustment of immigrants to the new labour market. The pattern of coefficients for earlier immigrant cohorts is very similar to that in column 1.

Comparing the first two columns of Table 5 to their counterparts in Table 2, the addition of controls for immigrant status has little effect on the estimated returns to education and literacy skills. The estimated returns to labour market experience increase with the addition of controls for immigrant status, reflecting the common finding that returns to experience are generally lower for immigrants, since much of their experience was gained in the country of origin and is potentially less relevant to the Canadian labour market.[19]

The story for hourly earnings is broadly similar. Recent immigrants earn about 39% less than comparable native-born Canadians do (column 3); this estimate drops to about 36% less after controlling for literacy skills. The negative coefficient (–17.8%) on immigrants who arrived between 1965 and 1979 is statistically significant, in contrast to the case with annual earnings. But with controls for literacy, this estimated impact drops to –7.8% and is no longer significantly different from zero. Those who arrived prior to 1965 have a large and statistically significant positive coefficient, suggesting that immigrants during the early postwar period may have been positively selected on unobservable characteristics such as motivation for material success.[20]

As was the case with annual earnings, adding controls for immigrant status has little impact on the estimated returns to education and literacy skills. The estimated returns to experience, however, are higher with the addition of controls for immigrant status.

Table 5 Determinants of annual and hourly earnings, including controls for immigrant status

Variable	1	2	3	4
Dependent variable (log earnings)	*Annual*	*Annual*	*Hourly*	*Hourly*
Female	-0.6356***	-0.6555***	-0.1971***	-0.2124***
	(0.0374)	(0.0371)	(0.0311)	(0.0309)
Married	0.3184***	0.2907***	0.2467***	0.2239***
	(0.0599)	(0.0594)	(0.0498)	(0.0495)
Rural	-0.1295**	-0.1281**	-0.0992**	-0.0977**
	(0.0510)	(0.0504)	(0.0425)	(0.0421)
Years of education	0.0821***	0.0566***	0.0625***	0.0425***
	(0.0058)	(0.0069)	(0.0049)	(0.0057)
Experience	0.0470***	0.0476***	0.0389***	0.0394***
	(0.0055)	(0.0055)	(0.0046)	(0.0046)
Experience^2	-0.0008***	-0.0008***	-0.0005***	-0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Immigrant, 1980–1994	-0.3472***	-0.3036***	-0.3919***	-0.3570***
	(0.1017)	(0.1009)	(0.0844)	(0.0838)
Immigrant, 1965–1979	-0.0597	0.0675	-0.1776**	-0.0776
	(0.0880)	(0.0890)	(0.0730)	(0.0739)
Immigrant, 1950–1964	0.2103	0.2269*	0.7117***	0.7251***
	(0.1330)	(0.1316)	(0.1103)	(0.1093)
Immigrant, pre-1950	0.1568	0.1773	0.5687	0.5850
	(0.6212)	(0.6146)	(0.5152)	(0.5103)
Percentile IALS score	—	0.0055***	—	0.0043***
		(0.0008)		(0.0007)
Constant	8.4688***	8.5043***	1.2603***	1.2869***
	(0.1091)	(0.1081)	(0.0907)	(0.0899)
Sample size	2,190	2,190	2,181	2,181
R-squared	0.2638	0.2797	0.2094	0.2246

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Results for the provincial controls have been suppressed in the interest of readability.
Individuals who immigrated to Canada when they were 15 years of age or younger are treated as native-born Canadians.
— variable was not included in the estimated equation

Table 6 Determinants of annual and hourly earnings, including controls for parents' education

Variable	1	2	3	4
Dependent variable (earnings)	*Annual*	*Annual*	*Hourly*	*Hourly*
Female	-0.6509***	-0.6696***	-0.2228***	-0.2408***
	(0.0373)	(0.0370)	(0.0315)	(0.0311)
Married	0.3409***	0.3062***	0.2569***	0.2210***
	(0.0601)	(0.0596)	(0.0507)	(0.0501)
Rural	-0.1377***	-0.1423***	-0.1044**	-0.1087***
	(0.0509)	(0.0503)	(0.0430)	(0.0424)
Years of education	0.0795***	0.0575***	0.0707***	0.0491***
	(0.0066)	(0.0072)	(0.0055)	(0.0060)
Experience	0.0449***	0.0451***	0.0325***	0.0327***
	(0.0055)	(0.0054)	(0.0046)	(0.0045)
Experience^2	-0.0007***	-0.0007***	-0.0003***	-0.0003***
	(0.0001)	(0.0001)	(8.98E-05)	(8.85E-05)
Mother: some high school	0.2458***	0.2007***	-0.1287**	-0.1732***
	(0.0662)	(0.0658)	(0.0558)	(0.0552)
Mother: high school graduate	0.2400***	0.2010***	-0.1053*	-0.1448**
	(0.0749)	(0.0743)	(0.0631)	(0.0624)
Mother: postsecondary graduate	0.2249**	0.1387	-0.0861	-0.1706**
	(0.0933)	(0.0931)	(0.0786)	(0.0781)
Mother: university graduate	0.2334*	0.2166*	-0.1300	-0.1459
	(0.1216)	(0.1203)	(0.1023)	(0.1008)
Father: some high school	-0.0200	-0.0606	-0.0874	-0.1281**
	(0.0639)	(0.0635)	(0.0538)	(0.0533)
Father: high school graduate	-0.1852***	-0.2440***	-0.1593***	-0.2173***
	(0.0720)	(0.0717)	(0.0606)	(0.0601)
Father: postsecondary graduate	-0.1267	-0.1765*	-0.1876**	-0.2371**
	(0.1034)	(0.1025)	(0.0873)	(0.0862)
Father: university graduate	-0.0425	-0.0923	-0.0982	-0.1491*
	(0.0930)	(0.0922)	(0.0785)	(0.0775)
Percentile IALS score	—	0.0056***	—	0.0055***
		(0.0008)		(0.0007)
Constant	8.3535***	8.4369***	1.4002***	1.4842***
	(0.1139)	(0.1133)	(0.0960)	(0.0950)
Sample size	2,190	2,190	2,181	2,181
R-squared	0.2676	0.2838	0.1904	0.2150

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Results for the provincial controls have been suppressed in the interest of readability.
— variable was not included in the estimated equation

Table 6 adds controls for mother's and father's education to the annual and hourly earnings equations. For both parents, the omitted category is those with only 'primary (elementary) education.' In the absence of controls for literacy, the impact of an additional year of education on annual earnings is now approximately 8.0% (versus 8.3% without controls for parents' education) and on hourly earnings about 7.1% (versus 6.2% without controls for parents' education). Adding controls for literacy by using the percentile in the distribution of literacy skills reduces these coefficients by about one-third—to 5.8% for annual earnings and 4.9% for hourly earnings. The magnitudes of the estimated impacts of literacy on earnings are essentially unchanged from those reported in Tables 2 and 4.

Although individual earnings and parents' education are positively correlated in the raw data, there is little evidence that parents' education exerts a positive influence on the child's labour market earnings as an adult, once we control for both educational attainment and literacy skills.

In the equation for annual earnings (column 2 of Table 6), a mother's education beyond primary school exerts a positive impact on earnings, but there is no difference in the estimated impact between 'some high school,' 'high school graduation,' 'postsecondary college completion,' and 'university graduation.' The father's education beyond primary school has a negative effect on earnings, thus offsetting the positive impact of the mother's higher education, although only 'high school graduation' and 'postsecondary college completion' are statistically significant.

In the hourly earnings equation (column 4), the evidence for a direct positive effect of parents' education on earnings is even weaker. The coefficients on both mother's and father's education in excess of primary school are consistently negative, though not all are statistically significant.

We interpret this evidence as suggesting that the positive correlation between parents' education and the individual's labour market earnings arises principally because of the influence of parents' education on the educational attainment and literacy skills of the child. Once these influences have been controlled for in the regression, there is little evidence of an additional positive or direct impact. Indeed, if anything, the direct impact appears to be negative rather than positive.[21, 22]

Section 3.4

Instrumental variables estimates

As discussed previously, economists have generally been reluctant to give a causal interpretation to the correlation between education and earnings because the relationship may partly reflect unobserved factors that influence both. A similar potential problem arises in interpreting the positive partial correlation between literacy and earnings. In an attempt to investigate the causal linkages among education, literacy and earnings, we report in Table 7 instrumental variables (IV) estimates of the impact of education and literacy on earnings. Because IV estimates can take account of the joint determination of earnings, education and literacy, they allow identification of causal effects.

Table 7 reports estimates of the earnings equation (see equation (5)), which we restate below:

$$log\ y = a_0\ E\ +\ a_1\ EXP\ +\ a_2\ EXP^2\ +\ a_3\ LIT\ +\ X\ b_1\ +\ u \qquad (6)$$

where:

y is earnings

E is years of education

EXP is potential experience (age minus years of education minus six)

LIT is literacy

X is the set of control variables used in the OLS estimates discussed previously (female, married, rural, province)

u is a random error term.

The challenge in the method of IV estimation is to obtain suitable instruments—that is, variables that are correlated with the endogenous right-hand side variables (in this case education and literacy) but uncorrelated with the error term *u*. In other words, we seek variables that influence education and literacy but do not directly influence earnings. We are fortunate in the Canadian IALS data set to have a number of arguably appropriate instrumental variables for both education and literacy. For the former we use responses to the question: "What was the main reason you stopped your schooling when you did?" Three dummy variables are constructed from the responses:

1. Had to work/financial reasons—denoted 'stop: financial'
2. Family reasons (for example, help family business, illness at home, marriage, pregnancy)—denoted 'stop: family'
3. School not available/not accessible—denoted 'stop: no access.'

As an instrumental variable for literacy, we use the response to a question about the language first spoken as a child to create an indicator variable for those whose first language spoken is different from the language in which the IALS interview was conducted (English or French).

We also use parents' education as an instrument for both educational attainment and literacy. As noted previously, the evidence from this sample is consistent with the view that while parents' education influences educational attainment and literacy skills, and thus indirectly influences the child's earnings as an adult, it does not exert a direct influence on the child's adult earnings. In these circumstances parents' education is an appropriate instrumental variable for both education and literacy.

For parents' education we use dummy variables for mother's and father's education, with primary education being the omitted category in each case. We also include interactions between mother's and father's education, thus allowing for the effect of the father's education, for example, to differ according to different levels of the mother's educational attainment. Because years of education enters into the calculation of potential experience, we also use *AGE* and AGE^2 as instrumental variables for *EXP* and EXP^2.

Two sets of instrumental variables estimates are presented. The first (columns 1 and 3 in Table 7) use the three 'reasons for stopping education' variables and the 'first language other than English or French' variable as instruments. As discussed previously, we regard these variables as suitable IVs for educational attainment and literacy, respectively. However, in this analysis these are used as IVs for all the right-hand side endogenous variables in the earnings equation. The second set of estimates (columns 2 and 4 in Table 7) adds mother's education, father's education, and interactions between mother's and father's education as IVs. As discussed previously, we interpret the evidence reported in Table 6 as suggesting that mother's and father's educational attainment are suitable instrumental variables for both education and literacy.[23] All of the equations reported in Table 7 also use *AGE* and AGE^2 as instrumental variables for *EXP* and EXP^2.

Table 7 Determinants of annual and hourly earnings using instrumental variables estimation

Variable	1	2	3	4
Dependent variable (log earnings)	*Annual*	*Annual*	*Hourly*	*Hourly*
Female	-0.6909***	-0.6636***	-0.2403***	-0.2350***
	(0.0417)	(0.0376)	(0.0335)	(0.0319)
Married	0.2552***	0.3019***	0.1548**	0.1642***
	(0.0806)	(0.0646)	(0.0658)	(0.0551)
Rural	-0.1500**	-0.1314**	-0.1486***	-0.1487***
	(0.0615)	(0.0525)	(0.0497)	(0.0448)
Years of education	-0.0100	0.0467**	0.0030	0.0096
	(0.0455)	(0.0210)	(0.0364)	(0.0178)
Experience	0.0428***	0.0439***	0.0485***	0.0479***
	(0.0071)	(0.0062)	(0.0058)	(0.0053)
Experience^2	-0.0006***	-0.0006***	-0.0006***	-0.0006***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Percentile IALS score	0.0178***	0.0072**	0.0067	0.0051**
	(0.0064)	(0.0029)	(0.0051)	(0.0025)
Constant	8.7402***	8.5461***	1.6688***	1.6752***
	(0.3072)	(0.1738)	(0.2466)	(0.1474)
Sample size	2,190	2,190	2,181	2,181
R-squared	0.1909	0.2736	0.1806	0.1835

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Results for the provincial controls have been suppressed in the interest of readability.
Instrumental variables in all regressions are 'years of education,' 'experience,' 'experience^2,' and 'percentile IALS score.'
Instruments used are 'age,' 'age^2,' 'reason for stopping schooling' (financial reasons, family reasons, school not available/accessible) and a dummy variable for first language spoken as a child other than the language of the IALS test. Regressions 2 and 4 add the interaction of parental education levels as instruments.

The IV estimates have the advantage of not being tied to a particular specification of the remainder of the system of jointly determined equations. That is, they account for the possibility that education, experience and literacy are endogenous right-hand side variables and are correlated with the error term in the earnings equation, but they are consistent with a variety of specifications of the education and literacy equations. Since our primary interest is in the earnings equation, this is an approach to estimating causal relationships that requires the fewest assumptions.

Comparing the first column of Table 7 to its OLS counterpart (column 3, Table 2), we see that the IV estimate of the return to education is small in magnitude and not significantly different from zero, whereas the return to experience is somewhat lower (0.043 versus 0.046). In contrast, the IV-estimated return to literacy is much higher than the OLS estimate (0.0178 versus 0.0055) and highly significant.

The differences between the OLS and IV estimates of the education and literacy coefficients become less pronounced with the addition of the parents' education variables to the set of instruments. The estimated return to education rises to 0.047 (versus the OLS estimate of 0.057) and is now significantly different from zero. The estimated return to literacy falls to 0.0072, still above the OLS estimate of 0.0055 but not significantly different from it. The experience and experience squared coefficients are not affected by these additional instruments and remain close to their OLS counterparts.

These estimates indicate that both education and literacy may exert a causal effect on earnings. When we include all of the potential IVs, the causal effect of education on annual earnings is smaller than the OLS estimate (0.047 versus 0.057), while the causal impact of literacy is higher than its OLS counterpart (0.0072 versus 0.0055). However, the IV estimates of these two parameters are less precise and are not significantly different from the OLS estimates. In addition, these estimated causal influences, and their relationship to the simple OLS estimates, are sensitive to the set of IVs employed. The estimated return to experience is slightly lower than the OLS estimate and is not sensitive to the choice of IVs.

The pattern of the hourly earnings results is similar, though a few differences are worth noting. With only the 'reasons for stopping education' and 'first language other than English or French' variables as instruments, the estimated return to education is again small in magnitude and not significantly different from zero. Similarly, the estimated return to literacy is higher than its OLS counterpart but, in the case of hourly earnings, much less precisely estimated and not statistically significant. Adding the parents' education variables provides a literacy coefficient that is statistically significant and somewhat larger than (though not significantly different from) the OLS estimate. However, the years of education coefficient remains small and not significantly different from zero, suggesting that the influence of education on hourly earnings may arise principally because of the impact of education on literacy skills.


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Section 3.5

Three-stage least squares estimates

This section reports estimates of a full structural model of the joint determination of education, literacy and earnings. The specification of the model underlying the three-stage least squares estimates is as follows:

$$\log y = a_0 E + a_1 EXP + a_2 EXP^2 + a_3 LIT + X b_1 + u_1 \quad (7)$$

$$E = X^* b_2 + PE\, d_2 + Z q + u_2 \quad (8)$$

$$LIT = a_4 E + a_5 EXP + a_6 EXP^2 + X b_3 + PE\, d_3 + W p + u_3 \quad (9)$$

where:

y is earnings

E is years of education

EXP is potential experience

LIT is the percentile literacy score

PE is a vector of variables measuring parents' education

X is the set of controls used in the OLS and IV estimates (female, married, rural, province)

X^* is X augmented by AGE and AGE^2

Z is a vector of instrumental variables that influence educational attainment but do not directly affect literacy or earnings

W is a similar set of instruments that influence literacy but do not directly affect education or earnings

u_1, u_2 and u_3 are random errors

a, b, d, p and q are vectors of parameters.

The model recognizes that education and literacy may influence earnings and that educational attainment may influence current literacy skills. We do not include literacy as a right-hand side endogenous variable in the education equation on the grounds that current literacy skills do not influence education, most of which was obtained in the past.

The three-stage least squares estimates are based on the system of equations (7) to (9). These use parents' education as instruments for both literacy and education, the three 'reasons for stopping education' variables as instruments for education, and the 'first language other than English or French' variable as an instrument for literacy skills. Educational attainment and labour market experience are included as endogenous variables in the literacy equation because both these human capital inputs may influence literacy skills. Table 8 reports some of the key structural parameter estimates for the case of annual earnings. The 'return to education' is below the OLS estimate (0.042 versus 0.057) and statistically significant at the 5% level. The estimated impact of literacy on earnings is higher than the OLS estimate and significantly different from zero at the 5% level. Both these estimates are very similar to those based on IV estimation with the full set of instruments (column 2, Table 7).

Table 8 Determinants of annual earnings using three-stage least squares

Variable	1	2	3
Dependent variable	*Log annual earnings*	*Years of education*	*Percentile IALS score*
Female	-0.6656*** (0.0374)	0.1798** (0.0755)	1.9496* (0.9982)
Married	0.3001*** (0.0643)	-0.3430*** (0.1246)	7.8065*** (1.7397)
Rural	-0.1333** (0.0523)	-0.2876*** (0.1018)	2.0335 (1.4435)
Years of education	0.0417** (0.0209)		7.2135*** (0.5295)
Experience	0.0404*** (0.0062)		-0.0384 (0.2005)
Experience^2	-0.0006*** (0.0001)		-0.0014 (0.0040)
Percentile IALS score	0.0074** (0.0029)		
Stop: financial		-2.1522*** (0.1733)	
Stop: family		-1.7650*** (0.2745)	
Stop: no access		-2.5114*** (0.4372)	
First language other than the language of the IALS test			-8.3872*** (1.5190)
Age		0.2044*** (0.0216)	
Age^2		-0.0028*** (0.0002)	
Constant	8.6423*** (0.1731)	9.1123*** (0.4580)	-47.7476*** (5.3308)
Sample size	2,190	2,190	2,190
Pseudo R-squared	0.272	0.313	0.357

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Additionally, interaction terms between mother's and father's education level are included as controls for the 'years of education' and 'percentile IALS score.' Results for the provincial controls and the parents' education levels have been suppressed in the interest of readability.
'Experience' and 'experience^2' are instrumented by 'age' and 'age^2,' respectively. Results are not reported due to space considerations.

In the equation for years of education, each of the 'reasons for stopping education' variables has a substantial negative impact on educational attainment, with the 'no access' response having the largest (–2.5 years). The literacy equation provides direct evidence on the impacts of education and experience on literacy skills. Each additional year of education is estimated to raise an individual's ranking in the distribution of literacy skills by a substantial amount (7.2 percentiles). As suggested previously by indirect evidence from the earnings equations, labour market experience has no significant net impact on literacy. Speaking neither English nor French as a first language has a large and statistically significant negative effect on literacy (–8.4 percentiles).

Table 9 reports the results for hourly earnings. These are generally similar to those for IV estimation with the full set of instrumental variables (column 4, Table 7). In the earnings equation, the years of education coefficient is small in magnitude and not significantly different from zero. The estimated return to experience is larger than both the OLS estimate (0.057 versus 0.034) and the IV counterpart (0.057 versus 0.048). The estimated marginal impact of literacy on hourly earnings is almost identical to the IV estimate (0.0050 versus 0.0051) and also close to the OLS estimate (0.0050 versus 0.0046). The parameter estimates for the educational attainment and literacy equations are very similar to those in the system for annual earnings shown in Table 8.

Table 9 Determinants of hourly earnings using three-stage least squares

Variable	1	2	3
Dependent variable	*Log hourly earnings*	*Years of education*	*Percentile IALS score*
Female	-0.2284*** (0.0314)	0.1830** (0.0757)	1.9130* (1.0003)
Married	0.1666*** (0.0543)	-0.3365*** (0.1253)	8.2065*** (1.7461)
Rural	-0.1430*** (0.0441)	-0.2896*** (0.1024)	2.0702 (1.4504)
Years of education	-0.0148 (0.0175)		7.2057*** (0.5300)
Experience	0.0574*** (0.0052)		-0.0627 (0.2009)
Experience^2	-0.0009*** (0.0001)		-0.0011 (0.0040)
Percentile IALS score	0.0050** (0.0024)		
Stop: financial		-2.1472*** (0.1730)	
Stop: family		-1.6829*** (0.2740)	
Stop: no access		-2.4227*** (0.4364)	
First language other than the language of the IALS test			-8.2977*** (1.5211)
Age		0.2042*** (0.0216)	
Age^2		-0.0028*** (0.0002)	
Constant	1.9257*** (0.1453)	9.0704*** (0.4594)	-47.6055*** (5.3385)
Sample size	2,181	2,181	2,181
Pseudo R-squared	0.143	0.312	0.357

Notes: *** = the estimated coefficient is statistically significant at the 1% level
** = significant at the 5% level
* = significant at the 10% level
Standard errors are reported in parentheses.
In addition to the variables listed above, all regressions included controls for provincial differences. Additionally, interaction terms between mother's and father's education level are included as controls for the 'years of education' and 'percentile IALS score.' Results for the provincial controls and the parents' education levels have been suppressed in the interest of readability.
'Experience' and 'experience^2' are instrumented by 'age' and 'age^2,' respectively. Results are not reported due to space considerations.

In summary, the IV and three-stage least squares estimates support the view that both education and literacy exert a causal influence on annual earnings. Indeed, the magnitudes of these estimated causal effects are similar to—and, in the case of literacy, possibly even larger than—those obtained from simple OLS estimates that do not take account of the possible joint determination of education, literacy and earnings. The IV and three-stage least squares estimates also indicate that literacy has a causal impact on hourly earnings, but evidence of education's direct causal effect on hourly earnings is weaker. Given the greater likelihood of measurement error in hourly earnings, we have more confidence in the results for annual earnings.

Conclusion

Literacy has a large effect on earnings and accounts for approximately one-third of the estimated 'return to education.' According to simple ordinary least squares estimates, each additional year of education raises annual earnings by approximately 8.3% and, of that, approximately 3.1 percentage points result from the combined influences of education on literacy and, in turn, literacy on earnings. The results suggest that educational attainment has a much larger impact on literacy than work experience does. Indeed, both direct and indirect evidence indicates that general labour market experience has little net effect on literacy.

Our results also provide some support for the view that literacy skills may play a role in how well immigrants adjust to the new labour market. The small number of immigrants in our sample precludes a stronger conclusion about the relationship between literacy skills and the earnings pattern of immigrants relative to the native-born. Further research is needed in this area.

Although individual earnings and parents' education are positively correlated, there is little evidence in the Canadian IALS data that parents' educational attainment exerts a positive effect on the child's earnings as an adult once controls are included for both educational attainment and literacy skills. This suggests that the positive association between parents' education and individual earnings arises principally because of the influence of parents' education on the literacy skills and educational attainment of the child.

Labour market outcomes depend on the skills of an individual and the value placed on those skills in the labour market. We have found some evidence—using instrumental variables and simultaneous equations estimation methods—that both literacy and educational attainment exert a causal effect on earnings that is substantial in magnitude. These findings support the human capital theory. Further research in this area is needed, however, to provide more support for our findings.


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Endnotes

[1] In contrast to the hundreds of studies of the relationship between education and earnings, only a few studies have examined the roles of direct measures of skills. Examples include Boissiere, Knight and Sabot (1985), Rivera-Batiz (1990, 1992), Murnane, Willett and Levy (1995) and Charette and Meng (1998).

[2] Note that in this 'pure' human capital formulation, educational attainment is assumed to exert no independent direct effect on earnings; the contribution of education to labour market success arises indirectly through its influence on skills formation. However, if, as in the signaling models of Arrow (1973) and Spence (1973), educational credentials serve as signals of worker productivity, then educational attainment should also appear on the right-hand side of equation (1).

[3] The specification (1) assumes that the earnings of individual *i* equal the sum of the labour market value of each of the skills possessed by that individual. It is straightforward to extend this simple specification to allow for circumstances in which the 'package' of skills matters, in which case there are potential interactions among the individual skills, as well as to allow for a non-linear relationship between skills and earnings.

[4] For surveys of this literature see Griliches (1977), Rosen (1977), Willis (1986) and Card (1999).

[5] For detailed information on the first round of the survey, see Organisation for Economic Co-operation and Development and Statistics Canada (1995). Statistics Canada, Human Resources Development Canada and National Literacy Secretariat (1996) provides further detail on the Canadian results. Organisation for Economic Co-operation and Development and Statistics Canada (2000) summarizes the findings of all three rounds of the IALS carried out in 22 countries.

[6] Respondents were tested in the official language(s) of the country; in Canada they were given a choice of English or French. In cases where respondents did not speak the official language, an interpreter helped provide the background information. Respondents whose poor grasp of the official language prevented them from completing the test were included in the survey.

[7] Because less than 5% of the population achieved level 5 in most countries (including Canada), levels 4 and 5 are combined so that when results are reported by literacy level these correspond to levels 1, 2, 3 and 4/5.

[8] Full-time students were excluded, as were 'in school youth'—that is, students who worked part time during the last year while attending school.

[9] There are 37 cases in which years of education is observed but highest level of schooling is not stated/not definable. In these circumstances we use the sample mean level of highest level of schooling completed.

[10] It is possible that the 'province controls' pick up some of the variation across regions in the quality of education.

[11] On all three literacy measures, the mean values for those aged 70 and over exceed the mean values for those aged 55 to 69. However, the number of earners aged 70 and over is small and the differences between these two age groups are not statistically significant.

[12] The weights associated with the first eigenvector are 0.576, 0.577 and 0.578, respectively.

[13] Osberg (2000) argues that the literacy scores should be regarded as ordinal rather than cardinal measures.

[14] Riddell and Sweetman (1998) document the positive association between education and both hours worked per week and weeks worked per year for Canadian workers. Card (1999) reports that, in recent U.S. data, about two-thirds of the return to education is reflected in the hourly wage and one-third in weeks and hours worked.

[15] We emphasize 'net effect' because it is possible that work experience adds to the literacy skills of some workers, but that the skills of other workers deteriorate over time due to lack of use. In these circumstances, the net effect may be positive, zero or negative, depending on the relative magnitudes of these offsetting positive and negative effects.

[16] These results provide indirect evidence of the impact of experience on literacy. Later in the paper we report direct evidence on this issue.

[17] See Baker and Benjamin (1994), Bloom, Grenier and Gunderson (1995) and Grant (1999) for examples of recent studies of immigrants in the Canadian labour market. An important issue examined in these and related studies is the extent to which more recent immigrant cohorts begin at a greater earnings disadvantage relative to the native-born and catch up less quickly than did earlier cohorts of immigrants.

[18] We also disaggregated the 1980–1994 cohort into three five-year intervals. There is some evidence that the negative 'entry effect' is largest for the most recent cohort (those arriving in 1990–94), especially for annual earnings. However, given the small number of observations, the differences in the three coefficients are not statistically significant.

[19] We also estimated models with interaction effects, thus allowing the return to education, experience and literacy to differ between immigrants and the native-born. Because of the small number of immigrants in our sample, these interaction terms are generally not statistically significant.

[20] The coefficient on the 1950–1964 immigrant cohort is implausibly large with hourly earnings. This large impact is not confirmed by the results using annual earnings as the dependent variable. Given the small sample size and the likelihood of greater measurement error in hourly earnings, we have more confidence in the results using annual earnings.

[21] There are a large number of responses to the questions relating to mother's and father's education that are coded 'don't know/not definable by level.' As we do throughout this study, these responses are set equal to the mean level in the sample. However, the finding that the direct impact of parents' education appears to be zero or negative is not affected (indeed, it is somewhat stronger), if we omit observations for which parents' education is not reported.

[22] Although not reported in Table 6 for space reasons, we also included a full set of interactions between mother's and father's education. The finding of little direct impact of parents' education is not altered by this more general specification.

[23] Parents' education will not be a suitable instrumental variable (IV) if higher ability parents are more highly educated and if there is a positive correlation between the ability of the parents and that of the children.

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