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Abstract

Most research on the contribution of human capital to economic growth and its role in the distribution of income uses indirect measures of human capital such as educational attainment and work experience. Such measures are arguably inputs into the production of human capital in the form of skills, competencies and knowledge.

This study uses Canadian data from the International Adult Literacy Survey to analyse the role of directly observed skills -- specifically, prose, document and quantitative literacy -- on individual labour market earnings. The contributions of unobserved skills are taken into account using input measures (education and experience). We find that literacy skills have a large and statistically significant causal effect on earnings. As much as one-third of the return to education may be due to the combined effects of education on literacy and of literacy skills on earnings. In contrast, very little of the return to labour market experience is associated with the combined effects of experience on literacy and literacy skills on earnings.

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INTRODUCTION

The development of the skills and knowledge of the labour force is increasingly being viewed as a central ingredient in national economic policy. The prominence being 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 of human capital. The skills and competencies of the workforce are also regarded as exerting an important influence on the distribution of economic rewards. In this respect, trends in many industrialized countries toward widening inequality in employment and earnings between the more and less skilled have generated considerable concern and have focused attention on national education and training systems.

Despite the substantial emphasis on the quality of human resources, most research on the contribution of human capital to economic growth and its role in the distribution of income uses only crude indicators such as educational attainment and years of 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 thus often proxied by "potential labour market experience" (age minus years of schooling minus six). However, individuals with the same years of education and potential labour market experience may have substantially different skills, depending on their family environment, the quality of their schooling, their fields of study, the amount of formal and informal training received during their working career, and other factors. More generally, educational attainment and work experience are "inputs" into the production of human capital rather than direct measures of the "outputs" – 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 the success of individual workers in the labour market and their skills, specifically prose literacy, document literacy and quantitative literacy. Earnings is the most commonly used and widely accepted measure of labour market success, and has the advantage of incorporating both "price" (i.e. wage rate) and "quantity" (hours worked per week, weeks worked per year) dimensions. For this reason this paper focuses on the relationship between literacy and annual, weekly and hourly earnings.[2] A multivariate framework is employed in order to take account of other factors that also influence labour market outcomes such as educational attainment, gender, and experience.

ANALYTICAL FRAMEWORK

The starting point for most empirical research on education and wage determination 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

[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 Bossiere, Knight and Sabot (1985), Rivera-Batiz, 1990, 1992; Murnane, Willett and Levy, 1995; and Charette and Meng, 1998.

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 deal with the situation in which some skills are observable to the researcher and some are unobservable. Both the 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 and knowledge possessed by the individual, the value or "implicit price" placed on each of these skills in the labour market, and other factors that influence earnings in addition to skills (such as union status, differences across regions in amenities and the cost of living, and so on). 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.[3] 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.[4]

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[2] 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.

[3] 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 skill 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).

[4] 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

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:

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

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 η_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 indicate the magnitude of the influence of each human capital input on earnings. Note that these parameters confound two influences: (i) the effects of inputs such as educational attainment on skills formation, captured by the matrix of input-output coefficients B, and (ii) 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:

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

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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.

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 (4) into equation (1) yields:

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

Estimating this equation will yield estimates of the parameters p^o, the "implicit prices" associated with the observed skills. Note that the "inputs" into human capital formation, the variables in the vector X^u_i, are included in the estimating equation to account for the influence of the 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 skill prices, the impact on earnings. However, in equation (5), where the observed skills are included as controls, 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 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:

$$ln\, y = p_1S_1 + p_2S_2 + p_3S_3 + Zd + e$$

$$= (p_1b_{11} + p_2b_{21} + p_3b_{31})\, E + (p_1b_{12} + p_2b_{22} + p_3b_{32})\, EXP + Zd + e$$

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

$$b^* = p_1b_{11} + p_2b_{21} + p_3b_{31}$$

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

$$ln\, y = p_1S_1 + (p_2b_{21} + p_3b_{31})\, E + (p_2b_{22} + p_3b_{32})\, EXP + Zd + e$$

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

$$b^{**} = p_2b_{21} + p_3b_{32}$$

The difference between the two coefficients is:

$$b^* - b^{**} = p_1b_{11}$$

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

$$c^* - c^{**} = p_1b_{12}$$

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 the 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 the observed and unobserved skills. This measure is simply the difference between the element of the vector $\boldsymbol{b}$ associated with education (i.e. the estimates obtained when observed skills are omitted as variables) and the element of the vector $\boldsymbol{b}^{u}$ associated with education (i.e. the estimates obtained when the observed skills are included).

Of course, we need to be cautious when giving a causal interpretation to ordinary least squares (OLS) estimates of equation (5). There might be unobserved factors such as ability or ambition that we are unable to take account of in this analysis and that influence both literacy skills and earnings (and perhaps also educational attainment). 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.[5] 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.

DATA

The data we use comes 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 are comparable across countries and language groups.[6] The first round was carried out in 7 countries, and the survey has now been carried out in 20 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.[7]

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 and Yukon and on reserves. Because certain groups were

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

[6] 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 20 countries.

[7] 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.

over-sampled, we use the LFS weights throughout in order to present results that are nationally representative.

The Canadian sample size was 5660 observations. For each individual the survey provided three measures of literacy: prose literacy, quantitative literacy (also referred to here as numeracy), and document literacy. 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 including editorials, news stories, poems and fiction.

Document literacy -- the ability to find and use information contained in documents such as job applications, payroll forms, transportation schedules, maps, tables and graphs.

Quantitative literacy – the ability to perform arithmetic operations to numbers such as balancing a chequebook, calculating a tip, or completing an order form.

Organisation for Economic Co-operation and Development and Statistics Canada (1995) provides 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.[8] According to Statistics Canada, individuals

[8] Because less than 5 percent 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.

with only level 1 or 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 and 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 the annual earnings measure (it incorporates both weekly or hourly wages and hours and weeks worked during the year), we focus particular attention on annual earnings.

LITERACY AND EARNINGS

All three parts of Figure 1 suggest that there is 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'.

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 individuals who reported they did not work during the previous 12 months, were students or were retired.[9] After also excluding those for whom earnings and years of education were not reported, we are left with a sample of 2190 observations 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 ever completed, categorized as follows: (i) primary not completed, (ii) completed primary, (iii) some high school, (iv) high school graduate, (v) non-university post-secondary graduate, and (vi) 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 providing comparability to the large literature on education and earnings, most of which uses years of education to measure educational attainment. However, we also report results using 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', 'post-secondary graduate' and 'university graduate'.[10]

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

[10] There are 37 cases in which years of education are 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.

The other control variables are as follows [for dummy variables, the omitted category is in square brackets]: Gender: Female [Male]; Marital Status: Married, includes separated/divorced and widowed [Single, never married]; Province of residence: Newfoundland to British Columbia [Ontario]; Rural [Urban]; Experience (Age - Years of education - 6) and Experience squared.[11]

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, quantitative and document 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.[12] 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. A substantial gap also exists in prose and quantitative literacy between college and university graduates.

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. Quebec, New Brunswick, Prince Edward Island and Newfoundland have the lowest average literacy scores. Residents of urban areas perform better in literacy proficiency than residents of rural regions, with the largest gap occurring for

[11] It is possible that the provincial controls pick up some of the variation across regions in the quality of education.

[12] On all three literacy measures, the mean values for those aged 70 and over exceed those 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.

document literacy. Immigrants perform at a lower level on all three measures of literacy than do native-born Canadians: the difference between these two groups is 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 and 0.897 between prose and quantitative and document literacy respectively, while the correlation between document and quantitative literacy is 0.904.) We therefore 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 over 93 percent of the variance.[13] The second principal component, which accounts for about 3.5 percent of the variance, is never statistically significant when added to the estimated log earnings equation. This analysis indicates that 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, and 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.

OLS estimates of the impact of education and literacy on earnings

Table 2 reports estimated log annual earnings equations 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 .083 associated with years of education, indicating that each additional year of education raises earnings by approximately 8.3 percent. This estimate of the 'return to education' is similar to those obtained with larger nationally representative data sets such as the Canadian Census. Labour market experience also has a large and statistically significant impact on earnings, boosting earnings by approximately 4.5 percent per year early in the career and by progressively smaller magnitudes with accumulated experience.

The average literacy score is statistically significant and its estimated impact is large: an increase of 10 points on the literacy scale (for example, an increase from 200 to 210 on the scale which ranges from 0 to 500) raises earnings by approximately 3.1 percent, 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 .083 to .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 literacy skills on earnings. In contrast to its effect on the estimated

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

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. Again the estimated impact of literacy is significant and quantitatively large. Other factors being held constant, an increase of 10 percentiles in the literacy distribution -- for example, from the median to the 60th percentile -- raises annual earnings by approximately 5.5 percent.

The results are very similar when highest level of schooling is used, rather than years of education. Without controlling for literacy skills, high school graduates earn approximately 50 percent more than the omitted category (incomplete or completed elementary school education) after controlling for other influences, while university graduation raises earnings by more than 100 percent. 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 post-secondary 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, and is equal to approximately a 3.3 percent 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 OLS estimates using the log of weekly and hourly earnings as dependent variables. We focus the discussion here on the hourly earnings results because the weekly earnings results are an intermediate case. Without literacy controls, the estimated return to education is 6.2 % per year (Table 4, column 1) versus 8.3 % in Table 2. Thus about three-quarters of the estimated return to education is reflected in the hourly wage rate -- the 'price' of labour -- and the remaining one-quarter is due to the fact that more highly educated workers work more hours per week and more weeks per year.[14]

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

[14] The positive association between education and both hours worked per week and weeks worked per year is documented for Canadian workers by Riddell and Sweetman (2000). Card (1999) reports that in recent U.S.

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 'post-secondary 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

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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.

overall impact of education on skills -- especially at the secondary level -- is its effect on literacy.

In the remainder of the 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 schooling 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.

The 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 behavior of immigrants differs considerably from that of native-born Canadians, especially during the first decade or so following arrival in Canada. Our small sample size precludes a detailed assessment of the impact of literacy skills on the earnings of immigrants relative to the native born.[17] 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

[17] 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 to Canada at age 16 or older. According to this definition there are 95 immigrants in our earnings sample of 2190 observations.

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.[18]

The annual earnings estimates in column 1 indicate that immigrants who had arrived between 1980 and 1994 earned 35% less than comparable native-born Canadians.[19] 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

[18] 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.

[19] 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.

for immigrants since much of their experience was gained in the country of origin, and is potentially less relevant to the Canadian labour market.[20]

The story for hourly earnings is broadly similar. Recent immigrants earn about 39% less than comparable native-born Canadians (column 3); this estimate drops to about 36% 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.[21]

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 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 parental education

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

[21] The coefficient on the 1950-64 immigrant cohort is implausibly large with hourly earnings and 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.

controls). 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 higher than primary exerts a positive impact on earnings but there is no difference in the estimated impact between 'some high school', 'high school graduation', 'post-secondary 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 'post-secondary 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 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 or direct impact. Indeed, if anything the direct impact appears to be negative rather than positive.[22] [23]

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 re-state 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 6), LIT is literacy, X is the set of control variables used in the OLS estimates discussed previously (female, married, rural, province) and u is a random error term. The

[22] 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 result 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.

[23] 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.

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 instrument *EXP* and EXP^2 with *AGE* and AGE^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.[24] All of the equations reported in Table 7 also instrument *EXP* and EXP^2 with *AGE* and AGE^2.

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

[24] Parents' education will not be a suitable 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.

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 minimal assumptions.

Comparing the first column of Table 7 to its OLS counterpart (column 3 in Table 2), we see that the IV estimate of the return to education is small in magnitude and not significantly different from zero, while the return to experience is somewhat lower (.043 versus .046). In contrast, the IV-estimated return to literacy is much higher than the OLS estimate (.0178 versus .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 .047 (versus the OLS estimate of .057) and is now significantly different from zero. The estimated return to literacy falls to .0072, still above the OLS estimate of .0055 but not significantly different from the OLS estimate. The coefficients on experience and experience squared 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 earnings is smaller than the OLS estimate (.047 versus .057) and the causal impact of literacy is higher than its OLS counterpart (.0072 versus .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 there are a few differences 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, this coefficient is much less precisely estimated and is not statistically significant. Adding the parents' education variables results in a literacy coefficient that is statistically significant and somewhat larger than (though not significantly different from) the OLS estimate. However, the coefficient on years of education 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.

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

The model recognizes that education and literacy may influence earnings, and 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 since 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 (.042 versus .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 of Table 7).

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 effect (-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 the 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 of 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 (.057 versus .034) and the IV counterpart (.057 versus .048). The estimated marginal impact of literacy on hourly earnings is almost identical to the IV estimate (.0050 versus .0051) and also close to the OLS estimate (.0050 versus .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.

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 the evidence of a direct causal effect of education 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.

CONCLUSIONS

This analysis suggests several conclusions:

1. Literacy has a large effect on earnings and is a substantial proportion -- in the order of one-quarter to one-third -- of the estimated return to education.

2. Other skills also contribute to the return to education, so in the absence of direct measures of these skills it is important to control for educational attainment and labour market experience in studying the relationship between literacy and earnings.

3. Adding controls for literacy in the human capital earnings function has little impact on the estimated return to experience. In terms of the analytical framework used in this paper, this result suggests that general labour market experience has little net effect on literacy. Estimation of a full structural model of the joint determination of education, literacy and earnings provides direct evidence supporting this conclusion.

4. Our results provide some support for the view that literacy skills may play a role in the adjustment of immigrants 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 behaviour of immigrants relative to the native-born.

5. Although individual earnings and parents' education are positively correlated, there is little evidence in the Canadian IALS data that parents' education 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.

6. We find some evidence that education and literacy exert a causal influence on labour market earnings. Instrumental variable and three stage least squares methods generally yield estimated impacts of education on annual earnings that are lower than their OLS counterparts, albeit less

precisely estimated and generally not significantly different from the corresponding OLS estimates. IV and three stage least squares estimates of the impact of literacy on earnings are generally somewhat above the OLS estimates but are also less precisely estimated and not significantly different from their OLS counterparts.

7. Obtaining fully convincing evidence of the causal effect of literacy on earnings may require more observations and/or a richer array of instruments than were available in this study. Nonetheless the results reported here do suggest that both literacy and educational attainment exert a causal effect on earnings that is substantial in magnitude.

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Figure 1: Annual Earnings by Literacy Level

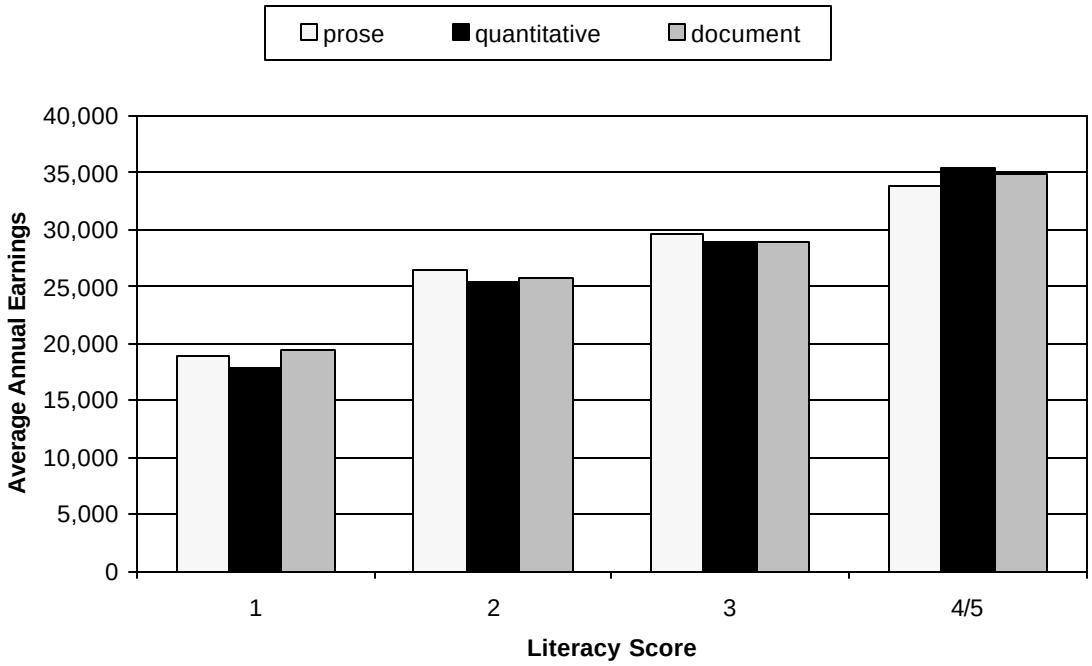

Table 1: Mean Literacy Scores by Individual Characteristics

	Observations	Mean Literacy Score		
		Prose	Quantitative	Document
All Individuals	2190	288 (1.30)	293 (1.29)	291 (1.35)
Males	1118	281 (1.81)	290 (1.86)	289 (1.99)
Females	1072	298 (1.82)	298 (1.77)	294 (1.79)
Aged 16-24	375	282 (2.82)	274 (2.82)	287 (3.23)
Aged 25-34	620	294 (2.14)	303 (2.29)	306 (2.28)
Aged 35-44	672	298 (2.34)	303 (2.03)	298 (2.40)
Aged 45-54	351	285 (3.40)	290 (3.62)	282 (3.08)
Aged 55-69	161	251 (5.48)	258 (5.17)	243 (6.16)
Aged 70+	11	262 (12.31)	276 (16.34)	275 (15.90)
Primary Only	180	180 (5.25)	195 (4.51)	179 (5.22)
Some High School	398	265 (2.49)	263 (2.36)	264 (2.31)
High School Grad	741	288 (1.60)	291 (1.47)	294 (1.74)
Post-Secondary Grad (not university)	498	302 (1.91)	303 (2.04)	311 (2.01)
University Grad	336	337 (2.00)	351 (2.47)	334 (2.52)
Newfoundland	63	276 (6.20)	272 (6.12)	269 (6.05)
Prince Edward Island	46	259 (9.45)	267 (8.14)	264 (9.22)
Nova Scotia	95	298 (5.19)	299 (5.85)	291 (5.49)
New Brunswick	419	282 (2.60)	285 (2.51)	285 (2.91)
Quebec	279	272 (3.33)	278 (3.26)	280 (3.69)

	Observations	Mean Literacy Score		
		Prose	Quantitative	Document
Ontario	726	291 (2.58)	299 (2.62)	293 (2.67)
Manitoba	101	301 (4.52)	300 (4.67)	302 (4.50)
Saskatchewan	140	305 (4.62)	308 (4.52)	306 (4.53)
Alberta	199	308 (3.27)	307 (3.06)	307 (3.38)
British Columbia	122	292 (5.12)	297 (5.02)	295 (5.29)
Urban	1486	290 (1.57)	296 (1.58)	294 (1.65)
Rural	704	281 (2.30)	283 (2.16)	279 (2.28)
Non-immigrant or immigrated before age 15	2102	295 (1.13)	298 (1.18)	298 (1.17)
Immigrant	88	232 (9.89)	255 (9.51)	239 (10.82)

Source: Authors Calculations using IALS Data for Canada
Standard errors are reported in parentheses.

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 Grad	––	––	––	0.5076***	0.1814**	0.3060***
				(0.0769)	(0.0871)	(0.0817)
Post-Secondary Grad	––	––	––	0.7532***	0.3822***	0.5150***
				(0.0817)	(0.0942)	(0.0881)
University Grad	––	––	––	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	2190	2190	2190	2190	2190	2190
R-squared	0.2588	0.2780	0.2754	0.2573	0.2766	0.2728

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.

(2) 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.

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 Grad	––	––	––	0.2479***	0.1090	0.1208*
				(0.0685)	(0.0785)	(0.0732)
Post-Secondary Grad	––	––	––	0.3498***	0.1923**	0.2004**
				(0.0728)	(0.0848)	(0.0790)
University Grad	––	––	––	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	2185	2185	2185	2185	2185	2185
R-squared	0.2178	0.2222	0.2274	0.2201	0.2247	0.2181

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.

(2) 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.

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 Grad	––	––	––	0.3180***	0.1269*	0.1576**
				(0.0643)	(0.0734)	(0.0684)
Post-Secondary Grad	––	––	––	0.3358***	0.1188	0.1469**
				(0.0683)	(0.0793)	(0.0738)
University Grad	––	––	––	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	2181	2181	2181	2181	2181	2181
R-squared	0.1824	0.1924	0.2007	0.1894	0.1997	0.2046

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.

(2) 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.

Table 5: Determinants of Annual and Hourly Earnings Including Controls for Immigrant Status

Variable	1	2	3	4
Dependent Var. (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)
imm8094	-0.3472***	-0.3036***	-0.3919***	-0.3570***
	(0.1017)	(0.1009)	(0.0844)	(0.0838)
imm6579	-0.0597	0.0675	-0.1776**	-0.0776
	(0.0880)	(0.0890)	(0.0730)	(0.0739)
imm5064	0.2103	0.2269*	0.7117***	0.7251***
	(0.1330)	(0.1316)	(0.1103)	(0.1093)
immpre50	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	2190	2190	2181	2181
R-squared	0.2638	0.2797	0.2094	0.2246

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.

(2) 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.

(3) Individuals who immigrated to Canada when they were 15 years of age or younger are treated as native born Canadians

Table 6: Determinants of Annual and Hourly Earnings Including Controls for Parent's Education

Variable	1	2	3	4
Dependent Var. (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 Grad	0.2400***	0.2010***	-0.1053*	-0.1448**
	(0.0749)	(0.0743)	(0.0631)	(0.0624)
Mother – Post-Secondary Grad	0.2249**	0.1387	-0.0861	-0.1706**
	(0.0933)	(0.0931)	(0.0786)	(0.0781)
Mother – University Grad	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 Grad	-0.1852***	-0.2440***	-0.1593***	-0.2173***
	(0.0720)	(0.0717)	(0.0606)	(0.0601)
Father – Post-Secondary Grad	-0.1267	-0.1765*	-0.1876**	-0.2371**
	(0.1034)	(0.1025)	(0.0873)	(0.0862)
Father – University Grad	-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	2190	2190	2181	2181
R-squared	0.2676	0.2838	0.1904	0.2150

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.
(2) 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.

Table 7: Determinants of Annual and Hourly Earnings Using Instrumental Variables Estimation

Variable	**1**	**2**	**3**	**4**
Dependent Var. (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	2190	2190	2181	2181
R-squared	0.1909	0.2736	0.1806	0.1835

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.
(2) 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.
(3) Instrumented variables in all regressions are years of education, experience, experience^2, and percentile IALS score.
(4) Instruments used are age, age^2, the reason for stopping schooling (financial reasons, family reasons, school not available / accessible) and a dummy for the first language spoken as a child being other than the language of the IALS test. Regressions 2 and 4 add the interaction of parental education levels as instruments.

Table 8: Determinants of Annual Earnings Using Three Stage Least Squares

Variable	**1**	**2**	**3**
Dependent Var.	*Log Annual Earnings*	*Years of Education*	*Percentile IALS Score*
Female	-0.6656***	0.1798**	1.9496*
	(0.0374)	(0.0755)	(0.9982)
Married	0.3001***	-0.3430***	7.8065***
	(0.0643)	(0.1246)	(1.7397)
Rural	-0.1333**	-0.2876***	2.0335
	(0.0523)	(0.1018)	(1.4435)
Years of Education	0.0417**		7.2135***
	(0.0209)		(0.5295)
Experience	0.0404***		-0.0384
	(0.0062)		(0.2005)
Experience^2	-0.0006***		-0.0014
	(0.0001)		(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***	9.1123***	-47.7476***
	(0.1731)	(0.4580)	(5.3308)
Sample Size	2190	2190	2190
pseudo R-squared	0.272	0.313	0.357

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.
(2) 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 parent's education levels have been suppressed in the interest of readability.
(3) Experience and Experience^2 are instrumented by Age and Age^2 respectively. Results are not reported due to space considerations

Table 9: Determinants of Hourly Earnings Using Three Stage Least Squares

Variable	**1**	**2**	**3**
Dependent Var.	*Log Hourly Earnings*	*Years of Education*	*Percentile IALS Score*
Female	-0.2284***	0.1830**	1.9130*
	(0.0314)	(0.0757)	(1.0003)
Married	0.1666***	-0.3365***	8.2065***
	(0.0543)	(0.1253)	(1.7461)
Rural	-0.1430***	-0.2896***	2.0702
	(0.0441)	(0.1024)	(1.4504)
Years of Education	-0.0148		7.2057***
	(0.0175)		(0.5300)
Experience	0.0574***		-0.0627
	(0.0052)		(0.2009)
Experience^2	-0.0009***		-0.0011
	(0.0001)		(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***	9.0704***	-47.6055***

	(0.1453)	(0.4594)	(5.3385)
Sample Size	2181	2181	2181
pseudo R-squared	0.143	0.312	0.357

Notes: (1) *** indicates the estimated coefficient is statistically significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in parentheses.

(2) 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 parent's education levels have been suppressed in the interest of readability.

(3) Experience and Experience^2 are instrumented by Age and Age^2 respectively. Results are not reported due to space considerations

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