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RESEARCH REPORT

The Prediction of Labor Force Status: Implications From International Adult Skill Assessments

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This report investigates the prediction of labor force status using observed variables, such as gender, age, and immigrant status, and more importantly, measured skill variables, including literacy proficiency and a categorical rating of educational attainment based on the 1994 International Adult Literacy Survey (IALS), the 2003 Adult Literacy and Life Skills Survey (ALL), and the 2011 Programme for the International Assessment of Adult Competencies (PIAAC) projects. We explored the regression relations in the past two decades for six trend countries and subnational regions that provide data for all assessments: the United States, Norway, the Netherlands, Italy, Canada's English-speaking region, and Canada's French-speaking region. Probit regression models with latent predictors were used in this cross-sectional study to investigate how those variables are structurally related to labor market outcomes. Results show the importance of literacy proficiency and education in determining individuals' labor force status across countries/regions, but with key differences among these countries/regions.

Keywords PIAAC; ALL; IALS; probit regression

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Over the past two decades, governments, economists, and other stakeholders have become increasingly interested in assessing skills and educational achievement of their adult populations to monitor how well individuals are prepared for the knowledge-based labor market and the economic well-being of nations. Given that the structure of labor markets and the requirements for occupations have been substantially altered by technological forces and economic fluctuations in recent years, young adults are expected to face more challenges and enhance their skills to adapt to the ever-changing society.

As knowledge-based economies that focus on the application of technology and ideas rather than manual labor become dominant worldwide, high levels of educational attainment and competencies have become closely associated with labor market success. Those individuals who lack advanced knowledge or skills to satisfy the increasingly technical demands of the new labor market may find themselves in less stable employment or trapped in long-term unemployment (Organisation for Economic Co-operation and Development & Statistics Canada, 2005).

Recently, the influence of educational attainment and skills on one's labor market experience has been recognized and frequently discussed by economists and educators (e.g., Organisation for Economic Co-operation and Development & Statistics Canada, 2011; Sum, Kirsch, & Yamamoto, 2004). For example, educational achievement has typically been used in social science research as an indirect measure of human capital in explaining earning differences (Organisation for Economic Co-operation and Development & Statistics Canada, 2011). Research has found that education, especially postsecondary education, has a statistically significant and positive effect on earnings across countries (Organisation for Economic Co-operation and Development & Statistics Canada, 2011).

Conversely, a growing number of studies have also been focused on the relations between skills and labor market outcomes. Some economists and sociologists have argued that skills tend to provide a more direct measure of knowledge and competencies than educational attainment and are more indicative of individual productivity differences (Stern & Tuijnman, 1994). Previous research has found that literacy and numeracy skills of individuals have a strong and positive influence on labor market outcomes in most countries, in terms of both the access to full-time employment and earning differences, even when taking into account the effects of educational attainment and other experience (e.g., Finnie &

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Meng, 2006; Organisation for Economic Co-operation and Development & Statistics Canada, 2005, 2011). Individuals with higher skill levels are more likely to have secured full-time employment when compared with their low-skill-level counterparts, even after controlling for age, gender, educational level, and children at home (Organisation for Economic Co-operation and Development & Statistics Canada, 2011).

Among all the relevant skills, literacy proficiency is of particular interest to researchers because of its close association with labor force status and its importance both at the macro and individual levels. At the macro level, literacy is an essential ingredient in the social and economic transformations that are occurring worldwide (Organisation for Economic Co-operation and Development & Statistics Canada, 2000). At the individual level, literacy proficiency not only has a positive influence on one's career prospects but also reduces the chance of long-term unemployment (Organisation for Economic Co-operation and Development & Statistics Canada, 2000). Further evidence has shown that literacy proficiency tends to be a strong predictor of young adults' future success (Sum, 1999). Individuals with stronger literacy skills are more likely to actively participate in the labor force and to avoid unemployment (Berryman, 1994; Sum, 1999). Thus, literacy proficiency is important for both individuals' professional development and social and economic outcomes.

Taken together, higher levels of formal education and literacy proficiency have been considered as benchmarks for achieving success in the labor market (Organisation for Economic Co-operation and Development & Statistics Canada, 2005). However, in most cases, educational achievement and literacy proficiency are not independent. Among a large number of antecedent variables, formal education has been found to be the strongest predictor of literacy proficiency (e.g., Organisation for Economic Co-operation and Development & Statistics Canada, 2000, 2005; Raudenbush & Kasim, 1998). Although these two variables are closely related, their relation is not perfect, and the magnitude of their correlation tends to differ by time and country (Organisation for Economic Co-operation and Development & Statistics Canada, 2011). Attaining a high level of formal education does not necessarily guarantee a high level of literacy proficiency. Conversely, unlike educational attainment, which can only improve throughout one's lifetime, an individual's literacy skills can deteriorate, as shown in later exploratory analyses. Thus, in the present study, both educational attainment and literacy proficiency are included in the analyses.

In the present study, we focus on the cross-sectional analyses and explore the regression of labor force status on predictors such as an estimate of literacy proficiency as well as a categorized educational level variable based on the International Standard Classification of Education (ISCED). In addition, observed variables, including gender, age, and immigrant status, are introduced as predictors. Previous research has often focused on the role of educational attainment in determining labor market outcomes in a particular socioeconomic context, with fewer studies looking into the link between literacy proficiency and labor market experiences across years and countries, largely because of the scarcity of large-scale surveys with comparable data.

The present study advances this line of research and examines the relations between the likelihood of being employed and education, literacy proficiency, and other demographic variables. We investigate the regression relations over the past two decades by using data from the 1994 International Adult Literacy Survey (IALS), the 2003 Adult Literacy and Life Skills Survey (ALL), and the 2011 Programme for the International Assessment of Adult Competencies (PIAAC) projects across six trend countries and subnational regions that provided data for all the assessments: the United States, Norway, the Netherlands, Italy, and Canada's English- and French-speaking regions.

The report is organized as follows. The next section presents a brief summary of research questions and purposes. In the third section, the methodology used in the present study, which consists of two major parts, is detailed. Relevant features of the IALS, ALL, and PIAAC, as well as some exploratory data analysis results, are presented in the initial portion of the section. The latter portion develops the main-effect model and the model with interaction effects for investigating the relative contributions of educational attainment, literacy, age, gender, and immigrant status to labor force status. Estimation methods are also described in some detail. The fourth section reports the results for the six trend countries and regions across the three international surveys. Finally, the report closes with a discussion and conclusion.

The Prediction of Labor Force Status

As mentioned, the purpose of the present study is to investigate the prediction of employment status using observed demographic variables, such as gender, age, and immigrant status, and more importantly, measured skill variables, including literacy proficiency and a categorical rating of educational attainment. Furthermore, we are interested in the effect of educational attainment over one's career, operationalized in this study as the interaction between age and educational

attainment in predicting the labor force status, controlling for gender, immigrant status, and literacy proficiency. In addition, we investigated the regression relations over the three assessments in all six trend countries and regions, including the United States, Norway, the Netherlands, Italy, and Canada's English- and French-speaking regions. In the following sections, we examine these major issues and describe the importance of the aforementioned five predictors to labor force status based on the three international large-scale surveys.

Methods

Data Sources

In the past two decades, there have been three major surveys of adult literacy proficiencies on the international level: IALS (1994), ALL (2003), and PIAAC (2011).

International Adult Literacy Survey

This was the first international comparative survey of adult literacy, with the goal of creating comparable literacy profiles across national, linguistic, and cultural boundaries (Organisation for Economic Co-operation and Development & Statistics Canada, 1995). This initiative was the joint effort of seven countries, and the first wave of data collection was carried out in 1994. Besides literacy proficiencies, the survey also offered comprehensive data on respondents' demographic and socioeconomic information, their participation in education and training, and their labor market experiences. Based on data from the first round of collection, a strong plausible link has been found between adult literacy and a country's economic potentials (Organisation for Economic Co-operation and Development & Statistics Canada, 1995). Subsequently, second and third waves of data collection were conducted in 1996 (Organisation for Economic Co-operation and Development & Human Resources Development Canada, 1997) and 1998 (Organisation for Economic Co-operation and Development & Statistics Canada, 2000), respectively, with an additional 16 countries around the world. In total, 23 countries and regions participated in IALS, with the questionnaire administered in multiple language forms. In our analyses, the data for Canada, the Netherlands, and the United States were collected in 1994, whereas those for Norway and Italy were collected in 1998.

Adult Literacy and Life Skills Survey

Built on the foundation of the IALS project, ALL was the second international comparative study designed to measure the literacy and numeracy skills of individuals between 16 and 65 years old. ALL was conducted according to internationally defined procedures, and the instruments were designed to allow comparisons at an international level across participating countries and regions. Two rounds of data collection were conducted: first, in 2003, and second from 2006 to 2008. Nationally representative samples of adult populations were obtained from 10 participating countries, including Bermuda, Canada, Italy, Norway, Switzerland, the United States, Australia, Hungary, the Netherlands, and New Zealand. The data for the Netherlands used in the present study were from the second round of data collection; the remainder was collected in 2003.

Programme for the International Assessment of Adult Competencies

Built on earlier results from the IALS and ALL projects, PIAAC—which continues to be administered in additional countries—is designed to facilitate an appropriate assessment of the current state of key cognitive and workplace skills needed for individuals and nations in the knowledge-based modern society. The framework of PIAAC broadens the definition of literacy of the previous two international surveys to make it more relevant to the 21st century, especially by including reading skills in digital environments. Similar to IALS and ALL, PIAAC is administered to nationally representative samples of 16- to 65-year-olds. The survey providing data for this study was delivered in 24 countries and subnational regions in more than 30 national languages in 2011–2012.

Data for the Present Study

Six countries and subnational regions that participated in all three international comparative surveys are included in the present study: the United States, Norway, the Netherlands, Italy, and Canada's English- and French-speaking regions. All

studies utilized state-of-the-art methodologies common to most international large-scale assessments (Mislevy, 1992; von Davier, Gonzalez, & Mislevy, 2009; von Davier, Sinharay, Oranje, & Beaton, 2006; Yamamoto & Mazzeo, 1992), providing comparable measures of proficiencies across participating countries and linked across IALS, ALL, and PIAAC (Yamamoto, Khorramdel, & von Davier, 2013, Chapter 17). The methodologies used produce plausible values (Mislevy, 1992) that can be considered imputations of literacy, numeracy, and other proficiencies based on the observed performance of the respondents while controlling for background characteristics (for details on the methodology, see von Davier et al., 2006; von Davier et al., 2009).

As mentioned, plausible values are imputed values drawn from an empirically derived distribution of literacy scale scores that are conditional on the observed values of the assessment items and the background variables (e.g., Mislevy, 1991, 1993; Rubin, 1987; von Davier et al., 2009). These multiple imputation values resemble individual literacy scale scores and have approximately the same distribution as the latent trait (i.e., literacy proficiency) being measured (Wu, 2005). Thus, literacy proficiency is a latent variable measured with error. The plausible values of literacy scale scores and several other trend variables, including gender, age, immigrant status, employment status, and the highest level of education, are used in the present study.

Literacy Scale Plausible Values

In both IALS and ALL, literacy is operationally defined as "a particular capacity and mode of behavior: the ability to understand and employ printed information in daily activities, at home, at work, and in the community — to achieve one's goals and to develop knowledge and potential" (Organisation for Economic Co-operation and Development & Statistics Canada, 2000, introduction). Built on the IALS/ALL definition, the definition of literacy has been expanded and refined in PIAAC to meet the requirement of the information age. The new definition is "understanding, evaluating, using, and engaging with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (Organisation for Economic Co-operation and Development, 2012, p. 20).

For example, in the PIAAC literacy assessment, tasks such as assessing and identifying information in a text, integrating and interpreting texts, and evaluating and reflecting on a text are included (Lennon & Tamassia, 2013, Chapter 2). The texts used in PIAAC are either digital or in print and belong to one of the six categories, including description, narration, exposition, argumentation, instruction, and records (Lennon & Tamassia, 2013, Chapter 2). The format of the text is either continuous, such as newspaper articles, or noncontinuous, such as tables, and the stimulus materials represent a variety of social contexts (Lennon & Tamassia, 2013, Chapter 2). In addition, reading components are included in the PIAAC assessment to gather more information about the comprehension skills of those with low literacy proficiency (Lennon & Tamassia, 2013, Chapter 2).

For each respondent participating in PIAAC, literacy proficiency is measured on a scale ranging from 0 to 500 points, and a set of 10 plausible values is generated for the literacy scale (whereas in the previous two survey projects, literacy was measured in prose and document literacy subscales separately). For comparisons among the three adult literacy assessments, the ETS-led PIAAC consortium has conducted a rescaling study of IALS and ALL data that combines the prose and document literacy scales into one comprehensive scale. In addition, this scale is constructed in a way to be aligned with the literacy scale as measured in PIAAC. As a result, for ALL and IALS, this composite literacy scale is comparable to the one used in PIAAC by construction. Details about the procedure can be found in the chapter on scaling of the PIAAC technical report (Yamamoto et al., 2013, Chapter 17). Ten plausible values are generated for the composite literacy scale for each of the participants in IALS, ALL, and PIAAC.

In the present study, the literacy proficiency plausible values are standardized for each country/region across time, so that the interpretation of the regression coefficients is comparable across the three surveys for each country. All 10 plausible values are used in our analyses for each data set per country as one of the predictors for the employment status. The 10 sets of inferences drawn from each data set are then combined based on Rubin's (1987) procedure, as shown in the following.

Educational Attainment

The education variable used in the present study is the highest level of education in three ordinal categories. It is a derived variable that collapses the original finer grained ISCED categories of schooling. Respondents are classified into three

Table 1 Dummy-Coded Variables for the Interaction Effect Between Age and Education

	Educational attainment		
Age (years)	1 = Below high school	2 = High school	3 = Above high school
≤34	Reference group	Inter2 = 1; otherwise = 0	Inter3 = 1; otherwise = 0
≥35	Inter4 = 1; otherwise = 0	Inter5 = 1; otherwise = 0	Inter6 = 1; otherwise = 0

major categories: 1 = having less than high school education, 2 = having completed high school education, and 3 = having some postsecondary education. Considering that noise may enter the transformation process and that the same level of education may indicate different levels of competencies in different countries and regions, the education attainment variable, similar to literacy proficiency, is also regarded as an indicator variable that likely contains both random error and some level of systematic difference in definition across countries and surveys.

Other Predictor Variables

Other predictors of interest are respondent's gender, age, and immigrant status, all of which are observed variables collected during the interview. Gender (i.e., 0 = male, 1 = female) and immigrant status (i.e., 0 = nonimmigrant, 1 = immigrant) are dichotomous variables, and age is ordinal. Age is defined in 10-year bands with a total of five categories. The first band is defined as 24 years old or younger and the last as 55 years and older.

Both age and the highest level of education are dummy coded using indicator coding for the main-effect model in our later probit regression analysis. When we examine the interaction effects between age and education, we further collapse the five-category age variables into two categories (i.e., 34 years old or younger and 35 years old or older) and create five dummy-coded variables using indicator coding to denote different age and education combinations (see Table 1).

Employment Status

Using the explanatory variables, we attempt to predict the employment status of individuals to be in one of two groups—the unemployed (coded as 0) and the employed (coded as 1)—at the time of responding to those surveys. Respondents in other response categories, including the retired, students, those who do unpaid household work, and those with "other" as occupational status, are excluded from our analysis.

Missing Data

All types of unobserved data (e.g., valid skip, do not know, refused) for the variables used in the present study are recoded as missing data (i.e., missing = 99) for our analysis. We do not differentiate different types of unobserved cases, nor do we apply any imputation or deletion for the missingness at the data preparation stage. Missingness is handled in the estimation process as a function of the observed covariates in a pairwise present manner.

Data Analysis

Exploratory Data Analysis

As a first step, the raw data were examined graphically and descriptive statistics were obtained from the three international surveys for the six trend countries and regions. Table 2 shows the unemployment and immigration rates of adults in the United States, Norway, the Netherlands, Italy, Canada's English-speaking region, and Canada's French-speaking region across the IALS, ALL, and PIAAC data sets.

The unemployment rates and immigration rates were calculated based on the total sample. With population weights taken into consideration, the descriptive statistics shown in this table were assumed to represent the population values for each country/region. The sample sizes indicated in Table 2 reflected the samples extracted for later probit regression analysis.

Table 2 Descriptive Statistics Obtained From the International Adult Literacy Survey (IALS), Adult Literacy and Life Skills Survey (ALL), and Programme for the International Assessment of Adult Competencies (PIAAC) Projects

Surveys	Sample sizes (employed and unemployed)	Unemployment rates (%)	Immigration rates (%)
United States			
IALS (1994)	2,150	3.8	12.7
ALL (2003)	2,610	9.2	14.7
PIAAC (2011)	3,539	8.4	14.7
Norway			
IALS (1998)	2,500	2.9	6.2
ALL (2003)	3,942	3.7	6.3
PIAAC (2011)	3,599	3.0	13.4
Netherlands			
IALS (1994)	1,927	4.3	6.7
ALL (2006)	3,973	4.1	9.8
PIAAC (2011)	3,618	4.3	12.9
Italy			
IALS (1998)	1,895	6.7	2.1
ALL (2003)	4,119	7.3	1.8
PIAAC (2011)	3,172	12.7	9.3
Canada (English)			
IALS (1994)	2,053	7.1	24.9
ALL (2003)	12,076	7.7	25.7
PIAAC (2011)	12,865	5.5	29.2
Canada (French)			
IALS (1994)	848	10.0	8.6
ALL (2003)	3,223	6.4	8.2
PIAAC (2011)	3,954	4.2	12.8

As shown in the Table 2, the unemployment rate increased for the United States from IALS (1994) to ALL (2003) but slightly decreased when assessed in the most recent (PIAAC) cycle. Conversely, the immigration rate increased from 12.7% to 14.7% from IALS (1994) to ALL (2003) and remained stable over the last decade. For both Norway and the Netherlands, their unemployment rates have remained stable over the last two decades, but their immigration rates have increased dramatically over the last 10 years. In addition, the unemployment rate for Italy has remained stable from IALS (1998) to ALL (2003) but has greatly increased over the last 10 years. The same trend was also observed for the immigration rate of Italy. Finally, for both the English- and French-speaking regions of Canada, the immigration rates have increased in the last decade by approximately 4%. The unemployment rate has decreased for Canada's French-speaking region over the last two decades, whereas the rate for Canada's English-speaking region has remained relatively stable, with only slight increases and decreases.

Furthermore, we examined the average literacy proficiency by age group. For exploratory purposes, we used only one set of plausible values to provide an approximation of the relation between literacy proficiency and age. As demonstrated in Figure 1, the literacy proficiency of adults in these six countries and regions was similar for individuals aged 24 years old or younger and those aged between 25 and 34 years. However, from 35 years old and up, the literacy level began to show a decreasing pattern, reaching its minimum for the last age group (i.e., 55 and older). These patterns were consistent across the three international data sets for all six trend countries and regions. Therefore, the exploratory plot has provided some indications that literacy proficiency, unlike educational attainment, is a variable that changes over one's lifetime. The exploratory analysis also provided some evidence that 35 years old was a reasonable cutoff value to collapse age categories for the investigation of the interaction effect between educational attainment and age.

In addition, we examined the employment rates as a function of the literacy proficiency for the three international surveys across the six trend countries and regions based on the extracted sample data that were used in later probit regression analyses. As described in the previous section, respondents in other irrelevant working status categories were excluded from our analysis. The percentage of respondents excluded ranged between 22.7% and 41.2% for those countries and regions. For each data set per country, the sample was divided into 10 subgroups at every 10th percentile of literacy proficiency, and the employment rate was calculated for each subgroup. A smoothing curve was imposed using a spline function for each data set to show the general tendency of employment rate as a function of the literacy proficiency.

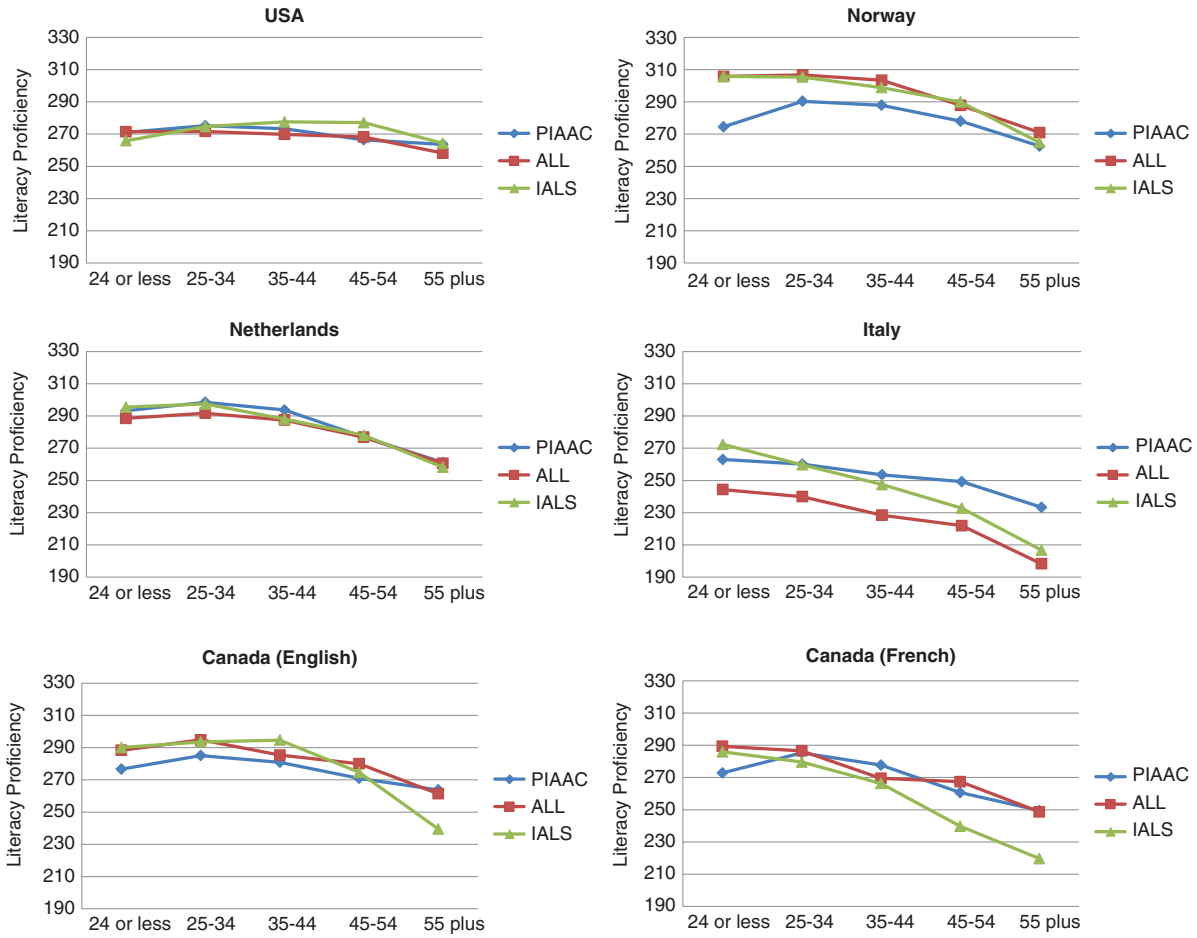

Figure 1 Average literacy proficiency by age group.

As shown in Figure 2, the role of literacy has become increasingly important in determining the labor force status for the United States and Italy over the last two decades. However, the pattern was the opposite for Norway, the Netherlands, and Canada's French-speaking region. The slopes of the curves became smaller as time went by, indicating that the variation in employment rates by literacy proficiency level became smaller for these three countries/regions, which was an important implication for the probit regression analysis presented in the following section. For Canada's English-speaking region, the pattern did not change much over the years.

Probit Regression With Latent Predictors

In the present study, we applied probit regression models to regress employment status (i.e., employed or unemployed) on observed variables, including respondent's gender, age groups, immigration status, and the highest level of education (in three levels), as well as literacy scale plausible values. In general, both logistic and probit regression models may be applied in this scenario, and very similar results would be obtained. Considering that the probit regression model is the default method in economics-related research and the current report focused on the socioeconomic changes in different trend countries and regions, a probit model was used in the present study.

Thus, the plan for analysis was first to determine whether the five aforementioned predictors taken together could predict the labor force status in all six trend countries and regions across the last two decades using Model 1. Only main effects were considered in Model 1; no interaction effects were allowed among the predictors:

$$\Pr\left(\mathrm{Emp}=1|\mathbf{X}\right)=\Phi\left(\beta_0+\beta_{\mathrm{Gen}}\left(\mathrm{Gen}\right)+\beta_{\mathrm{Imm}}\left(\mathrm{Imm}\right)+\beta_{A2}\left(\mathrm{Age2}\right)+\beta_{A3}\left(\mathrm{Age3}\right)+\beta_{A4}\left(\mathrm{Age4}\right)\right.$$
$$\left.+\beta_{A5}\left(\mathrm{Age5}\right)+\beta_{E2}\left(\mathrm{Edu2}\right)+\beta_{E3}\left(\mathrm{Edu3}\right)+\beta_{\mathrm{Lit}}\left(\mathrm{PVLIT}\right)\right), \quad (1)$$

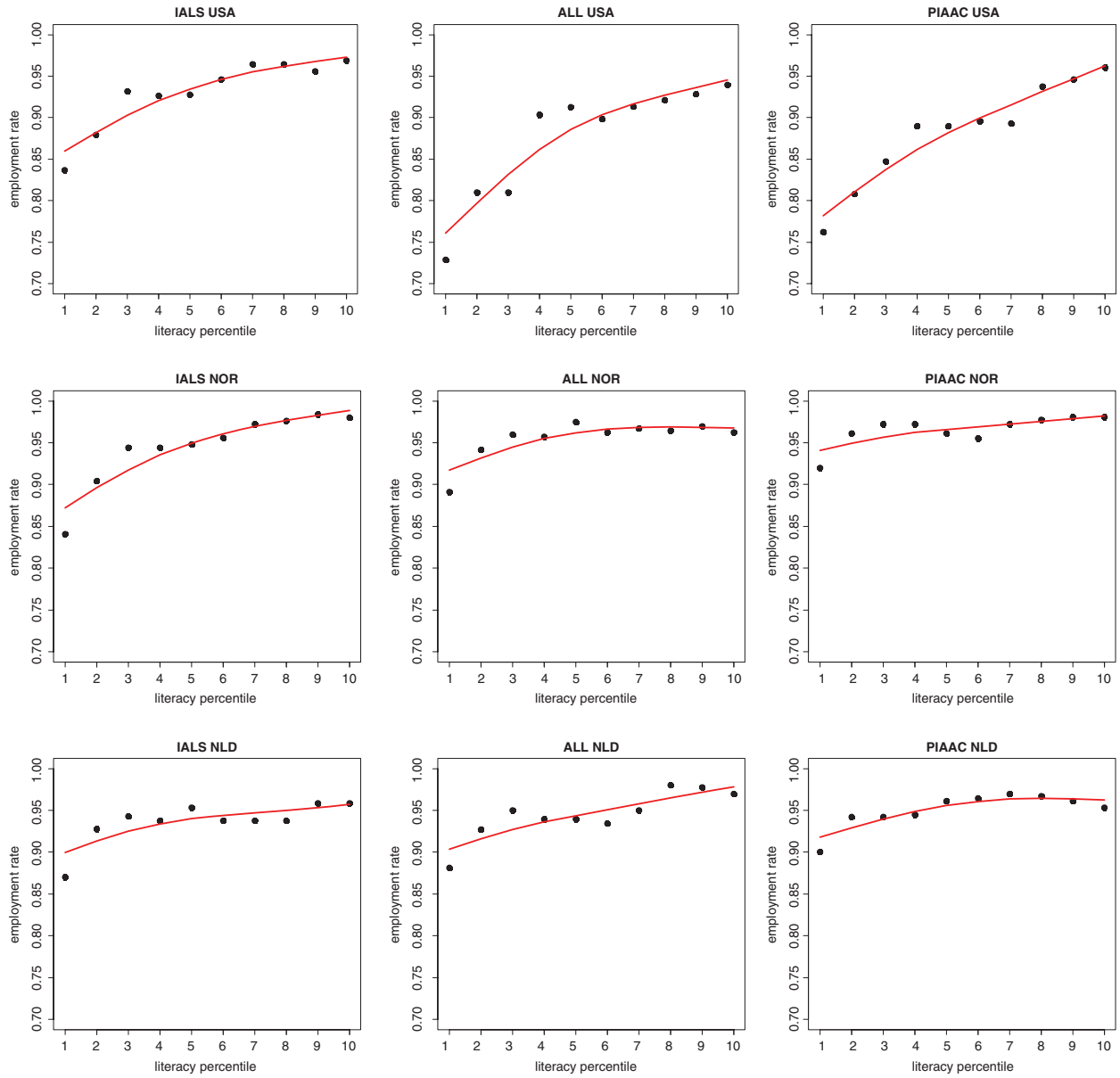

Figure 2 Average employment rate by literacy proficiency percentiles.

where **X** stands for the vector of predictors, Pr denotes probability, and Φ indicates the cumulative distribution function (CDF) of the standard normal distribution.

Then, according to the second research question, Model 2 was used to investigate the interaction between age and educational attainment in the prediction of labor force status, controlling for gender, age, and literacy proficiency. In Model 2, the main effects of age and educational attainment were removed to reduce the collinearity between predictors:

$$\Pr\left(\text{Emp}=1|\mathbf{X}\right)=\Phi\left(\beta_0+\beta_{\text{Gen}}\left(\text{Gen}\right)+\beta_{\text{Imm}}\left(\text{Imm}\right)+\beta_{\text{Int2}}\left(\text{Int2}\right)+\beta_{\text{Int3}}\left(\text{Int3}\right)\right.$$
$$\left.+\beta_{\text{Int4}}\left(\text{Int4}\right)+\beta_{\text{Int5}}\left(\text{Int5}\right)+\beta_{\text{Int6}}\left(\text{Int6}\right)+\beta_{\text{Lit}}\left(\text{PVLIT}\right)\right). \quad (2)$$

Estimation and Combined Inferences

Model estimation was carried out using Mplus 6.1 with a robust weighted least squares estimator based on a diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistic that use a full weight matrix

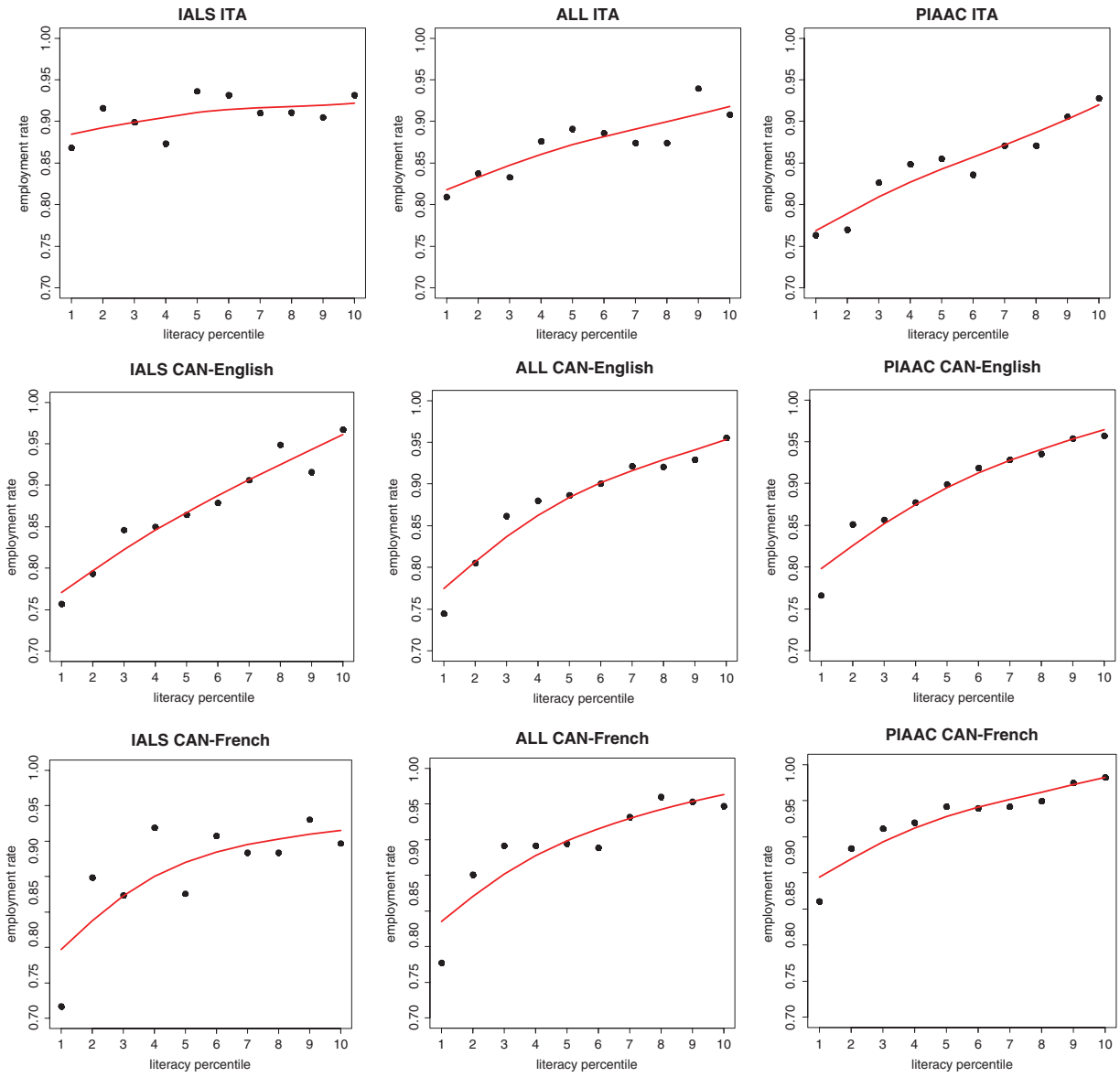

Figure 2 Continued

(i.e., WLSMV). The WLSMV, which uses the diagonal weight matrix to obtain the estimates, is a robust estimator that does not assume normally distributed variables and provides the best option for modeling categorical or ordered data (Brown, 2006). Both the replicate weights and the total sampling weights were taken into consideration. For each data set per country/region, the estimation was repeated 10 times respectively for each set of literacy plausible values. The 10 sets of parameter estimates were then combined into a single set of results using Rubin's (1987) procedure. Specifically, let Q_i be the probit regression coefficient estimate obtained based on the ith (i.e., $i = 1, \ldots, m$) set of plausible values and U_i its corresponding variance. The point estimate for Q based on the m imputed data sets is

$$\overline{Q} = \frac{1}{m}\sum_{i=1}^{m} Q_i \tag{3}$$

The within-imputation variance $\overline{U}$ is defined as

$$\overline{U} = \frac{1}{m}\sum_{i=1}^{m} U_i \tag{4}$$

and the between-imputation variance is

$$B = \frac{1}{m-1}\sum_{i=1}^{m}\left(Q_i - \overline{Q}\right)^2 \tag{5}$$

Thus, the variance associated with the $\overline{Q}$, which is the average of the regression coefficient estimates based on the m sets of plausible values, is given by

$$T = \overline{U} + \left(1 + \frac{1}{m}\right)B \tag{6}$$

with $f = (m-1)[1 + (\overline{U}/(1+m^{-1})B)]^2$ degrees of freedom (Satterthwaite, 1941, 1946). Consequently, hypothesis testing with the null hypothesis $Q = 0$ can be performed with the test statistic $\overline{Q}/T^{1/2}$, which follows a t-distribution with f degrees of freedom under the assumed condition that there are a finite number of multiple imputations but an infinite number of observations in the sample (Rubin & Schenker, 1986).

Results

Model 1 was first used to fit the data from the three large-scale surveys for each country/region, and the combined inferences are provided in Tables 3 – 8. For interpretation purposes, all of the regression coefficients are converted to probability based on the CDF of the standard normal distribution. To start, indicated in Table 3, the probability of being employed in the United States in IALS (1994) was .857 for nonimmigrant male individuals who were 24 years old or younger, having less than high school education and with average literacy proficiency. However, this probability decreased to .762 in ALL (2003) and to .685 in PIAAC (2011). For a 1 standard deviation increase in the literacy proficiency above the baseline (i.e., 0), the likelihood of employment increased by .03 in 1994; by comparison, the increase was .071 in 2003 and .061 in 2011, holding all else constant. The effect of literacy proficiency on the likelihood of being employed was statistically significant in 2003 and 2011.

For those who obtained a high school diploma, the probability of employment was .072 greater than those who had below high school education based on the IALS data; for those who had at least some postsecondary education, the probability of employment was .09 greater than for those who were below high school, controlling for all other variables. In 2003, the likelihood of employment was .101 greater for those who completed high school education and .125 greater for those who had above high school education, compared with their counterparts who received below high school education. In 2003, the differences became even greater, at .133 and .203, respectively, for the two higher educational levels.

Furthermore, those who received a high school diploma and those who had at least some postsecondary education were found to be significantly different from those who had below high school education in terms of the likelihood of being employed. Overall, both the descriptive statistics and the hypothesis testing results have provided evidence that the likelihood of being employed tended to be more differentiated by education, especially postsecondary education, in the last decade compared to 20 years ago, as shown in the ALL and PIAAC results.

As for the three demographic variables, immigrants were more likely to find a job and women were slightly less likely to be employed in the United States, as indicated by the results based on the ALL and PIAAC data. The four age groups of adults older than 25 years were more likely than their younger counterparts to be employed. The age effect became more pronounced in the 2003 ALL and 2011 PIAAC data than it was two decades earlier.

Table 4 demonstrates the results for Norway based on the three large-scale surveys. For nonimmigrant male individuals who were 24 years old or younger, the probability of being employed was .920 in IALS (1998) if they had less than high school education and average literacy proficiency. However, the probability decreased to .871 in ALL (2003) and .825 in PIAAC (2011). For a 1 standard deviation increase in the literacy proficiency above the baseline (i.e., 0), the likelihood of being employed increased by .02 in 1998; the increase was .046 in 2003 and .018 in 2011, holding all else constant. The effect of literacy proficiency on the likelihood of being employed was statistically significant in 1998 and 2003 but was no longer significant in 2011, controlling for the other predictors.

However, as indicated by the PIAAC results, for those who obtained a high school diploma, the probability of employment was .107 greater than for those who had below high school education; for those who had at least some postsecondary education, the probability of employment was .127 greater than for those who had below high school education, controlling for all other variables. In the 2008, IALS data and the 2011 PIAAC data, education

Table 3 Parameter Estimates for Model 1: The United States

	IALS (1994)	ALL (2003)	PIAAC (2011)
Intercept	1.068 (0.161)***	0.714 (0.123)***	0.482 (0.105)***
Literacy	0.142 (0.087)	0.253 (0.050)***	0.180 (0.044)***
Gender	−0.053 (0.096)	−0.230 (0.071)**	−0.136 (0.059)*
Immigrant status	0.063 (0.149)	0.252 (0.122)*	0.282 (0.113)*
Age2	0.122 (0.144)	0.122 (0.095)	0.337 (0.094)***
Age3	0.336 (0.156)*	0.346 (0.096)***	0.294 (0.086)***
Age4	0.330 (0.183)	0.460 (0.114)***	0.346 (0.092)***
Age5	0.485 (0.241)*	0.348 (0.142)*	0.383 (0.109)***
Edu2	0.403 (0.173)*	0.382 (0.082)***	0.425 (0.095)***
Edu3	0.544 (0.296)	0.496 (0.109)***	0.736 (0.086)***

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

Table 4 Parameter Estimates for Model 1: Norway

	IALS (1998)	ALL(2003)	PIAAC (2011)
Intercept	1.403 (0.154)***	1.132 (0.201)***	0.934 (0.148)***
Literacy	0.193 (0.057)**	0.253 (0.074)**	0.072 (0.052)
Gender	−0.056 (0.134)	−0.041 (0.101)	−0.077 (0.082)
Immigrant status	−0.572 (0.178)**	−0.103 (0.116)	−0.414 (0.120)**
Age2	0.195 (0.107)	0.208 (0.154)	0.372 (0.135)**
Age3	0.669 (0.103)***	0.559 (0.181)**	0.341 (0.145)*
Age4	0.696 (0.134)***	0.907 (0.195)***	0.646 (0.151)***
Age5	0.735 (0.153)***	0.740 (0.179)***	0.780 (0.153)***
Edu2	−0.019 (0.162)	0.063 (0.159)	0.557 (0.128)***
Edu3	0.315 (0.203)	0.143 (0.214)	0.727 (0.151)***

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

was not found to be statistically significant in predicting the likelihood of being employed. Furthermore, immigrants were found to be less likely to find a job in 1998 and 2011. The three age groups of individuals older than 35 years were more likely than their counterparts who were 24 years old or younger to be employed. The difference in the probability of employment for those 25 – 34 years and those 24 years or younger was less pronounced across time.

In the Netherlands (Table 5), for nonimmigrant male individuals who were 24 years old or younger, having below high school education and average literacy proficiency, the probability of being employed was comparable across time: .896 in IALS (1994), .885 in ALL (2006), and .903 in PIAAC (2011). For a 1 standard deviation increase in the literacy proficiency above the baseline (i.e., 0), the likelihood of being employed increased by .019 in 1994, by .021 in 2003, and by .016 in 2011, holding all else constant. The effect of literacy proficiency on the likelihood of being employed was statistically significant in 1994 and 2006 but was no longer significant in 2011.

High school education was not found to make a statistically significant difference in the likelihood of employment. However, based on the ALL and PIAAC results, for those who had at least some postsecondary education, the probability of being employed was, respectively, .047 and .044 greater than for those who had below high school education in 2006 and 2011, controlling for all other variables. Furthermore, similar to Norway, immigrants were less likely to be hired across time. However, females were found to be more likely to find a job than males in 2011. Unlike the United States and Norway, the differences among age groups with regard to the likelihood of being employed seemed less pronounced in the Netherlands.

Table 6 displays the results for Italy based on IALS (1998), ALL (2003), and PIAAC (2011) data. For nonimmigrant male individuals who were 24 years old or younger, the probability of being employed in 1998 was .745 if they had less

Table 5 Parameter Estimates for Model 1: The Netherlands

	IALS (1994)	ALL (2006)	PIAAC (2011)
Intercept	1.258 (0.150)***	1.198 (0.186)***	1.300 (0.130)***
Literacy	0.115 (0.048)*	0.116 (0.049)*	0.096 (0.051)
Gender	0.078 (0.091)	−0.128 (0.111)	0.221 (0.076)**
Immigrant status	−0.664 (0.184)***	−0.415 (0.194)*	−0.590 (0.118)***
Age2	0.178 (0.183)	0.485 (0.188)*	0.078 (0.131)
Age3	0.398 (0.180)*	0.482 (0.179)**	0.254 (0.136)
Age4	0.423 (0.178)*	0.495 (0.169)**	0.259 (0.142)
Age5	0.083 (0.205)	0.024 (0.182)	0.010 (0.124)
Edu2	0.121 (0.127)	0.181 (0.102)	0.141 (0.102)
Edu3	0.101 (0.148)	0.295 (0.106)**	0.315 (0.119)**

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

Table 6 Parameter Estimates for Model 1: Italy

	IALS (1998)	ALL (2003)	PIAAC (2011)
Intercept	0.659 (0.174)***	0.299 (0.102)**	0.118 (0.119)
Literacy	0.251 (0.083)**	0.154 (0.041)***	0.144 (0.048)**
Gender	−0.246 (0.107)*	−0.172 (0.081)*	−0.368 (0.059)***
Immigrant status	0.166 (0.308)	0.208 (0.325)	−0.014 (0.117)
Age2	0.700 (0.169)***	0.683 (0.090)***	0.536 (0.128)***
Age3	0.957 (0.205)***	1.345 (0.129)***	0.852 (0.114)***
Age4	1.586 (0.198)***	1.350 (0.118)***	0.911 (0.129)***
Age5	1.009 (0.411)*	0.886 (0.124)***	0.966 (0.144)***
Edu2	−0.177 (0.109)	0.347 (0.099)***	0.291 (0.082)***
Edu3	−0.445 (0.174)*	0.299 (0.083)***	0.488 (0.125)***

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

than high school education and average literacy proficiency. However, the probability decreased to .618 in 2003 and to .547 in 2011. For a 1 standard deviation increase in the literacy proficiency above the baseline (i.e., 0), the likelihood of being employed increased by .074 in 1998, by .057 in 2003, and by .056 in 2011, holding all else constant. The effect of literacy proficiency on the likelihood of being employed was statistically significant across time.

In addition, as indicated by the ALL results, for those who obtained a high school diploma, the probability of employment was .123 greater than for those who had below high school education; for those who had at least some postsecondary education, the probability of employment was .107 greater than for those who had below high school education, controlling for all other variables. In 2011, the differences became even greater, at .112 and .181, respectively, for the two higher educational levels, suggesting that the importance of education has shifted from high school diploma to postsecondary education in Italy. Postsecondary education tended to be a stronger predictor of labor force status in the knowledge-based society.

Furthermore, females were less likely to find a job in Italy, but immigrant status was not found to be a significant predictor of labor force status. The four age groups of individuals aged older than 24 years were consistently much more likely than their counterparts who were 24 years old or younger to be employed. Age tended to be a stronger predictor of labor force status in Italy than any other country or region.

With regard to Canada, the data were analyzed separately for the English- and French-speaking regions. In Canada's English-speaking region (see Table 7), the probability of being employed in IALS (1994) was .885 for nonimmigrant male individuals who were 24 years old or younger, having less than high school education, and with average literacy proficiency. The likelihood of being employed slightly decreased to .774 in ALL (2003) and to .815 in PIAAC (2011). For a 1 standard deviation increase in the literacy proficiency above the baseline (i.e., 0), the likelihood of being employed increased by

Table 7 Parameter Estimates for Model 1: Canada, English-Speaking Region

	IALS (1994)	ALL (2003)	PIAAC (2011)
Intercept	1.202 (0.189)***	0.752 (0.119)***	0.897 (0.108)***
Literacy	0.165 (0.140)	0.137 (0.041)**	0.196 (0.046)***
Gender	−0.104 (0.228)	−0.121 (0.068)	0.045 (0.072)
Immigrant status	−0.018 (0.234)	−0.152 (0.086)	−0.074 (0.100)
Age2	−0.095 (0.201)	0.231 (0.107)*	0.270 (0.111)*
Age3	−0.196 (0.127)	0.442 (0.120)***	0.272 (0.099)**
Age4	−0.110 (0.344)	0.485 (0.095)***	0.422 (0.090)***
Age5	0.328 (0.497)	0.794 (0.120)***	0.469 (0.100)***
Edu2	0.200 (0.329)	0.400 (0.082)***	0.251 (0.105)*
Edu3	0.570 (0.492)	0.416 (0.092)***	0.390 (0.101)***

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

Table 8 Parameter Estimates for Model 1: Canada, French-Speaking Region

	IALS (1994)	ALL (2003)	PIAAC (2011)
Intercept	1.390 (0.510)**	0.992 (0.120)***	1.193 (0.145)***
Literacy	0.224 (0.243)	0.369 (0.063)***	0.226 (0.050)***
Gender	−0.200 (0.360)	−0.187 (0.095)*	0.115 (0.077)
Immigrant status	0.047 (4.889)	−0.380 (0.154)*	0.017 (0.175)
Age2	−0.126 (0.395)	0.190 (0.105)	0.049 (0.131)
Age3	−0.556 (0.511)	0.586 (0.101)***	0.251 (0.156)
Age4	0.023 (0.414)	0.630 (0.110)***	0.042 (0.120)
Age5	−0.781 (1.033)	0.558 (0.119)***	0.244 (0.130)
Edu2	0.183 (0.317)	0.197 (0.117)	0.174 (0.130)
Edu3	0.161 (0.645)	0.274 (0.128)*	0.284 (0.114)*

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

.029 in 1994, by .105 in 2003, and by .047 in 2011, holding all else constant. In addition, in 2003, for those who obtained a high school diploma, the probability of employment was .101 greater than for those who had below high school education; for those who had at least some postsecondary education, the probability of employment was .105 greater than for those who had below high school education, controlling for all other variables. In 2011, the likelihood of employment was .060 greater for those who completed high school education and .086 greater for those who had above high school education, compared to their counterparts who received below high school education.

Additionally, gender and immigrant status were not found to be statistically significant in the prediction of labor force status in Canada's English-speaking region. The four age groups of adults above 24 years old were more likely than their younger counterparts to be employed, as indicated by the ALL and PIAAC results. The results for Canada's English-speaking region were similar to those found for the United States.

Finally, for nonimmigrant male adults in Canada's French-speaking region (see Table 8), the probability of being employed in IALS (1994) was .918 if they were 24 years old or younger, having less than high school education and average literacy proficiency. The likelihood of being employed slightly decreased to .839 in ALL (2003) and to .884 in PIAAC (2011). For a 1 standard deviation increase in the literacy proficiency above the baseline (i.e., 0), the likelihood of being employed increased by .029 in 1994, by .074 in 2003, and by .038 in 2011, holding all else constant. The effect of literacy proficiency on the likelihood of being employed was statistically significant in 2003 and 2011 but was not significant in 1994. Conversely, high school education was not found to make a statistically significant difference in the likelihood of employment at all times.

However, based on the ALL and PIAAC results, for those who had at least some postsecondary education, the probabilities of employment were, respectively, .058 and .046 greater than for those who had below high school education,

Table 9 Parameter Estimates for Model 2: The United States

	IALS (1994)	ALL (2003)	PIAAC (2011)
Intercept	1.265 (0.169)***	0.898 (0.125)***	0.494 (0.128)***
Literacy	0.133 (0.088)	0.243 (0.049)***	0.174 (0.042)***
Inter2	0.190 (0.261)	0.204 (0.091)*	0.584 (0.151)***
Inter3	0.486 (0.334)	0.396 (0.134)**	1.073 (0.145)***
Inter4	0.047 (0.265)	0.021 (0.114)	0.441 (0.153)**
Inter5	0.654 (0.216)**	0.636 (0.143)***	0.748 (0.140)***
Inter6	0.687 (0.274)*	0.710 (0.152)***	1.02 (0.134)***
Gender	−0.068 (0.102)	−0.228 (0.071)**	−0.142 (0.059)*
Immigrant status	0.076 (0.152)	0.247 (0.120)*	0.289 (0.111)*

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

controlling for all other variables. Furthermore, gender and immigrant status were only found to be significant predictors of labor force status in 2003. The three age groups of adults above 35 years old were more likely than their younger counterparts to be employed, as shown in the ALL results. In the IALS and PIAAC results, age did not seem to make a difference in determining the labor force status.

Overall, the two measured skill variables, educational attainment and literacy proficiency, and the three observed demographic variables of age, gender, and immigrant status worked well in the prediction of labor force status. The pseudo R^2 for Model 1 was approximately .09 – .13 for all countries across time, with two exceptions that the model worked better for Canada's French-speaking region and for Italy in the IALS and ALL data. The pseudo R^2 on average was .17 for Canada's French-speaking region and .20 for Italy. The pseudo R^2 used in the present study was based on the assumption that there is an underlying continuous variable for the dichotomous response variable (McKelvey & Zavoina, 1975) and that the R^2 value corresponds to the variation of the latent variable (i.e., employment status) explained by the model.

To address the second research question, Model 2 was fitted to the data to investigate the interaction between age and educational attainment in the prediction of labor force status, controlling for gender, immigrant status, and literacy proficiency.

As shown in Table 9, in the United States, the effect of high school and postsecondary education in determining the labor force status tended to be more pronounced for individuals aged 35 years and older in IALS (1994), controlling for the other variables. However, in both ALL (2003) and PIAAC (2011), those adults who completed high school education and had at least some postsecondary education were found to be more likely to find a job than their counterparts who received less education, regardless of age. Across age groups, those who had above high school education tended to have greater probability of being employed than those who only obtained a high school diploma. Additionally, as indicated by the PIAAC results, for the individuals who had below high school education, it was more likely for those who were 35 years old or older to find a job than it was for their younger counterparts.

For Norway (see Table 10), the effects of high school and postsecondary education in the prediction of labor force status were not found to be statistically significant for individuals 34 years of age or younger in IALS (1998) and ALL (2003). However, it was found that adults aged 34 years or younger who completed high school education or had at least some postsecondary education were more likely to be employed than their counterparts who had below high school education in PIAAC (2011), controlling for the other variables. Across time, individuals who were older and received more education tended to have greater chance of being employed than those who were younger and only obtained a high school diploma. Additionally, for individuals who had below high school education, it was more likely for those who were aged 35 years old or older to find a job than it was for their younger counterparts.

Regarding the Netherlands (see Table 11), the interaction between age and education in the prediction of labor force status did not seem to be pronounced in IALS (1994). In ALL (2006) and PIAAC (2011), individuals who were older and had more formal education were generally more likely to be employed than those who were younger and only obtained a high school diploma, controlling for the other variables. Nevertheless, for adults aged 34 years or younger, completing high school education did not seem to make a difference in the probability of employment in 2011; for those who received below high school education, the likelihood of employment was not found to differ by age groups.

Table 10 Parameter Estimates for Model 2: Norway

	IALS (1998)	ALL (2003)	PIAAC (2011)
Intercept	1.384 (0.184)***	1.139 (0.183)***	0.855 (0.176)***
Literacy	0.192 (0.053)**	0.239 (0.072)**	0.062 (0.053)
Inter2	0.143 (0.246)	0.191 (0.227)	0.919 (0.193)***
Inter3	0.488 (0.250)	0.328 (0.252)	1.212 (0.230)***
Inter4	0.865 (0.216)***	0.790 (0.206)***	0.896 (0.185)***
Inter5	0.662 (0.199)**	0.742 (0.217)**	1.100 (0.182)***
Inter6	1.026 (0.260)***	0.837 (0.279)**	1.289 (0.173)***
Gender	−0.059 (0.133)	−0.044 (0.105)	−0.092 (0.081)
Immigrant status	−0.558 (0.179)**	−0.104 (0.118)	−0.403 (0.115)***

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
**$p < .01$; ***$p < .001$.

Table 11 Parameter Estimates for Model 2: The Netherlands

	IALS (1994)	ALL (2006)	PIAAC (2011)
Intercept	1.390 (0.130)***	1.279 (0.143)***	1.236 (0.133)***
Literacy	0.121 (0.049)*	0.147 (0.050)**	0.113 (0.050)*
Inter2	0.089 (0.168)	0.528 (0.235)*	0.288 (0.157)
Inter3	0.065 (0.160)	0.575 (0.183)**	0.499 (0.195)*
Inter4	0.189 (0.164)	0.349 (0.147)*	0.295 (0.159)
Inter5	0.361 (0.202)	0.412 (0.162)*	0.376 (0.163)*
Inter6	0.382 (0.216)	0.539 (0.135)***	0.527 (0.154)**
Gender	0.076 (0.088)	−0.106 (0.100)	0.214 (0.077)**
Immigrant status	−0.648 (0.190)**	−0.318 (0.193)	−0.551 (0.109)***

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

Table 12 Parameter Estimates for Model 2: Italy

	IALS (1998)	ALL (2003)	PIAAC (2011)
Intercept	1.248 (0.133)***	0.750 (0.086)***	0.570 (0.099)***
Literacy	0.228 (0.075)**	0.164 (0.039)***	0.154 (0.048)**
Inter2	−0.425 (0.150)**	0.334 (0.112)**	0.207 (0.129)
Inter3	−0.513 (0.280)	0.310 (0.117)**	0.355 (0.174)*
Inter4	0.410 (0.173)*	0.780 (0.100)***	0.406 (0.109)***
Inter5	0.558 (0.175)**	1.116 (0.146)***	0.740 (0.128)***
Inter6	0.245 (0.316)	1.414 (0.184)***	1.074 (0.152)***
Gender	−0.236 (0.101)*	−0.177 (0.083)*	−0.352 (0.059)***
Immigrant status	0.115 (0.298)	0.217 (0.296)	−0.034 (0.113)

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

For Italy (see Table 12), the effects of high school and postsecondary education in predicting the employment status were not found to be pronounced in the IALS (1998) data, controlling for the other variables. Education even had a negative effect on the prediction of labor force status for individuals aged 34 years or younger at that time. However, it was found that in ALL (2003) and PIAAC (2011), those individuals who completed high school or had at least some postsecondary education were more likely to be employed than their counterparts who received less education, regardless of age. Furthermore, the likelihood of employment was consistently higher for those who were aged 35 years or older than it was for their younger counterparts across time.

Table 13 Parameter Estimates for Model 2: Canada, English-Speaking Region

	IALS (1994)	ALL (2003)	PIAAC (2011)
Intercept	1.214 (0.123)***	0.732 (0.134)***	1.119 (0.148)***
Literacy	0.147 (0.130)	0.136 (0.042)**	0.189 (0.044)***
Inter2	0.159 (0.254)	0.578 (0.105)***	0.140 (0.146)
Inter3	0.363 (0.651)	0.584 (0.160)***	0.324 (0.179)
Inter4	−0.151 (0.261)	0.621 (0.137)***	0.088 (0.140)
Inter5	0.067 (0.403)	0.849 (0.131)***	0.393 (0.160)*
Inter6	0.522 (0.348)	0.947 (0.106)***	0.567 (0.149)***
Gender	−0.131 (0.227)	−0.117 (0.068)	0.040 (0.070)
Immigrant status	0.015 (0.257)	−0.134 (0.083)	−0.073 (0.111)

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

Table 14 Parameter Estimates for Model 2: Canada, French-Speaking Region

	IALS (1994)	ALL (2003)	PIAAC (2011)
Intercept	1.001 (0.858)	1.007 (0.135)***	1.093 (0.174)***
Literacy	0.291 (0.234)	0.364 (0.062)***	0.239 (0.049)***
Inter2	0.550 (0.901)	0.365 (0.166)*	1.081 (0.236)***
Inter3	0.702 (0.925)	0.349 (0.180)	0.286 (0.198)
Inter4	0.255 (0.854)	0.603 (0.153)***	0.321 (0.198)
Inter5	0.051 (0.814)	0.703 (0.158)***	0.203 (0.192)
Inter6	−0.212 (1.143)	0.891 (0.161)***	0.601 (0.190)**
Gender	−0.190 (0.406)	−0.175 (0.094)	0.130 (0.080)
Immigrant status	0.119 (4.870)	−0.378 (0.155)*	0.040 (0.187)

Note. ALL = Adult Literacy and Life Skills Survey; IALS = International Adult Literacy Survey; PIAAC = Programme for the International Assessment of Adult Competencies.
*$p < .05$; **$p < .01$; ***$p < .001$.

As for Canada, the English-speaking region (see Table 13) and the French-speaking region (see Table 14) showed similar patterns in terms of the interaction between age and educational attainment in the prediction of employment status. As indicated by the IALS (1994) results, being older or receiving more education did not seem to make a difference in the likelihood of being employed in both regions. However, in ALL (2003), individuals who were older or received more formal education were generally more likely to be employed than those who were aged 34 years or younger and only obtained a high school diploma. Education was found to be a less salient predictor of the likelihood of employment for individuals aged 34 years or younger in the English-speaking region.

In addition, in PIAAC (2011), the interaction effect between age and education in the prediction of labor force status was found to differ for the English- and French-speaking regions in Canada. For the English-speaking region, adults aged 35 years or older who had a high school diploma or some postsecondary education tended to have significantly greater likelihood of being employed than their counterparts who were 34 years old or younger and only obtained a high school diploma. Conversely, for the French-speaking region, the completion of high school education tended to have a significantly positive effect on the likelihood of being hired for those aged 34 years or younger. Moreover, individuals who had at least some postsecondary education and were 35 years old or older had a significantly greater chance of being employed than those who were 34 years old or younger and only obtained a high school diploma in the French-speaking region.

Discussion

The purpose of the present study was to examine the regression of labor force status on observed demographic variables, such as gender, age, and immigrant status, and more importantly, education and skill variables, such as literacy proficiency and a categorical rating of educational attainment. It was also of interest to researchers whether there was an interaction

between age and educational attainment. The data used in the present study were obtained from IALS, ALL, and PIAAC and from six trend countries and regions.

In general, based on the results from probit regression analyses, the five variables taken together were identified as effectively predicting the employment status in the six trend countries and regions across time. With regard to the two skill variables, either education attainment or literacy proficiency, or both, tended to be significant predictors of employment status for the trend countries or regions, with the exception of the results from Canada's IALS data. For the other demographic variables, the results were quite diverse and country or region specific. For example, the United States was the only one among the six countries and regions with immigrants more likely to be employed. Also, in the most recent cycle (PIAAC), the Netherlands had women more likely to be employed, as opposed to the pattern observed in other countries and regions. These interesting results may be driven by a variety of socioeconomic reasons that were country specific.

Specifically, for the United States, Italy, and Canada's English-speaking and French-speaking regions, literacy proficiency was found to be a significant predictor of labor force status even after controlling for educational attainment, age, gender, and immigrant status (neither literacy nor education was found to be significant in the IALS data for Canada). In Norway and the Netherlands, either literacy proficiency or educational attainment was a statistically significant predictor of labor force status after taking other variables into account. For example, literacy proficiency tended to be a significant predictor of employment status above and beyond other variables for Norway, as shown in the IALS and ALL results; however, in the 2011 PIAAC results, educational attainment tended to be statistically significant, and literacy proficiency was no longer significant. It is possible that there were changes in the educational systems in these two countries in the last two decades that resulted in the change of relative importance of these two variables in the prediction of labor force status. Further analysis is required to identify the exact reason, which is beyond the scope of the goals of the current investigation.

Among the three observed demographic variables, immigrant status emerged as a significant predictor of employment status in the United States, Norway, and the Netherlands. In the United States, immigrants were found more likely to be employed than natives across all three adult assessments, even after controlling for other predictors, while immigration status was negatively associated with employment in Norway and the Netherlands. The differences in the regression relation might be attributed to the different immigration policies in the United States and Western Europe. Furthermore, there may be an interaction between immigrant status and education in these countries that is worth investigating in future research. For the other three countries and regions, immigrant status was not found to be significant in determining the labor force status.

Furthermore, in most countries, females were less likely to be employed than their male counterparts, with the exception of the Netherlands in 2011. Future research could take a closer look at the Netherlands to figure out what sociodemographic changes have resulted in this interesting pattern.

Additionally, the effect of age in the prediction of labor force status appeared to be significant in the United States, Norway, Italy, and Canada's English-speaking region across time, with older individuals more likely to be employed than their counterparts aged 24 years or younger (not observed for Canada's English-speaking region in the IALS data), controlling for all the other variables. The age effect was relatively stronger for Italy. For the Netherlands, the age effect gradually diminished over time. Moreover, in Canada's French-speaking region, the age variable was found to be pronounced in predicting the labor force status in the 2003 ALL but was weaker in the 1994 IALS and 2011 PIAAC.

Given these results, we further explored the interaction between age and education in the prediction of employment status using five dummy-coded predictors that corresponded to different age and education combinations. Note that educational attainment on average improves over one's lifetime given that older individuals tend to accumulate more formal education than their younger counterparts. As shown in the IALS results, being older and having more education did not make a difference in labor force status in the Netherlands and in Canada's English- and French-speaking regions. However, in the United States and Norway, older adults who completed high school education or had at least some postsecondary education were generally more likely to be employed. In Italy, education tended to have negative effects for young adults. Further investigation is needed to fully explain this phenomenon, which appeared two decades ago.

At the time of ALL, older adults who had a high school diploma or at least some postsecondary education were more likely to be employed across all countries and regions. The only exception was Norway, in that having more formal education did not tend to increase the likelihood of being employed for those aged 34 years or younger.

Finally, in the PIAAC data, the six trend countries and regions showed different patterns in terms of the interaction between age and education. Whereas the patterns for the United States and Italy did not show much change from ALL to PIAAC, educational attainment appeared to be a stronger predictor for employment status in Norway for the younger adults. In addition, postsecondary education was found to be important for the Netherlands across age groups in 2011, but having a high school diploma did not seem to make a difference. For Canada's English-speaking region, older individuals with more formal education tended to have more advantages in the labor market. However, for the French-speaking region, younger adults with a high school diploma were most likely to find a job in the labor market.

Based on the rich data provided by the three international large-scale surveys, the present study has probed the regression relations of labor force status on some measured skill variables and observed demographic variables over the last two decades. With comprehensive cross-sectional data analyses across six trend countries and regions, the present study has made several contributions, as detailed in the following paragraphs.

First, the present study has provided a global picture of the regression relations among labor force status and literacy proficiency, education attainment, gender, age, and immigrant status from 1994 to 2011. With globalization and technological changes occurring worldwide, many similarities have been found among countries and regions. However, some interesting country-specific patterns still have emerged. Some of the patterns may be artifacts of the statistical models due to sample sizes, measurement errors, and so forth, yet some may actually indicate the distinct socioeconomic changes certain countries have been undergoing.

Second, this study has shed light on the importance of literacy proficiency and educational attainment in the labor market of the knowledge-based society. These two notions are related yet complementary in certain circumstances. In most countries and regions, literacy skills and educational attainment are essential ingredients in the move toward a knowledge economy.

Third, and finally, both observed demographic variables and variables measured with error are included in this study. Therefore, the results also provide important implications for educators, economists, and policy makers from perspectives both at the macro level, such as equalizing employment opportunities for nations, and at the micro level, such as enhancing individuals' economic well-being.

In addition to the contributions, certain limitations remain in the present study and are worth investigation by future research. First, while the literacy proficiency estimate was considered as a fallible indicator variable and handled with plausible value methodology, educational attainment was treated as a variable measured without appreciable error. However, this conjecture did not hold when inspected more closely: educational attainment assessed in most surveys was based on self-reporting (except for a few countries where this variable was part of the registry of inhabitants). Self-reported variables were prone to error due to respondent variables (such as impression management) as well as potential interviewer variables (e.g., whether all interviewers probed when a clear response was not immediately available or whether they recorded the most likely response). Moreover, most educational attainment variables either relied on the number of years spent in school or on a categorization of educational history of a person based on a country-dependent scheme. This national classification was then typically mapped onto an international classification system such as the ISCED. The lack of invariance of the educational attainment measures could contribute to the observed differences in the relations over time.

Second, the present study was based on the strong assumptions of measurement invariance across the three surveys and absence of systematic differences in the survey respondents over time within each country. Any possible violation of these assumptions could potentially impact the results.

Third, there may be sample size issues in Canada's IALS data. For example, the models for Canada's English- and French-speaking regions failed to predict the probabilities of being employed based on all variables, and the sample size of IALS for the French-speaking region was only 848. Either the sample size issue or the accuracy of the literacy assessment scores could contribute to the poor performance of the model in this cycle.

Fourth, the samples we used for probit regression were not for the entire survey samples. As discussed in previous sections, respondents in irrelevant working status categories were excluded from our analysis, and the weighted

proportions of the variables may not be exactly the same as the population distributions. This resulted in some uncertainty in the interpretation of the results.

Finally, we used stringent functional form assumptions for the models in the present study. Future research could explore other methods, such as modern regression tools (e.g., tree-based methods), particularly for dichotomous outcomes, which might also reveal some important findings.

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