

The Gap of Cognitive Skills between Those with High and Low Levels of Formal Educational Attainment: Examining Cross-National and Cross-Cohort Variation

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* Paper submitted for the presentation at the annual meeting of Population Association of America, New Orleans, April 17 – 19, 2008.

Using data of cognitive skills among four cohorts of adults in 19 countries from the International Adult Literacy Survey, we examine cross-national and cross-cohort variation in the gap of cognitive skills between people with college degrees and those who did not graduate from high school. Although people with higher levels of educational attainment tend to have higher levels of cognitive skills than their counterparts of low education, the gaps of cognitive skills by educational attainment may vary across countries and cohorts. We hypothesize that the cross-national and cross-cohort variation is partially accounted by between-country and between-cohort differences in the degree of educational standardization and accessibility of adult education and training. Utilizing the data structure in which individuals are cross-classified by country and cohort, we estimate models of cross-classified random effects to examine how country-level and cohort-level variables affect the relationship between educational attainment and cognitive skills at the individual level.

Cross-National and Cross-Cohort Variation in Cognitive Skills

Recent economic transformations in industrial nations as represented by changes in work organization, technological development, and globalization, have increased the demand for highly skilled workers (OECD 2000). For these countries, enhancing the levels of knowledge and cognitive skills of the population is a critical national agenda. Cognitive skills are important at the individual level as well, because they are significantly associated with labor market outcomes, such as earnings and income even after educational qualifications are held constant (Kerckhoff et al. 2001). Cognitive skills are particularly important for older population given the possible link between cognitive skills and health outcomes. People with limited cognitive skills may not perform well in health-related activities, particularly in properly using health and medical materials, which likely affects individuals' health outcomes. Examining variations in literacy skills and social factors responsible for the variations is essential for understanding differentials among older adults in economic and health outcomes and the overall aging processes.

Recently, a growing number of studies have explored determinants and consequences of cognitive skills in a variety of contexts (Schnittker 2005 for the United States; Berman et al. 2006 for Guatemala), extending our understanding of the role of cognitive skills in stratification processes. However, these studies focused on single countries. Cross-national comparisons of population levels and distributions of cognitive skills may extend our insight further to understand structural factors that underlie cross-national differences in the distribution of cognitive skills. In fact, the summaries of the basic findings from a large-scale international survey of cognitive skills (International Adult Literacy Survey: IALS) show that countries vary substantially both in the overall

level and the dispersion of cognitive skills among population (OECD 2000). For instance, Sweden shows significantly higher average scores on the scales of prose, document, and quantitative cognitive skills than do the United States and Chile. Although the United States has the similar average score on the prose scale as Denmark, the range of scores between the bottom 5th and the top 5th percentile in the United States is twice as large as the corresponding range in Denmark.

In this study, we examine the distributions of literacy skills among adults aged 26 – 65 in 19 countries using data from the International Adult Literacy Survey (IALS). We focus on the gap in cognitive skills between those with high levels of formal educational attainment and those with low levels of educational attainment. A substantial amount of literacy skills are acquired through schooling (OECD 2000). Probably in most countries, those with more formal education have higher levels of literacy skills than do those with less education. However, the size of the cognitive gap between people with different levels of educational attainment may vary across countries. In countries with high inequality in cognitive skills, people with low educational attainment may be in ‘double jeopardy’ in that they have substantially lower cognitive skills as well as a lower level of educational attainment. On the contrary, in countries where differentials in cognitive skills do not vary substantially by educational attainment, those with low educational attainment may not face disadvantages as much as the low educated in societies where the gap in cognitive skills is significant.

In addition to cross-national variation in the effect of educational attainment on cognitive skills, we simultaneously assess variation across cohorts within countries. Examining cross-cohort variation in the gap of cognitive skills by educational attainment

may shed light into the debate in health literature regarding trajectory over time of health disparities by educational attainment. A perspective argues for convergence of health disparities by educational attainment in later old age (House et al. 1994), while a contrasting view claims a widening gap with age in health status between those with high and low levels of educational attainment (Ross and Wu 1996). Given that a great deal of cognitive skills are acquired through schooling and also cognitive skills are associated with health status, changing disparities over the life course in cognitive skills between those with high and low levels of educational attainment may offer an insight into understanding changing health disparities over the life course by educational attainment. Of course, differences across cohorts should not be equivalent to aging effect. Therefore, as in most previous studies that used cross-sectional data and thus could not avoid this problem, our interpretation of cohort effect related to aging effect should be cautious.

Specifically, we first assess the extent to which the gaps in cognitive skills between those with the highest and the lowest levels of educational attainment vary across countries and cohorts within countries. This analysis will identify which countries are more successful than others in maintaining disparities in cognitive skills by educational attainment. Those 19 countries in the IALS data vary substantially in various aspects of societies including educational systems and labor market, which provides leverage for us to go further, beyond description of cross-national variation, to explore structural sources of cross-national variation in the gaps of cognitive skills by educational attainment.

Sources of Cross-National and Cross-Cohort Variation

We hypothesize that cross-national and cross-cohort variation in the gap of cognitive skills by educational attainment is partially attributable to two structural factors: different degrees of standardization of educational systems and different accessibility of adult education and training among the low educated across countries and cohorts. Studies of educational standardization have shown the role of standardization in preventing low achieving students falling too far behind through the consistent standard of teaching and learning (Gamoran 1996). In contrast, in localized and non-standardized systems the relative lack of standard may be particularly harmful for low achieving students, which may enlarge achievement gaps between high and low achieving students than the gaps in standardized educational systems.

However, the acquisition of literacy skills is not one-time event that occurs only in schools. Not only formal schooling but also post-schooling experiences such as job experiences, participation in adult education and training programs may affect adults' literacy skills (Behrman et al. 2006; Hauser et al. 2005). The opportunities of post-schooling learning should be particularly important for adults with low levels of formal educational attainment. By participating in adult education and training programs, those low educated can increase their literacy skills, which may compensate for their low levels of formal educational attainment. Therefore, we expect a significant role of accessibility of adult education and training in reducing the gap of cognitive skills between those with high and low levels of formal educational attainment.

Data and Variables

The data for this study come from the International Adult Literacy Survey (IALS). IALS administered tests for three kinds of cognitive skills: prose, document, and quantitative skills among adults aged 16-65 across 19 countries in 1994-98: Belgium (Flemish), Canada, Chile, the Czech Republic, Denmark, Finland, Great Britain, Germany, Hungary, Ireland, Italy, the Netherlands, New Zealand, Norway, Poland, Slovenia, Sweden, Switzerland, and the United States. Applying comparable and sophisticated designs and measurement instruments, IALS attempted to produce reliable and comparable measures of cognitive skills among adult population across a large number of countries (OECD 2000). Considering completion of schooling, we drop those who are 25 years old or younger from the analysis.

We examine each measure of cognitive skills, separately, to see how the results are robust or different across different dimensions of cognitive skills. Prose skills indicate “the knowledge and skills needed to understand and use information from texts including editorials, news stories, brochures, and instruction manuals,” while document skills indicate “the knowledge and skills required to locate and use information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables and charts” (OECD 2000: 10). Quantitative skills pertain to “the knowledge and skills required to apply arithmetic operations, either alone or sequentially, to numbers embedded in printed materials, such as balancing a chequebook, figuring out a tip, completing an order form or determining the amount of interest on a loan from advertisement” (OECD 2000: 10). Each skill was measured on a scale ranged from 0 to 500.

The focal independent variable is the respondent's educational attainment, which was classified according to the International Standard Classification of Education (ISCED). We grouped respondents into three categories: less than high school completed (ISCED 0-2). High school completed (ISCED 3), college education (ISCED 5-7). We are primarily interested in the extent of gap in cognitive skills between those with college education and those with less than high school completed. In order to examine variation across cohorts within countries, we classify respondents into four different cohorts: aged 26 – 35, 36 – 45, 46 – 55, and 56 – 65. We control for several individual variables such as gender, immigrant status, parental education and employment status.

In addition to these individual-level variables, we use the degree of educational standardization as a major country-level variable to explain between-country variation in the gap of cognitive skills by educational attainment. To categorize educational systems across countries according to their levels of educational standardization, we focus on whether educational matters such as curriculum, textbook, instruction methods, and teacher's training are determined at the national or local level. To obtain information on the location of educational decisions within countries, we consulted various reference sources including the International Encyclopedia of National Systems of Education (Postlethwaite 1995), and the Eurydice website (www.eurydice.org). Although some educational systems have experienced changes in the degree of educational standardization across different cohorts, educational systems of the 19 countries were overall constant over time in regard to their educational standardization, which forced us to treat this variable as a country-level variables.

In order to assess the extent to which opportunities of adult education and training are given to low educated, we directly calculated from the IALS data the percentage of low educated who received any education or training since the last year. Note that we do not use the percentage of all respondents but the percentage of low educated specifically. Because this percentage varied substantially across cohorts, we treated it as a cohort-level variable. We control for other country-level and cohort-level variables to better assess the impacts of educational standardization and accessibility of adult education and training.

Method

Note that in the IALS data structure, individuals are cross-classified by cohort and country. To fully utilize this cross-classified structure of data, we estimate models of cross-classified random effects (Raudenbush and Bryk 2002). The models can allow variance partition into three components: the random effect of country, the random effect of cohort, and the within-cell variance. Furthermore, similar to the structure of hierarchical linear model, we can model how country-level variables and cohort-level variables influence the effect of individuals' educational attainment on cognitive skills. The basic model is specified as follows (in the case of only two covariates: a dummy variable of high school graduation and a dummy variable of college degree)

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}(\text{HighSch})_{ijk} + \pi_{2jk}(\text{College})_{ijk} + e_{ijk}$$

$$\pi_{pjk} = \theta_p + (\beta_p + b_{p1j})X_k + (\gamma_p + c_{p1k})W_j + b_{p0j} + c_{p0k}$$

Where, Y_{ijk} indicates a test score of an individual i in country j and cohort k . In the level-2 equation, a country-level predictor W_j and a cohort-level predictor X_k are postulated to affect the intercept and two slopes of high school graduation and college degree.

Following Raudenbush and Bryk (2002: 381-382):

θ_p is the model intercept

β_p is the fixed effect of X_k (averaged over all countries)

b_{p1j} is the random effect of country j on the association between X_k and π_{pj}

γ_p is the fixed effect of W_j (averaged over all cohorts)

c_{p1j} is the random effect of cohort k on the association between W_j and π_{pj}

b_{p0j} and c_{p0j} are residual random effects of countries and cohorts, respectively.

Results

Partition of Variation

We first estimated an unconditional model to decompose the total variation in test scores. Our result showed that 18 percent of the total variance in quantitative skills lied between countries and 5 percent of the total variance lied between cohorts. The remaining 77 percent of total variance lied within cells (within combination of country and cohort). The result generally indicates that although individual-level differences are major components of total variance, there is a substantial amount of variation between countries. This pattern of decomposition was similar for document and prose skills.

Descriptive Results

Cross-National Variation

Figure 1 displays the gaps of quantitative skills (gross scores without controls) among three different groups of educational attainment among aged 26 – 35 by countries. Countries are sorted in descending order according to the gap of quantitative skills between those with college education and those with less than high school education. The United States shows the largest gap of quantitative skills by 125 points between those with the highest and lowest levels of formal educational attainment, while Germany shows the smallest gap by 36 points. An interesting observation from the figure is that countries vary in the level of quantitative skills more substantially among those with the lowest level of educational attainment than among those with the highest level of educational attainment. For instance, people with college degrees in the United States scored 313 points, which is not substantially different from their German counterparts who scored 327 points. On the contrast, people who did not graduate from high schools in the United States scored 188 points, which is considerably lower than their German counterparts who scored 291 points. In other words, Figure 1 clearly shows substantial variation across countries in the gap of cognitive skills by educational attainment, which is mainly driven by differences across countries in the level of cognitive skills among the low educated. The pattern is very similar for document and prose skills (not shown).

Cross-Cohort Variation within Countries

Figure 2 and 3 present average scores of quantitative skills among three educational groups across four cohorts in the United States, which shows the largest gap

of quantitative skills between those with college degrees and those with less than high school, and in Denmark, which shows the second smallest gap. The variation across cohorts is rather small in both the United States and Denmark, which suggests the relatively small portion of variation due to differences between cohorts. However, the two countries in Figure 2 and 3 reveal an interesting contrast. In the United States, the average score of those who did not graduate from high school is higher among the oldest cohort (56 – 65) than any younger cohorts, while the average score of those with college degrees is lowest among the oldest cohort. In Denmark, younger cohorts regardless of their educational attainment show higher average scores than older cohorts.

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Figure 1. Quantitative Skills by Educational Attainment

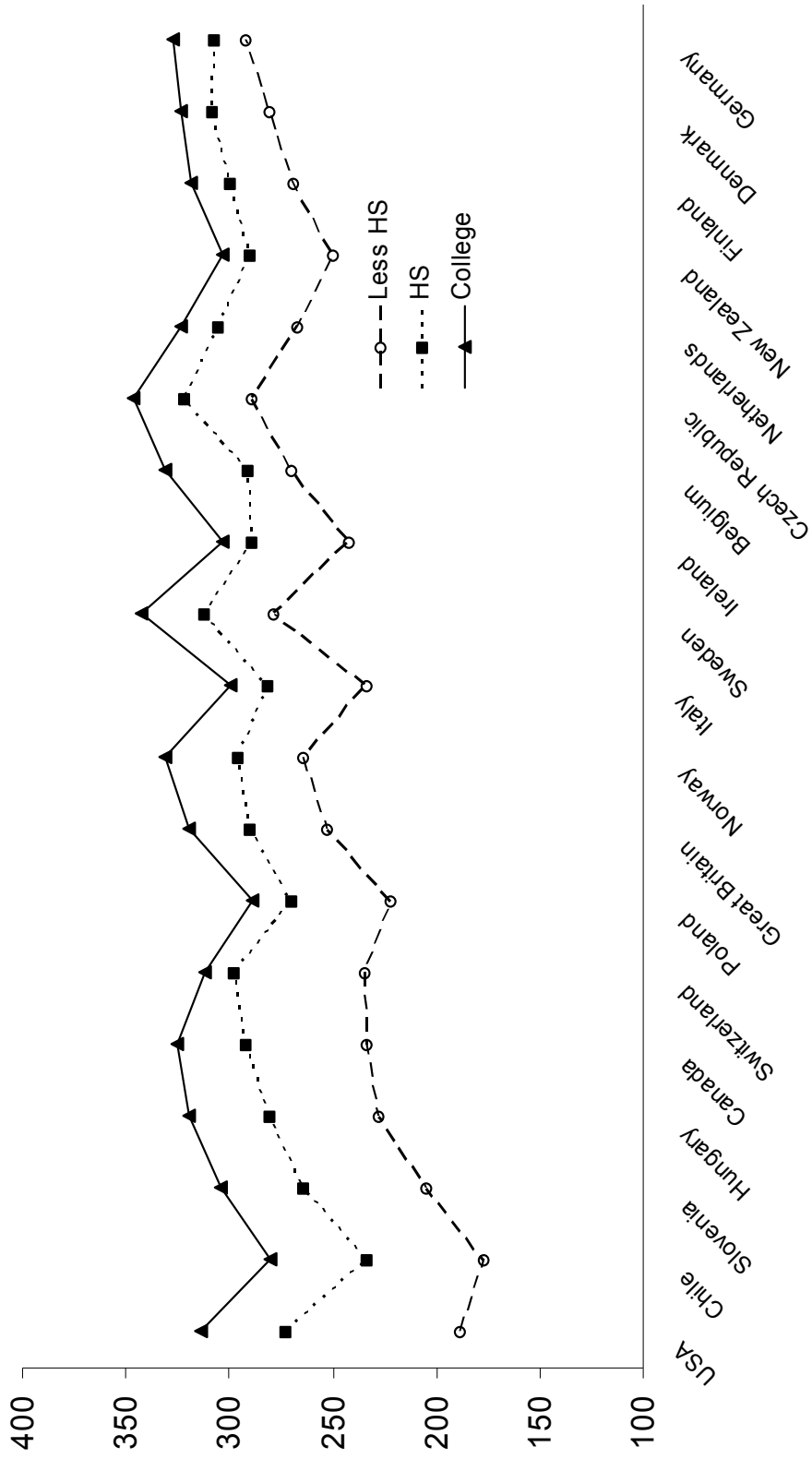


Figure 2. Quantitative Skills by Educational Attainment across Cohorts (US)

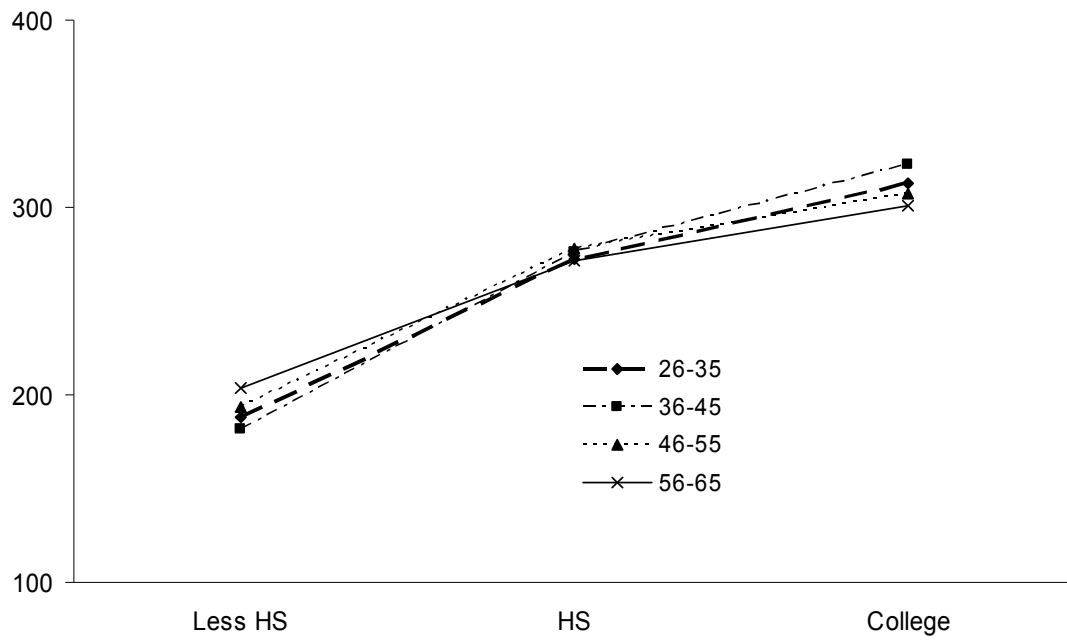


Figure 3. Quantitative Skills by Educational Attainment across Cohorts (Denmark)

