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General Education, Vocational Education, and Labor-Market Outcomes over the Life-Cycle

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Abstract

Policy debates about the balance of vocational and general education programs focus on the school-to-work transition. But with rapid technological change, gains in youth employment from vocational education may be offset by less adaptability and thus diminished employment later in life. To test our main hypothesis that any relative labor-market advantage of vocational education decreases with age, we employ a difference-in-differences approach that compares employment rates across different ages for people with general and vocational education. Using micro data for 18 countries from the International Adult Literacy Survey, we find strong support for the existence of such a trade-off, which is most pronounced in countries emphasizing apprenticeship programs. Results are robust to accounting for ability patterns and to propensity-score matching.

JEL-Code: J240, J640, J310, I200.

Keywords: vocational education, apprenticeship, employment, wages, life-cycle, adult education, International Adult Literacy Survey (IALS).

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1. Introduction

Most advanced economies are concerned about the ease with which young workers can make the transition from school to work. The unemployment rate for youth invariably exceeds that for the economy as a whole, contributing to a variety of social problems. In addition, many young workers struggle to find their place in the labor force, changing not only employers but also occupations multiple times before they settle down to stable jobs. One appealing way to deal with this transition problem is to link students more closely to jobs through vocational education programs and through apprenticeships with firms (see Ryan (2001)). Moreover, the potential for improving youth labor markets in this manner has considerable political support around the world. This study takes a broader perspective on vocational education programs. In contrast to previous research that has focused almost entirely on the school-to-work transition of youth, this paper studies the difference in life-cycle work experience – employment, wages, and career-related training – between individuals receiving vocational and general education.

Countries have actually adopted very different schooling structures that differ fundamentally in their focus on the job transition. Some stress vocational education that develops specific job-related skills in order to prepare students to work in specific occupations, while others emphasize general education that provides students with broad knowledge and basic skills in mathematics and communication and serves as the foundation for further learning and on-the-job training. The United States, for example, has largely eliminated vocational education as a separate track in secondary schools on the argument that specific skills become obsolete too quickly and that it is necessary to give people the ability to adapt to new technologies. On the other hand, many European and developing countries, led by Germany's "dual system," provide extensive vocational education and training at the secondary level – sometimes with direct involvement of industry through apprenticeships. The underlying rationale is that by

concentrating on specific vocational skills, it is possible to improve the entry of workers into the economy and to make them productive at an earlier point.

These differing perspectives suggest a possible trade-off between short-term and long-term costs and benefits for both individuals and the entire society: The skills generated by vocational education may facilitate the transition into the labor market but may later on become obsolete at a faster rate. Our main hypothesis is thus that any initial labor-market advantage of vocational relative to general education decreases with age. This argument is related to the macroeconomic perspective of Krueger and Kumar (2004a, 2004b) who have argued that the propensity to use vocational rather than general education may be an underlying cause of growth-rate differentials between the U.S. and Europe. The argument is simply that vocational ("skill-based") as opposed to general ("concept-based") education leads to slower adoption of new technologies. While similar notions underlie our work here, we are really interested in the other side of the relationship: If there is rapid technological and structural change, what does this mean for hiring workers with vocational and general education?

The existing empirical analysis of the impact of educational type on individuals is fairly limited and provides mixed information about either the existence or magnitude of our hypothesized trade-off. The general-vocational education debate has centered on whether vocational education is effective in facilitating youth school-to-work transition.[1] However, even at job entry, existing studies have not found a universal advantage of vocational over academic education for youth's labor-market outcomes, although the analysis has been problematic.[2] As

[1] Another larger literature focuses on the firm side of the market and their incentives to invest in general or specific education; see the initial work by Becker (1964) and more recent analysis by Acemoglu and Pischke (1998, 1999).

[2] For examples, see Arum and Shavit (1995); Malamud and Pop-Eleches (2010); and the reviews in Ryan (2001) and Wolter and Ryan (2011). Oosterbeek and Webbink (2007) and Fersterer, Pischke, and Winter-Ebmer (2008) are recent examples studying the labor-market outcomes of vocational education.

Paul Ryan (2001) states: "The merits of vocational curricula and work-based preparation are particularly difficult to evaluate statistically, given the potential importance of selection around unobservables, the near-absence of experimental evidence, and the paucity of prior labor market experience to use in econometric modeling" (p. 73).

Studying the life-cycle implications of vocational education thus presents a number of challenges. First, as noted in the job-entry studies, people entering various kinds of vocational education may differ systematically from those entering general education. Second, investigating life-cycle outcomes requires comparing individuals of different ages, but ensuring that the workers of one age cohort are otherwise similar to those of another cohort is difficult. At the very least, sufficiently detailed information on individuals is required to check the validity of any melding of information across age groups. A third issue that we must face revolves around varying definitions of programs and of institutions (see, for example, the discussion in Mansuy et al. (2001)). The definition of vocational education is not consistent across countries, so what one country calls vocational education may be very different from that of another even when the underlying institutional structure appears similar. As such, many of the existing analyses actually compare very different kinds of programs including various kinds of school-based training, firm-based training, and apprenticeships. Thus, understanding the importance of different kinds of programs suggests a necessity of comparison of effects across different types of countries.

This paper employs an international sample of labor-market outcomes for workers across the age spectrum, using micro data from the International Adult Literacy Survey (IALS). The database is unique because it provides detailed information about the education and skills of workers across the life-cycle in countries with varying structures of vocational schooling and

training. To address the concern of selection into different types of education, we propose a difference-in-differences framework, comparing labor-market outcomes across different ages for people with general and vocational education. We further address the remaining concern that selectivity into education types might have changed over time by accounting for individual-level measures of ability and of family background, as well as country-specific changes in the size and ability composition of the different education types over cohorts. We also employ propensity-score matching to reduce concerns of selectivity further.

Starting with a sample pooling individuals from 18 countries, we find that individuals with general education initially face worse employment outcomes but experience improved employment probability as they become older relative to individuals with vocational education. When we conduct the estimation for each country separately, the estimates, however, vary noticeably across countries. In the U.S. and other countries without a noteworthy vocational education system, the employment probability of individuals with different types of education does not vary with age at all, whereas in most of the European countries in the sample, the age-employment pattern differs and sometimes quite significantly between individuals with general and vocational education. The pattern is most pronounced in the well-known apprenticeship countries of Denmark, Germany, and Switzerland. In these countries, the easier entry into the labor market is balanced by noticeably greater withdrawal at older ages.

One reason underlying the estimated employment pattern for the "apprenticeship countries" seems to be adult training. With increasing age, individuals with general education are more likely to take any career-related training and receive more hours of career-related training relative to those with vocational education, giving them the opportunity to continue updating their skills to be employed in a changing economy.

Policy judgments about the efficacy of vocational education and apprenticeships depend of course on the balance between early-career and late-career costs and benefits. The life-cycle wage patterns by education type are remarkably similar in most countries, suggesting that the primary determinant of differences in lifetime earnings is the life-cycle employment pattern. Preliminary results about lifetime earnings are mixed for the apprenticeship countries, with apprenticeships having a positive return in Switzerland but not in Denmark and Germany. Interestingly, this pattern matches the growth pattern of these economies over past decades.

In the following, Section 2 introduces the database and Section 3 the empirical model. Section 4 presents the main results on employment impacts of education types, and Section 5 analyzes heterogeneity across countries. Section 6 presents results on impacts of education types on adult education and wages. Section 7 weighs early against late labor-market experience in a calculation of individual lifetime earnings, and Section 8 concludes.

2. Data

To investigate our primary hypothesis, we require data about education type and about employment patterns over the life-cycle. But, more than that, we need sufficient detail about the labor-market skills of individuals so that we can identify the impact of education type on employment rates in the face of individual selection into schooling programs.

2.1 The International Adult Literacy Survey (IALS)

Our primary data source, the International Adult Literacy Survey (IALS),[3] provides a unique opportunity to investigate the impact of education type.[4] Conducted in the participating

[3] The IALS survey was developed by the Organisation for Economic Co-operation and Development (OECD). A follow-on – the Programme for the International Assessment of Adult Competencies (PIAAC) – is currently in process.

countries between 1994 and 1998, IALS provides us with data for 18 countries, including 15 European countries plus the U.S., New Zealand, and Chile.[5] The IALS contains information about respondents' years of schooling and whether they completed a vocational program or general program in secondary and post-secondary education for a representative sample of adults between 16 and 65 years of age in each country. Obviously, average educational attainment varies across countries and over time (see Appendix Table A1), which is the topic of an extensive literature already, but what we are most interested in here is the distinction between general and vocational programs.

While other datasets may also record employment patterns for different age cohorts, a key element of the IALS is its extensive data on other individual employment-related characteristics including age, gender, years of schooling, employment status, earnings, adult training, parents' educational attainment, and, for a subset of countries, father's occupation. Additionally, each individual was given a series of assessments of cognitive skills (called "literacies") that are comparable within and across countries. The literacy tests in prose, document, and quantitative domains are designed to measure basic skills needed to participate fully in modern society. As discussed in Hanushek and Zhang (2009), the test scores appear to be a reasonable index of general levels of skills. These detailed individual measures are important in investigating any changes across time in the selectivity of general and vocational programs.

For the empirical analysis, we restrict our sample to individuals who completed at least secondary education and who are currently not students. This is the sample on which general

[4] For an overview of economic studies using the IALS data, see section 5 in Hanushek and Woessmann (2011).

[5] Another country with IALS data is Canada, but it could not be included in the analysis because it only provided bracketed age information.

and vocational education types can be defined for individuals' final schooling level. We also restrict our analysis to males, because of their stable aggregate labor-force participation patterns in prime-age groups across most countries in our sample. This circumvents concerns about cohort-specific selection into work by females.

For individuals who finished secondary education, a general education is defined if their education program is academic or college preparatory; a vocational education is defined if their education program is business, trade, or vocational. Some individuals report their education type as secondary-level equivalency or simply as "other"; since it is not clear what exactly these programs entail, we classify this as a separate category.[6] For individuals who finished the first stage of tertiary education, a general program is one that leads to a university degree (BA/BS), and a vocational program is one that does not lead to a university degree.[7]

2.2 Descriptive Patterns

Tables 1 and 2 show the overall distribution of education types by country and by age group. On average, 35 percent of males in our sample completed a general education and 47 percent completed a vocational education (the remainder being in the residual "other" category). Of the 73 percent of individuals in our sample whose final education is at the secondary level, about one quarter completed a general education and one half a vocational education. More than half of those completing a tertiary education finished with a bachelor's degree.

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[6] According to the Organisation for Economic Co-operation and Development (2010), at the secondary level, general programs are programs that are not designed explicitly to prepare participants for a specific class of occupations or trades or for entry into further vocational or technical education programs, while vocational education prepares participants for direct entry, without further training, into specific occupations.

[7] We essentially define the tertiary type-A programs as general education and tertiary type-B programs as vocational. The former are largely theory-based and are designed to provide sufficient qualifications for entry to advanced research programs and professions with high skill requirements, such as medicine, dentistry, or architecture. The latter are typically shorter and focus on practical, technical, or occupational skills for direct entry into the labor market (Organisation for Economic Co-operation and Development (2010)).

The variation across countries is striking, especially at the secondary level (Table 1). The share of individuals completing a general secondary education ranges from under five percent in the Czech Republic to 72 percent in Italy. Most European countries heavily emphasize vocational programs at the secondary level, with less than one-third completing a general secondary education, while Chile reports a majority completing a general secondary education.[8] At the tertiary level, the variation across countries is smaller. For all but a few countries, between one third and two thirds of individuals completing a tertiary education received a university degree, and the U.S. and Chile fall right in the middle. Overall, the U.S. has the largest share completing tertiary education.

The clear picture from Table 1 is the significant differences in how school systems around the world are organized. These institutional differences represent distinct policy choices that presumably affect the labor-market outcomes across countries.

Table 2 describes the educational attainment of different age groups across all sampled countries. This table highlights the evolution of educational attainment over time. Overall, the distribution of people completing general or vocational education is quite stable over time. This description, however, masks differences in the trend across individual countries, where there is considerable heterogeneity. As shown in Figure 1, although the percentage completing a general education shows little variation over time for a number of countries, some have moved toward less general education (e.g., Denmark, Germany, and New Zealand) while others have moved in the opposite direction (e.g., Belgium, Hungary, Ireland, and Poland).[9] (Appendix Table A2

[8] Inaccurate reporting of education type at the secondary level is a substantial problem for the U.S.; 60 percent report "secondary-school equivalency" and do not distinguish general and vocational schooling. The problem is also quite severe for the Czech Republic and Norway, and, to a lesser extent, for Finland.

[9] A caveat here and in the regression analysis is that many of the 16- to 25-year olds are still in school and excluded from the sample; hence the break from trend by the 16-to-25-year-old cohort may simply reflect this sample

presents a more complete picture of the distribution of educational attainment for each country and over time).

An important issue, particularly when looking across time within countries, is whether the relative skills of those in general and vocational programs are changing. The battery of literacy tests in IALS permits direct observations of cognitive skills by age and schooling type. The literacy score we use is the average of the three test scores in prose, document, and quantitative literacy, normalized to have mean zero and standard deviation one within each country. Table 3 shows that the literacy score is in general higher for younger people and people with general education.[10] The exception is the 16- to 25-year-old cohort, whose literacy score is lower than the two cohorts immediately ahead of them, but this likely reflects the fact that many people in this age group are still in school, and those who are not in school are overall of lower ability. Figure 2 depicts literacy scores by cohort and education type for each country. Except for a few pairs, in every country the literacy scores for each education type follows a similar pattern over time, providing some general evidence that the relative selectivity between vocational and general education programs has not changed substantially over time.

Figure 3 plots the distribution of literacy scores of the two education types for each country. Again, the figure shows that individuals with general education have on average higher scores than those with vocational education. More importantly, it shows there is substantial overlap in literacy scores between the two types, suggesting that individuals completing general and vocational education share a common support in this important characteristic.

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selection. This is most pronounced in the percentage finishing a secondary education and the percentage finishing a general tertiary education, as shown in Table 1.

[10] While literacy scores for each country have been normalized to mean zero and standard deviation one, the average for both general and vocational schooling is almost always positive, reflecting that both groups are more skilled than the "other" category that includes individuals not completing secondary school and aiming for neither vocational or academic programs.

The focus of our analysis is employment patterns over the life-cycle. Table 4 shows the percentage employed of males with different education types across the entire sample for each cohort, where not being employed includes the unemployed, the retired, and homemaking at the time of the survey. Individuals with vocational education have a higher employment rate than individuals with general education for the youngest cohort (16-to-25 years of age). For older cohorts, however, individuals with general education are more likely to be employed than those with vocational education, and this is most pronounced for the 56-to-65-year-old cohort.

The employment pattern is not, however, uniform across countries. Figure 4 shows that the age-employment profile varies significantly, with some countries like the U.S. having almost identical employment patterns by education type and others like Germany displaying widely different patterns. Our analysis flows from these differences.

3. Identification of the Impact of Education Type

We are interested in the impact of education types on labor-market outcomes over the life-cycle. To test our main hypothesis that the relative labor-market advantage of vocational over general education decreases with age, we compare the age-employment patterns of workers of the two education types within each country. In the simplest difference-in-differences form, we permit the age pattern of employment for those with a general education to diverge linearly from the pattern for the remainder of workers:

$$emp_i = \alpha_0 + \alpha_1 age_i + \alpha_2 age_i^2 + \beta_1 \cdot gen_i + \beta_2 \cdot gen_i \cdot age_i + X_i \cdot \gamma + \varepsilon_i \qquad (1)$$

In Equation (1), emp_i = 1 if individual i is currently employed and 0 otherwise; age and age squared capture the normal age-employment pattern in the economy; gen_i is an indicator

equaling 1 if individual *i* has a general education type and 0 otherwise;[11] and *X* is a vector of control variables for other factors that might affect employment patterns including, importantly, country fixed effects to eliminate overall country differences and various measures of individual labor-market skills (other than education type). The coefficient β_1 measures the initial employment probability of those with general education relative to those with vocational education (normalized to age 16 in the empirical application), while β_2 measures the differential impact of a general education relative to a vocational education on employment with each year of age.[12]

The overall difference in employment probabilities between general education and vocational education reflected in β_1 does not adequately identify the impact of general education. This parameter implicitly includes any elements of selectivity in the completion of different types of schooling not captured in *X*, and we doubt that the measured influences on employment found in our data (and most other surveys) fully capture the systematic differences across schooling groups. (Note that this is precisely the challenge for attempts to estimate the impact of vocational education on the school-to-work transition, and highlights the existing uncertainty about the efficacy of common vocational education policies).

The key parameter for our analysis, however, is β_2. In this difference-in-differences formulation, this reflects the divergence in employment patterns by education type over age cohorts. The crucial assumption for identifying the causal impact of education type on changes in employment patterns over the life-cycle is that the selectivity of people into general and

[11] The sample for the empirical analysis includes those who reported completing secondary-school equivalency or other programs. In the estimation, they are treated as a separate category ("other" type), and its interaction with age is also included.

[12] An interaction term between the general-education indicator and age squared is not statistical significant in our main specification, so we rely on a simple linear-in-age interaction in the basic specification.

vocational education (conditional on the *X*) does not vary over time. In other words, we assume that today's old people (in each education category) are a good proxy for today's young people in 30 years,[13] allowing us to estimate the impact of education type by the divergence in age-employment patterns across the life-cycle.

If general education becomes less selective relative to vocational education over time in ways that are not captured by the *X*, then the changes in the labor market with general education may reflect simply the varying ability of young and old workers in the different education categories. Table 3 and Figure 2 show that differences in literacy scores of individuals with general and vocational education have been generally stable over time, suggesting that the nature of selection between the two types of education has also been reasonably stable over time. But, in the estimation we explicitly condition on individual school attainment and literacy scores along with a series of alternative proxies for selectivity of education within each country. In addition, we estimate propensity-score matching estimators that match each individual with vocational education to an observationally comparable individual with general education.

Finally, to allow for nonlinear changes in the impact of education types on employment with age, we also consider a variant:

$$emp_i = \alpha_0 + \alpha_1 age_i + \alpha_2 age_i^2 + \beta_1 \cdot gen_i + \sum_j \left(\beta_{2j} \cdot gen_i \cdot cohort_{ij}\right) + X_i \cdot \gamma + \varepsilon_i \qquad (2)$$

where the impact of general education on employment is allowed to differ for each age cohort defined by ten-year age intervals ($cohort_{jj}$ being an indicator equaling 1 if individual *i* belongs to cohort *j* and 0 otherwise).

[13] This assumption of comparability of age cohorts is of course identical to the normal assumption in estimating Mincer earnings functions and other applications that make cohort comparisons with cross-sectional data; see the specific earnings analysis in Hanushek and Zhang (2009).

4. The Impact of Education Type on Employment

Our investigation begins with basic estimates of how employment patterns over the life-cycle are affected by general and vocational education. We then pursue a series of alternative specifications and robustness checks.

4.1 Basic Results

Table 5 reports OLS regression results of equation (1) for males, in which the impact of education type on employment status changes linearly with each year of age.[14] The sample pools individuals from all 18 countries in our IALS sample, but all specifications control for country fixed effects so that the employment impacts are estimated by just the within-country variation. Column 1 is the most basic specification, where employment status is a function of age, age squared, years of schooling, as well as whether one's highest level of education is general education and its interaction with age. *Ceteris paribus*, employment rates generally increase with age, reach the peak at age 36, and then start to decline, consistent with the description in Table 4. They also increase with years of schooling: one more year of schooling increases the employment rate by 1.2 percentage points.

Most important to our purpose, while individuals with a general education are initially (normalized to an age of 16 years) 7 percentage points less likely to be employed than those with a vocational education, the gap in employment rates narrows by 2 percentage points every ten years. This implies that by age 50, on average, individuals completing a general education are more likely to be employed than individuals completing a vocational education. Individuals completing a secondary-school equivalency or other program (the "other" category) have a virtually identical employment trajectory as those completing a vocational education.

[14] Estimates from a probit model of employment are substantively the same.

As noted in the previous section, the coefficient on the general education-age interaction (β_2) can be interpreted as the causal impact of general education on the employment change over the life-cycle as long as any selectivity into education type has not changed over time. In the subsequent columns, we add more control variables to account for potential biases from unmeasured ability or other possible influences on employment (that might vary over time for people in the different education-type categories).

4.2 Addressing Varying Selectivity into Education Types

A prime concern is that the ability level of individuals completing a general education may have changed over time with the expansion of education systems around the world, implying that the coefficient on education type and its interaction with age would also capture the impact of unmeasured ability on employment at different ages. For example, more able people may adapt more readily to a changed environment regardless of schooling, making them more likely to be employed at older age.

We begin by adding the literacy score and its interaction with age (Column 2 of Table 5). The coefficient on the literacy score is already positive at the age of 16, and the coefficient on its interaction with age is also significantly positive – implying that more able workers continue their employment at higher rates with age. The time pattern of literacy skills on employment underscores exactly the concern with identification of the impact of education types (and shows the importance of the IALS data). The coefficients on general education type and its interaction with age become slightly smaller in magnitude – precisely what would be expected with the expansion of general education and the relatively lower ability of the average young person in general education. But, importantly, both the general-education indicator and its interaction with

age remain statistically significant. In this specification, individuals with general education overtake those with vocational education in employment probability at age 55.[15]

In Column 3, in another expansion to allow for time-changing patterns of ability by school type, we add dummy variables for mother's education and their interactions with age. The coefficient estimates on these controls are insignificant in themselves, and they have little impact on the estimates of other variables relative to Column 2. As a result, we do not control for mother's education in later specifications. In Column 4, because parents may directly influence the educational choices of children, we add a dummy variable for father's occupation, taking a value of 1 for professional, and its interaction with age. However, due to missing information, our sample now only includes seven countries.[16] Estimates on these added controls are insignificant, and again, the estimates on the main variables of interest – general education type and its interaction with age – are qualitatively the same as in Columns 1-3.

Varying selectivity into the education groups is a general threat to our identification strategy. In Column 5, we return to the full sample and add three control variables at a more aggregate level: the percentages completing general and vocational education, respectively, in each country for each cohort, and the average literacy test score for individuals completing a particular type of education by country and cohort. These variables reflect variations in labor skills that change over time and that might distort the selectivity of education choices over time. A higher average test score indicates higher overall ability of individuals completing a particular

[15] The fact that the IALS literacy score is measured at the time of labor-market observation, rather than when the initial decision between entering a general or vocational program is made, suggests that the measured score may be affected by the employment history, which includes both occupation-specific skill obsolescence and continuing adult education. Existing evidence (Ludwig and Pfeiffer (2006)) and our analysis below suggests that both aspects work against people with vocational education, which introduces bias against our reported findings and suggests that these may be lower-bound estimates.

[16] The seven countries where individuals are surveyed about their father's occupation are Chile, the Czech Republic, Finland, Hungary, Italy, Poland, and the U.S.

type of education; a larger share of individuals completing a particular type of education indicates lower selectivity of that education type. The estimates in Column 5 appear to confirm this speculation: *Ceteris paribus,* the employment probability is positively related to the average test score and negatively related to the size of an individual's education type of each cohort. Nonetheless, estimates for the key interaction of general education with age (and other variables) are again almost identical to those in Column 2. In subsequent estimations, we take Column 5 as our primary specification.

The potential impact of missing students who are still in school is an additional concern. Column 6 therefore reports results of another robustness check, where we restrict the sample to individuals aged 20 to 65. The concern is that many of the very young people are still in school. Hence, when we exclude current students from the analysis, the young people included in the analysis may not be representative of the youth who eventually finish school and start the school-to-work transition. With the youngest of all individuals dropped, the young people remaining in the sample will more closely represent the overall youth population. Indeed, of the males aged 16 to 19, two thirds are still in education, while of those aged 20 to 25, only one quarter are currently in education.[17] These shares of current students in different age groups also suggest that we do not want to drop all the 16- to 25-year-old group; otherwise, we lose too many young people who are already potentially in the labor force, and we will not be able to obtain the estimate of the relative impact of different education types on the school-to-work transition. The choice of age cutoff in this column is a compromise between these two competing forces related to the youngest people. Regardless, results from the restricted sample are quite similar to the

[17] Of the males aged 26 to 30, about 3 percent are currently students.

results in Column 5 for the corresponding specification with a larger age range. The robustness of the results prompts us to focus on the entire 16-to-65 age group in virtually all later analysis.

While there is a general presumption that the vast majority of male non-employment – including early retirement – in this age group is involuntary, there is a possibility that generous early-retirement schemes may be differentially available to workers with vocational and general education. In this case, the detected age-employment pattern may not necessarily be driven by differential adaptability to changing economic conditions, but rather by specifics of the existing retirement policies. As another robustness test to address this possibility, in Column 7 we restrict the sample to those employed and those unemployed but looking for work, effectively dropping those from the non-employed category who are retired, homemakers, or non-employed for other reasons. Results confirm the differential age-employment pattern by education type, showing that people with vocational education who would like to work are increasingly becoming more unemployed with age, relative to people with general education. This pattern of involuntary unemployment indicates that the main finding is not just driven by voluntary early retirement.[18]

4.3 Propensity-Score Matching

Figure 3 shows a substantial overlap in literacy test scores between individuals completing general and vocational education in all countries, even though there are average skill differences across the groups in most countries. Indeed, this substantial overlap is also found for age, years of schooling, and family background between individuals completing different types of education. To further limit possible concerns of selection bias, we can estimate our main

[18] In this regard, it might be indicative to look at the age-employment pattern for blue-collar and white-collar workers separately. Unfortunately, though, in the IALS data occupational information is available only for the employed and not for those not working at the time of the survey.

model using propensity-score matching to make individuals with a vocational education comparable to individuals with a general education.

Matching allows us to compare observationally more similar individuals, providing more confidence in our ability to isolate the impact of the education type itself. The sample is selected by comparing, for each country, the propensity scores of completing a vocational education between those individuals who actually completed a vocational education and those individuals who completed a general education. Individuals in the latter group whose propensity scores are closest to those in the former group are included in the sample, along with all individuals in the former group who share a common support in propensity score with the latter group.[19] Specifically, in a first stage we estimate a probit model for each country of vocational education type on age, years of schooling, literacy test scores, and whether mother or father completed a high-school education. With the predicted propensity score, we use the nearest-neighbor matching algorithm to match each individual completing a vocational education to one completing general education. Post-matching tests indicate that in the matched sample, the disparity between the two groups has been reduced to such an extent that in the majority of countries, individuals completing the two types of education are statistically identical in each of the matching variables and the matching variables jointly have no predictive power for the probability of completing a vocational education, lending credibility to the matching procedure.[20]

Column 8 of Table 5 reports the results of the matching estimator, which compares vocational-education individuals only to such general-education individuals who – based on their ability, family background, age, and years of schooling – would have had the same propensity of obtaining a vocational education than they themselves had. The matched sample is reduced by

[19] In the matched sample, the group with "other" types of education drops out.

[20] Detailed results are available from the authors upon request.

about one third. Still, results on the matched sample are very close to the previous results, indicating that the latter are unlikely to be driven by selection into different education types.

While the reported estimation already imposes a common support by dropping vocational-education individuals whose propensity score is above the maximum or below the minimum propensity score of the general-education individuals, our results are confirmed in additional analyses (not shown) that further improve the common support by trimming 1 (or even 10) percent of the vocational-education observations for whom the propensity-score density of the general-education observations is the lowest or by imposing a tolerance level (caliper) of 5 (or even 0.5) percent on the maximum propensity score distance between vocational-education and general-education individuals. Furthermore, results using alternative matching algorithms such as radius or kernel matching (not shown) also yield qualitatively similar results.

In sum, the estimates in Table 5 show that individuals completing a vocational education are more likely to be employed when young, but this employment advantage diminishes with age: as early as age 50, individuals completing a general education start to experience higher probabilities of employment. This pattern is robust to adding more control variables, dropping the youngest group in the sample, and using a matched sample. Thus, the raw employment patterns in Table 4 cannot be attributed simply to varying selectivity into general and vocational education but instead appear to be caused by the different focus of the schools.

5. Institutional Variations across Countries

The analysis in the previous section pools all countries in the sample even though there is substantial variation across countries in the relative size of the general and vocational programs and in the specific organization of the vocational programs. This section takes a closer look at these differences and how they influence the estimates of the employment trajectory.

We first draw on information from the OECD's *Education at a Glance* (EAG, see Organisation for Economic Co-operation and Development (2010)). Each year, EAG provides administrative information on the distribution of upper-secondary-school students between general and vocational programs. Furthermore, it provides the percentage of students in the vocational program that are in "combined school and work-based" programs. In these latter programs, instruction is shared between school and the workplace and may even take place primarily in the workplace. A good example of the latter is the "dual system" in Germany where at least 25 percent of the instruction takes place in the work place. Appendix Table A2 presents the distribution for 2007, the most recent year available, and for 1996, close to the survey time.

The heterogeneity is clear. The U.S. has virtually no vocational program by the official definitions. In contrast, a number of the European countries such as Belgium, Finland, and the Netherlands have most of their vocational students in school-based programs. Finally, Germany, Denmark, and Switzerland stand out by having large combined school and work-based vocational programs that emphasize apprenticeships.

We classify countries into different categories based on both information from the IALS sample and the statistics from EAG. Appendix Table A2 also provides the program distribution of individuals completing an upper secondary education in the IALS sample. We define "*vocational*" countries as those countries whose vocational share is at least 40 percent in IALS data and is at least 50 percent in 1996 EAG or 2007 EAG. Eleven countries belong to this category: Belgium, Czech Republic, Denmark, Finland, Germany, Hungary, the Netherlands, Norway, Poland, Switzerland, and Slovenia. Of these eleven vocational countries, six (Czech Republic, Denmark, Germany, Hungary, Poland, and Switzerland) have a vocational sector with at least 25 percent in combined school and work-based programs. We dub these six countries as

"*non-school based*" vocational countries. Note that half the countries in this group are former centrally-planned economies. Additionally, in a finer look at the mix of school and work programs, we classify Denmark, Germany, and Switzerland as "*apprenticeship*" countries, signifying that the share in combined school and work-based programs exceeded 40 percent in both 1996 and 2007. Earlier literature suggests that the apprenticeship vocational programs are the most effective in facilitating youths' school-to-work transition (see, for example, Lerman (2009) and the larger review in Wolter and Ryan (2011)). Therefore, the lifetime employment experience of individuals completing general or vocation education in these countries is particularly interesting from a policy perspective. Four countries – Chile, Italy, New Zealand, and the U.S. – are "*non-vocational*" countries based on these criteria.[21]

We estimate our preferred specification (Column 5 in Table 5) for each country group and report the results in Table 6. The first column reproduces the results of Column 5 in Table 5 for comparison. The second column reveals that this pattern does not hold at all for the non-vocational countries: the estimates are insignificant, and there is virtually no difference in employment patterns between individuals completing different education programs. Moving from Columns 3 to 5, the samples of countries have gradually larger shares of vocational education in the form of combined school and work-based programs, which also makes the definition of the vocational education type clearer and more consistent. Tracing through these groups, the initial employment gap between individuals finishing vocational and general education becomes larger, while the rate at which this gap narrows with age also becomes higher.

[21] Although Italy has a significant share in vocational programs from EAG, in the IALS data the share is very small, at 15.7 percent. Our classification does not apply to Great Britain, Ireland, and Sweden, because information about education programs for individuals completing secondary school for these countries is missing in the IALS.

The pattern is most pronounced in the group of "apprenticeship countries" (Denmark, Germany, and Switzerland), making the trade-off between early and late employment obvious. This is depicted for five cohorts in Figure 5, where the employment gains from vocational education early in the life-cycle are balanced by later employment losses. Given that the definition of general vs. vocational education types is clearest for apprenticeship countries, part of our subsequent analysis will focus closely on these countries.

Table 7 reports estimation results separately for each of the vocational countries. While the results for Denmark are less strong, all three countries belonging to the "apprenticeship" group display a clear age pattern of employment for individuals finishing different education programs, confirming the results in the final column of the previous table. Of the five countries with mostly school-based vocational education programs, Belgium, Norway, and the Netherlands display no clear age pattern of employment for individuals finishing different education programs, while Finland and Slovenia appear to be more similar to the "apprenticeship" countries. The remaining three countries, all former centrally-planned economies, also display no clear age pattern of employment for individuals finishing different education programs.

In Table 8, we consider a more flexible, nonlinear model, Equation (2), where we allow the impact of education type on employment status to vary for different ten-year age cohorts. The estimation is carried out for each vocational country separately. In Germany and Switzerland, the age-employment pattern is again striking, with the 56-65 age group completing a general education having the largest employment advantage over the same age group completing a vocational education. For Denmark, the estimates have the expected sign but are mostly of marginal significance. In the pooled sample of the three "apprenticeship" countries, shown in the final column, the pattern is very clear. In Finland and Slovenia, older people

completing general education also are more employed than their counterparts completing a vocational education. For other countries, we do not observe a clear difference in employment pattern for people completing different education programs. Appendix Table A3 reports results from a slightly different non-linear model, in which we restrict the sample to 20-65-year olds and define the young as 20-30, the middle aged as 31-50, and the old as 51-65. The results are largely similar.

In another sensitivity test, Table 9 reports results for each country of the linear model with the sample restricted to individuals completing just secondary education. We lose about one third of the sample who had tertiary schooling. The results are quite similar to those in Table 7. Germany, Switzerland, and Finland again display pronounced education program-employment trends; in Denmark, Slovenia, Norway, and Poland, the estimates are insignificant but of the expected directions.

Overall, the most salient distinction relates to the amount of employer-based programming. We observe the strongest impact of education programs on employment over age for Germany, Switzerland, and to a lesser extent, Denmark – all three with large shares of vocational education in the form of combined school and work-based programs. For other vocational countries with a much smaller section of the combined programs, only Finland stands out and shows significantly different age-employment trends for individuals completing general and vocational education.

In sum, the disaggregation of the IALS sample by intensity of vocational education shows clear heterogeneity of employment effects. Specifically, countries at the more vocational end of the spectrum see strong interactions of the age-employment pattern with vocational training. This lessens to insignificant when we move back to the non-vocational countries.

6. The Impact of Education Type on Adult Education and Wages

We consider two additional outcome variables related to education type in this section: career-related adult education and earnings.

Adult education may help explain the difference in age-employment trends for individuals finishing different education programs, as people taking more career-related education are likely more employable given their updated knowledge and skills. We create two measures of adult education from the IALS: a dummy variable for whether the worker received any career-related adult education during the past 12 months and the total number of hours of career-related adult education during the past 12 months. About one third of all males had some career-related training during the 12 months leading to the survey. At 37 percent, individuals with a general education are somewhat more likely to have had career-related training compared to 30 percent for individuals with a vocational education. We again focus on the three "apprenticeship" countries, Denmark, Germany, and Switzerland, since these countries show the strongest age-employment trend for different education types. We estimate a linear age-education specification similar to Equation (1). The results for the indicator of receiving training (in a linear probability model) and hours of training (in a Tobit model) are reported in Table 10. For all three countries, individuals completing a general education are more likely to receive career-related education and to receive more hours of it as they become older, but only in Germany is the estimate statistically significant. Note that for Switzerland, the sample size becomes much smaller than in the employment analysis.

We also estimate an earnings equation for individuals who work full-time in the 12 months before the survey. This is a straightforward extension of a Mincer earnings function with the addition of possible age-related differences in earnings patterns for those with general and

vocational education. Table 11 reports the estimates on the initial wages of general education individuals and the interaction with age for each of the vocational countries.[22]

Finland is the only country where individuals completing a general education earn significantly less when young but catch up with those with a vocational education over time. In five of the remaining countries, there is a similar but insignificant pattern. However, we again encounter a problem of small sample sizes for individual countries. In the pooled sample of all ten "vocational" countries (with country fixed effects), there is a significant age pattern in earnings that resembles the age pattern in employment: general-education individuals earn initially less and later more than vocational-education individuals. Nevertheless, for most individual countries, the labor-market impact of general versus vocational education comes mostly through the life-cycle employment effects and not through wage effects.

7. Lifetime Earnings

The previous analysis points to a clear trade-off between early career employment and employment later in the life-cycle. Thus, we ask the simple question of whether the early employment gains outweigh the later losses from the viewpoint of individual labor-market earnings.

Importantly, while we have clear causal estimates of the impact of education type on the age-employment profile, our estimates of the initial differential in employment are less well identified. The identification of the initial impact of education type rests on adequately separating the influence of education type from other market-related factors correlated with these choices (through the observed skill and background factors). Nonetheless, using the estimate of the initial employment losses from general education (β_1), we calculate the present value of

[22] Belgium does not have earnings information in the survey.

lifetime employment for workers with different schooling types in the three "apprenticeship" countries for which we found clearest evidence of the age-employment pattern.[23] We weight the employment at each age by the average earnings for each age cohort by schooling type.[24] Future earnings are discounted back to age 16 at 3 percent.

These calculations produce very interesting results, suggesting that aspects of the larger labor market are important for evaluating the efficacy of apprenticeship programs. For Germany and Denmark, the present value of earnings favors those with a general education. Over the lifetime, the German worker with a general education will have 24 percent higher earnings than one with a vocational education, while a Dane with general education will see six percent higher earnings. For Switzerland, however, the higher present value goes to those with vocational education; the early earnings gains more than make up for the gains in later earnings that accrue to workers with general training, and vocational workers have eight percent higher lifetime earnings.[25]

An obvious explanation of the country differences follows the motivation for this whole analysis. In faster growing societies, with commensurately larger technological change, we expect the greater adaptability of general education coupled with the added adult employment to yield advantages to the workers. The Swiss annual growth rate in GDP per capita from 1970-2000 was just 1.1 percent (Heston, Summers, and Aten (2011)). This is less than half the comparable OECD growth rate (2.4 percent). The Danish growth rate of 2.1 percent and German

[23] To the extent that β_1 incorporates a combination of the causal impact of general education plus an element of selection involving other factors, the interpretation would be limited to the economic impact on the typical worker now in general education as opposed to just the impact of general education.

[24] As an alternative, we also use the estimated earnings functions to provide the age-by-schooling information. This approach acts to smooth out cohort jumpiness in the averages, recognizing that some of the age cohort samples become fairly small. Nonetheless, the qualitative results with this approach do not differ from using the simple age cohort earnings averages.

[25] Detailed results are available from the authors on request.

growth rate of 2.2 percent suggest much more dynamic economies, where the flexibility of general education has a much greater payoff.[26]

Interestingly, Wolter and Ryan (2011) indicate that, from the viewpoint of the firm, Swiss apprenticeships are also beneficial while German apprenticeships are not.[27] This raises a small puzzle, because lower relative wages of trainees partially contribute to the net benefits to Swiss firms. Thus, at least during the training period, one might expect that the worker would see lower net benefits in Switzerland. By our data, this training-period disadvantage relative to Germany is overcome by smaller reductions in subsequent employment and wages of workers with vocational education relative to Germany.

The overall employment effects of training are undoubtedly related in part to the social safety net in the specific country being considered. Without early retirement options, it is likely that a significant fraction of those leaving the labor force in their mid-fifties would actually stay employed. Thus, for example, in a developing country without a mature system for retirement income, we might see a very different pattern of employment across the life-cycle along with a potentially different wage structure.

Moreover, the interaction of the lifetime incomes with government policies and programs makes it clear that these calculations do not represent a benefit-cost analysis. Both workers and the government see a different total economic impact, something that goes beyond our analysis here.

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[26] This may not, however, be the correct comparison. The Swiss economy did suffer a growth slowdown that is often attributed to the financial sector. It may be more appropriate to compare the vocational employment results to the rate of innovation in the economies, something that is intrinsically hard to measure.

[27] There is a substantial variation across firms, but Wolter and Ryan (2011) report that "in Switzerland 60% of all training firms obtain positive net benefits, while in Germany, 93% of training firms incur net costs. A complementary difference between the countries shows up in labor turnover. In Germany more apprentices remain with their training company after completion than in Switzerland: 50% and 36% of apprentices stay put for at least a year afterwards, respectively" (p. 543).

8. Conclusions

Our estimates of the impact of vocational education on age-employment profiles indicate that much of the policy discussion about education programs is too narrow. Vocational education has been promoted largely as a way of improving the transition from schooling to work, but it also appears to have an impact on the adaptability of workers to technological and structural change in the economy. As a result, the advantages of vocational training in smoothing entry into the labor market have to be set against disadvantages later in life.

We estimate the impact of education type on employment over the life-cycle in a difference-in-differences approach, comparing the relative performance of individuals with different education types at different ages. A series of robustness checks validates the assumption that differential selectivity by age cohort does not bias the estimates.

We also conclude that the impact of vocational education varies considerably with the specific institutional structure of schooling and work-based training. While the declining age-employment pattern for those with vocational education relative to those with general education is found in all vocational education countries, it is most acute in the three apprenticeship countries in our sample. The balance of early gains against later losses for vocational relative to general education is not uniform across these countries, though: In line with the relative pace of economic change in their economies, the balance in lifetime earnings appears to be in favor of vocational education in Switzerland, but in favor of general education in Denmark and Germany.

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Table 1: Educational Attainment and Type by Country

			Secondary and tertiary		Secondary		Tertiary
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	N	% completing secondary	% completing general	% completing vocational	% completing general	% completing vocational	% completing general
Belgium	680	72.4	34.0	64.9	27.8	70.7	49.2
Chile	722	76.7	51.4	46.1	49.1	47.5	57.7
Czech Rep.	917	97.2	4.8	71.8	4.4	71.6	19.8
Denmark	1,006	76.9	23.4	60.1	14.3	63.8	51.0
Finland	1,021	77.3	42.8	56.1	36.5	61.9	60.2
Germany	748	84.0	25.6	66.7	15.0	75.7	81.0
Great Britain	639	80.4	58.2	41.8	–	–	58.2
Hungary	1,022	84.9	34.3	64.4	26.1	72.3	79.5
Ireland	119	81.4	41.1	58.9	–	–	41.1
Italy	809	89.3	75.2	21.0	72.2	23.3	91.8
Netherlands	1,111	75.4	46.8	53.2	29.3	70.7	100.0
New Zealand	1,229	74.3	25.6	65.9	23.0	64.5	31.0
Norway	897	81.0	17.8	57.8	8.3	59.0	45.9
Poland	919	84.5	14.3	85.7	4.4	95.6	68.0
Slovenia	1,097	86.3	47.2	47.7	45.7	48.4	56.9
Sweden	245	71.0	58.1	41.9	–	–	58.1
Switzerland	1,228	82.3	7.7	91.8	9.1	90.3	2.2
USA	809	59.4	34.4	32.5	17.9	19.8	53.1
All countries	15,218	73.4	35.2	47.2	23.2	50.4	59.2

Note: Data source: International Adult Literacy Survey (IALS). Sample includes all males who finished secondary education or the first stage of tertiary education and are not currently enrolled in school. Secondary education is classified as one of three types: general for academic or college preparatory programs; vocational for business, trade, or vocational programs; and other for secondary level equivalency or other programs. First stage of tertiary education is classified as general or vocational. A general program is one that leads to a university degree (BA/BS); a vocational program is one that does not lead to a university degree, which is typically shorter and focuses on practical, technical, or occupational skills for direct entry into the labor market. For Great Britain, Ireland, and Sweden, information on the secondary education types is unavailable.

Table 2: Educational Attainment and Type by Age Cohort

			Secondary and tertiary		Secondary		Tertiary
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cohort	N	% completing secondary	% completing general	% completing vocational	% completing general	% completing vocational	% completing general
16-25	2,029	86.8	30.1	50.0	27.7	48.1	41.5
26-35	4,087	71.9	35.6	48.8	22.4	53.8	60.7
36-45	4,060	66.4	36.0	48.7	22.8	51.4	55.2
46-55	3,018	72.5	37.0	44.0	23.3	48.0	63.9
56-65	2,024	75.1	35.5	42.8	19.1	48.6	68.8

Note: See note to Table 1 for data source, sample, and definition of education types.

Table 3: Literacy Score by Education Type and Age Cohort

Cohort	(1) All	(2) Vocational	(3) General	(4) Difference
16-25	0.144	0.168	0.531	0.363
26-35	0.260	0.249	0.673	0.424
36-45	0.289	0.229	0.731	0.502
46-55	0.192	0.079	0.593	0.514
56-65	-0.085	-0.202	0.404	0.606

Note: See note to Table 1 for data source, sample, and definition of education types. Literacy score is the average of prose, document, and quantitative test scores and is normalized to have a mean of 0 and a standard deviation of 1 within each country.

Table 4: Percentage Employed by Education Type and Age Cohort

Cohort	(1) All	(2) Vocational	(3) General	(4) Difference
16-25	0.796	0.794	0.693	-0.101
26-35	0.915	0.912	0.940	0.028
36-45	0.906	0.890	0.943	0.053
46-55	0.850	0.846	0.874	0.028
56-65	0.485	0.429	0.573	0.144

Note: See note to Table 1 for data source, sample, and definition of education types. Individuals employed are those who are employed at the time of the survey; individuals not employed include retired, unemployed who are looking for work, homemakers, and others.

Table 5: The Effect of General vs. Vocational Education on Employment over the Life-Cycle

	(1)	(2)	(3) Mother's education	(4)	(5)	(6) 20-65 age sample	(7) Unemployment	(8) Matching
General education type	-0.070	-0.067	-0.066	-0.106	-0.075	-0.069	-0.055	-0.083
	(0.015)***	*(0.015)****	*(0.015)****	*(0.026)****	*(0.017)****	*(0.017)****	*(0.015)****	*(0.022)****
General education type * age/10	0.022	0.017	0.018	0.032	0.016	0.014	0.010	0.019
	(0.006)***	*(0.006)****	*(0.006)****	*(0.010)****	*(0.006)****	*(0.006)***	*(0.005)**	*(0.008)***
Other education type	-0.018	-0.015	-0.011	0.059	0.001	-0.001	0.012	
	(0.026)	*(0.026)*	*(0.027)*	*(0.036)*	*(0.027)*	*(0.028)*	*(0.023)*	
Other education type * age/10	-0.012	-0.010	-0.013	-0.025	-0.013	-0.012	-0.003	
	(0.010)	*(0.010)*	*(0.010)*	*(0.014)**	*(0.010)*	*(0.011)*	*(0.009)*	
Age/10	0.345	0.335	0.327	0.384	0.335	0.330	0.114	0.330
	(0.011)***	*(0.011)****	*(0.017)****	*(0.019)****	*(0.011)****	*(0.012)****	*(0.011)****	*(0.013)****
$(Age/10)^2$	-0.086	-0.082	-0.082	-0.094	-0.081	-0.080	-0.020	-0.080
	(0.002)***	*(0.002)****	*(0.002)****	*(0.004)****	*(0.002)****	*(0.002)****	*(0.002)****	*(0.003)****
Years of schooling	0.012	0.005	0.005	0.009	0.005	0.004	0.002	0.005
	(0.001)***	*(0.001)****	*(0.001)****	*(0.002)****	*(0.001)****	*(0.001)****	*(0.001)**	*(0.001)****
Literacy score		0.018	0.020	0.029	0.019	0.022	0.044	0.015
		(0.008)**	*(0.009)***	*(0.014)***	*(0.008)***	*(0.009)***	*(0.009)****	*(0.010)*
Literacy score * age/10		0.016	0.015	0.009	0.015	0.014	-0.003	0.017
		(0.003)***	*(0.003)****	*(0.005)**	*(0.003)****	*(0.003)****	*(0.003)*	*(0.004)****
Father has professional occupation				0.018 *(0.026)*				
Father has professional occupation * age/10				-0.011 *(0.011)*				
Average lit. score, country-cohort-educ. type					0.049	0.048	0.052	0.044
					(0.020)**	*(0.020)***	*(0.016)****	*(0.026)**
% with general education, country-cohort					-0.513	-0.53	-0.183	-0.634
					(0.139)***	*(0.140)****	*(0.113)*	*(0.176)****
% with vocation education, country-cohort					-0.309	-0.317	-0.314	-0.439
					(0.135)**	*(0.136)***	*(0.108)****	*(0.172)***
Constant	0.499	0.548	0.560	0.475	0.900	1.000	0.982	1.139
	(0.036)***	*(0.036)****	*(0.050)****	*(0.034)****	*(0.137)****	*(0.137)****	*(0.109)****	*(0.173)****
Observations	15,038	15,038	14,830	5,639	15,038	14,670	13,291	10,782
Countries	18	18	18	7	18	18	18	18
Adjusted R^2	0.21	0.23	0.23	0.24	0.23	0.23	0.05	0.23

Note: Linear probability models. Dependent variable: Individual is employed. Sample includes males aged 16 to 65 with secondary or first stage of tertiary education. All specifications control for country fixed effects. Omitted education type is vocational. Age variable subtracted by 16 throughout. Column 3 controls for indicators for mother's education and their interaction with age (which turn out insignificant, not shown). Column 7 regards only the unemployed in the non-employed category. Column 8 is estimated by nearest-neighbor propensity-score matching, with vocational types matched to general types based on age, years of schooling, literacy scores, and parental education; see text for details. Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Table 6: The Effect of Education Type on Life-Cycle Employment: Country Groups

	(1) All	(2) Non-vocational	(3) Vocational	(4) Non-school based	(5) Apprenticeship
General education type	-0.075	0.023	-0.095	-0.121	-0.209
	(0.017)***	*(0.034)*	*(0.021)****	*(0.033)****	*(0.043)****
General education type * age/10	0.016	-0.017	0.022	0.032	0.051
	(0.006)***	*(0.013)*	*(0.007)****	*(0.011)****	*(0.016)****
Observations	15,038	3,421	10,615	5,819	2,970
Countries	18	4	11	6	3

Note: Linear probability models. Each column is a separate regression with the same controls as in Column 5 of Table 5. Age variable subtracted by 16. Countries are grouped based on the shares of upper-secondary-school students in vocational programs, school-based vocational programs, and apprenticeship reported in the OECD Education at a Glance or calculated from the IALS data (see text for details). Non-vocational countries are Chile, Italy, New Zealand, and the U.S. Apprenticeship countries are Denmark, Germany, and Switzerland. Non-school based vocational countries are the apprenticeship countries plus the Czech Republic, Hungary, and Poland. Vocational countries are the non-school based vocational countries plus Belgium, Finland, the Netherlands, Norway, and Slovenia. (Great Britain, Ireland, and Sweden are in the full sample of countries but in no sub-sample as the information on secondary school type required for the classification is missing.) Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Table 7: The Effect of Education Type on Life-Cycle Employment: Vocational Education Countries

	(1) Belgium	(2) Czech Rep.	(3) Denmark	(4) Finland	(5) Germany	(6) Hungary	(7) Netherlands	(8) Norway	(9) Poland	(10) Slovenia	(11) Switzerland
General educ. type	0.039	0.143	-0.042	-0.151	-0.403	-0.027	-0.032	-0.022	0.380	-0.137	-0.333
	(0.104)	*(0.131)*	*(0.062)*	*(0.064)***	*(0.137)****	*(0.068)*	*(0.115)*	*(0.098)*	*(0.331)*	*(0.050)****	*(0.076)****
General educ. type	-0.019	-0.018	0.073	0.049	0.055	0.000	-0.001	0.030	0.011	0.045	0.104
* age/10	*(0.026)*	*(0.043)*	*(0.028)****	*(0.025)***	*(0.028)**	*(0.025)*	*(0.023)*	*(0.026)*	*(0.041)*	*(0.020)***	*(0.029)****
Observations	670	914	1,006	1,021	744	1,016	1,111	897	919	1,097	1,220

Note: Linear probability models. Each column is a separate regression with the same controls as in Column 5 of Table 5. Age variable subtracted by 16. Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Table 8: Nonlinear Specification of the Effect of Education Type on Life-Cycle Employment

	(1) Belgium	(2) Czech R.	(3) Denmark	(4) Finland	(5) Germany	(6) Hungary	(7) Netherlands	(8) Norway	(9) Poland	(10) Slovenia	(11) Switzerland	(12) Apprenticeship
General educ. type	-0.019	-0.053	-0.115	-0.203	-0.217	-0.044	-0.061	-0.034	-0.026	-0.081	-0.574	-0.308
	(0.090)	*(0.179)*	*(0.087)*	*(0.083)***	*(0.109)***	*(0.079)*	*(0.067)*	*(0.106)*	*(0.203)*	*(0.073)*	*(0.155)****	*(0.066)****
General educ. type	0.037	0.074	0.068	0.107	0.228	-0.020	0.060	0.053	-0.106	0.013	0.491	0.215
* Cohort 26-35	*(0.096)*	*(0.180)*	*(0.095)*	*(0.093)*	*(0.120)**	*(0.100)*	*(0.073)*	*(0.114)*	*(0.219)*	*(0.079)*	*(0.161)****	*(0.067)****
General educ. type	0.041	0.168	0.044	0.225	0.222	0.091	0.065	-0.040	0.049	0.057	0.550	0.225
* Cohort 36-45	*(0.098)*	*(0.182)*	*(0.096)*	*(0.090)***	*(0.130)**	*(0.097)*	*(0.077)*	*(0.113)*	*(0.211)*	*(0.080)*	*(0.159)****	*(0.068)****
General educ. type	-0.028	0.075	0.115	0.212	0.192	-0.066	0.041	-0.003	0.096	0.065	0.569	0.217
* Cohort 46-55	*(0.101)*	*(0.191)*	*(0.100)*	*(0.098)***	*(0.131)*	*(0.103)*	*(0.088)*	*(0.119)*	*(0.221)*	*(0.093)*	*(0.161)****	*(0.713)****
General educ. type	-0.087	-0.001	0.113	0.150	0.406	0.055	0.001	0.234	-0.037	0.206	0.711	0.307
* Cohort 56-65	*(0.142)*	*(0.268)*	*(0.139)*	*(0.126)*	*(0.155)****	*(0.098)*	*(0.112)*	*(0.143)*	*(0.229)*	*(0.099)***	*(0.181)****	*(0.088)****
Observations	670	914	1,006	1,021	744	1,016	1,111	897	919	1,097	1,220	2,970

Note: Linear probability models. Each column is a separate regression. Each regression also controls for dummy variables for "other education type", age cohorts, their interactions, and all other control variables in Column 5 of Table 5. "Apprenticeship" countries are Denmark, Germany, and Switzerland (specification includes country fixed effects). Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Table 9: The Effect of Education Type on Life-Cycle Employment: Sample of Individuals with Just Secondary Education

	(1) Belgium	(2) Czech Rep.	(3) Denmark	(4) Finland	(5) Germany	(6) Hungary	(7) Netherlands	(8) Norway	(9) Poland	(10) Slovenia	(11) Switzerland	(12) Apprenticeship
General educ. type	0.045	0.015	-0.131	-0.151	-0.202	-0.025	0.051	-0.094	-0.299	-0.081	-0.304	-0.334
	(0.092)	*(0.118)*	*(0.087)*	*(0.068)***	*(0.090)***	*(0.069)*	*(0.056)*	*(0.131)*	*(0.227)*	*(0.053)*	*(0.098)****	*(0.085)****
General educ. type	-0.032	-0.002	0.027	0.047	0.077	0.004	-0.021	0.055	0.082	0.020	0.097	0.065
* age/10	*(0.038)*	*(0.044)*	*(0.039)*	*(0.028)**	*(0.039)**	*(0.023)*	*(0.024)*	*(0.048)*	*(0.064)*	*(0.021)*	*(0.036)****	*(0.022)****
Observations	343	879	735	739	620	875	761	503	778	966	893	2,248

Note: Linear probability models. Sample includes males with secondary education only. Each column is a separate regression including the same control variables as in Column 5 of Table 5. Age variable subtracted by 16. "Apprenticeship" countries are Denmark, Germany, and Switzerland (specification includes country fixed effects). Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Table 10: The Effect of General vs. Vocational Education on Adult Education over the Life-Cycle (Apprenticeship Countries)

Dependent variable	Career-related adult education			Annual hours of career-related adult education		
Model	Linear probability model			Tobit model		
	(1)	(2)	(3)	(4)	(5)	(6)
	Denmark	Germany	Switzerland	Denmark	Germany	Switzerland
General education type	-0.058	-0.066	-0.085	-31.287	-303.052	-82.401
	(0.078)	*(0.066)*	*(0.210)*	*(65.713)*	*(174.865)**	*(95.833)*
General education type	0.010	0.051	0.032	1.475	177.121	25.259
* age/10	*(0.029)*	*(0.024)***	*(0.076)*	*(24.120)*	*(68.374)****	*(33.447)*
Literacy score	0.075	0.117	0.066	29.810	288.742	71.607
	(0.035)**	*(0.027)****	*(0.071)*	*(35.689)*	*(90.254)****	*(50.954)*
Literacy score * age/10	0.008	-0.029	-0.007	6.937	-90.718	-14.125
	(0.012)	*(0.008)****	*(0.026)*	*(12.019)*	*(33.141)****	*(18.180)*
Age/10	0.089	0.145	-0.007	-71.094	370.821	-29.933
	(0.053)*	*(0.036)****	*(0.090)*	*(49.553)*	*(121.332)****	*(44.785)*
$(Age/10)^2$	-0.030	-0.034	-0.005	2.101	-94.148	1.497
	(0.010)***	*(0.006)****	*(0.016)*	*(8.452)*	*(23.728)****	*(8.109)*
Years of schooling	0.030	0.001	0.034	17.323	-0.750	19.447
	(0.007)***	*(0.006)*	*(0.011)****	*(5.025)****	*(11.401)*	*(6.118)****
Observations	1,006	744	420	1,006	743	420

Note: The dependent variable in the first three columns is a dummy variable for whether one received any career-related adult education during the 12 months prior to the survey; the dependent variable in Columns 4-6 is the number of hours of career-related adult education received during the 12 months prior to the survey. Included in each regression but not reported are the dummy variable for other education type and its interaction with age. Age variable subtracted by 16 throughout. Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Table 11: The Effect of General vs. Vocational Education on Wages over the Life-Cycle

	(1) Czech Rep.	(2) Denmark	(3) Finland	(4) Germany	(5) Hungary	(6) Netherlands	(7) Norway	(8) Poland	(9) Slovenia	(10) Switzerland	(11) Vocational
General educ. type	0.199	-0.024	-0.269	0.014	-0.158	-0.063	0.010	-0.467	-0.006	0.059	-0.155
	(0.247)	*(0.095)*	*(0.133)***	*(0.155)*	*(0.166)*	*(0.085)*	*(0.141)*	*(0.360)*	*(0.109)*	*(0.185)*	*(0.069)***
General educ. type * age/10	-0.093	0.038	0.113	0.082	0.098	0.091	-0.056	0.199	0.025	-0.046	0.045
	(0.082)	*(0.038)*	*(0.051)***	*(0.057)*	*(0.069)*	*(0.035)***	*(0.054)*	*(0.117)**	*(0.048)*	*(0.077)*	*(0.017)****
Observations	505	765	631	395	424	776	592	508	485	804	5.885

Note: Dependent variable is natural logarithm of annual wage. Sample includes individuals who worked full-time during the 12 months prior to the survey. Each column is a regression including the same control variables as in Column 5 of Table 5. Age variable subtracted by 16. "Vocational" countries refers to all ten counties pooled (specification includes country fixed effects). Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Appendix Table A1: Educational Attainment by Country and by Cohort

(A) Country	Average years of schooling	% completing: Less than secondary	1st stage secondary	2nd stage secondary	Technical college	BA/BS	Advanced degree
Belgium	12.0	20.1	21.8	34.0	14.6	8.6	0.9
Chile	9.4	30.8	28.3	25.0	7.5	7.8	0.6
Czech Rep.	12.4	11.8	46.5	30.0	1.4	0.4	10.0
Denmark	12.7	11.9	14.5	47.1	10.0	10.3	6.2
Finland	12.1	6.9	24.1	48.1	8.7	11.5	0.8
Germany	11.2	12.0	54.5	19.7	3.3	9.4	1.2
Great Britain	12.0	5.8	55.5	19.3	8.1	8.7	2.7
Hungary	11.7	4.9	24.4	53.2	4.3	12.6	0.5
Ireland	10.2	26.2	29.7	27.2	8.8	4.7	3.3
Italy	10.0	26.0	32.4	32.6	0.9	7.0	1.0
Netherlands	12.6	15.7	27.9	37.7	0.0	18.4	0.4
New Zealand	11.9	4.6	46.5	23.2	15.5	6.7	3.5
Norway	11.7	0.2	12.1	62.3	9.6	10.4	5.5
Poland	11.0	26.5	35.1	24.0	6.2	7.7	0.5
Slovenia	11.0	10.3	24.9	49.5	7.7	6.5	1.1
Sweden	11.6	18.1	11.1	45.2	13.5	12.1	0.0
Switzerland	12.2	13.6	13.1	55.9	10.1	0.2	7.2
USA	13.3	9.8	5.9	46.1	15.1	16.3	6.7

(B) Cohort	Average years of schooling	% completing: Less than secondary	1st stage secondary	2nd stage secondary	Technical college	BA/BS	Advanced degree
16-25	12.1	10.0	30.9	44.0	8.5	6.2	0.4
26-35	12.6	8.6	26.1	36.8	9.9	16.3	2.3
36-45	12.5	10.6	23.6	36.2	11.4	13.3	4.9
46-55	12.0	14.6	25.1	33.6	8.8	11.4	6.4
56-65	11.0	24.4	25.2	29.6	7.2	9.1	4.6

Note: Sample includes all individuals (male and female) who are not currently enrolled in school.

Appendix Table A2: Upper Secondary Education by Program Orientation

	OECD 2007				OECD 1996			IALS Data		
	General	Pre-vocational	Vocational	Combined school- and work-based	General	Vocational	Combined school- and work-based	General	Vocational	Other
Belgium	30.4	–	69.6	3.4	32	68	3	38.5	60.3	1.2
Chile	64.9	–	35.1	–	58	42	–	53.4	45.2	1.4
Czech Rep.	24.7	–	75.2	34.0	16	84	47	12.8	53.1	34.1
Denmark	52.3	–	47.7	47.2	47	53	48	24.8	59.6	15.7
Finland	33.3	–	66.7	11.5	48	52	5	18.4	75.9	5.7
Germany	42.6	–	57.4	42.2	24	76	52	54.5	45.5	0.0
Hungary	76.4	10.4	13.2	13.2	32	68	26	17.8	80.4	1.8
Ireland	66.5	31.3	2.2	2.2	80	20	5	–	–	–
Italy	40.2	33.2	26.5	–	28	72	–	82.0	15.7	2.3
Netherlands	32.4	–	67.6	18.5	30	70	23	33.5	66.5	0.0
New Zealand	–	–	–	–	62	38	8	54.3	38.6	7.1
Norway	42.5	–	57.5	14.9	42	58	–	8.9	52.6	38.6
Poland	55.7	–	44.3	6.4	31	69	69	22.6	77.4	0.0
Slovenia	35.1	–	64.9	1.6	–	–	–	48.5	44.4	7.1
Sweden	42.9	1.0	56.2	–	46	51	–	–	–	–
Switzerland	35.2	–	64.8	59.0	31	69	60	13.1	86.9	0.0
UK	58.6	–	41.4	–	43	57	–	–	–	–
USA	100.0	–	–	–	–	–	–	19.7	19.5	60.8

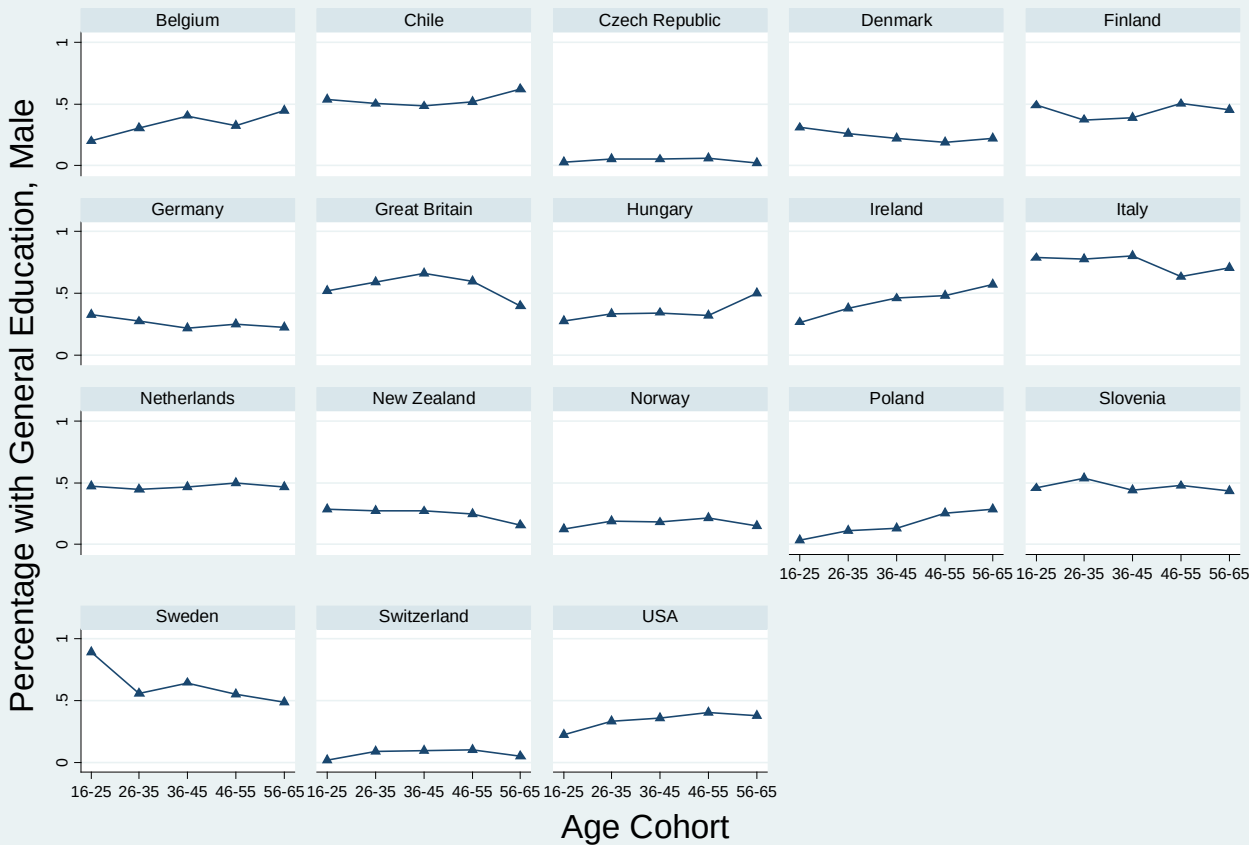
Note: Data for OECD 2007 and 1996 are from the 2009 and 1998 versions of the OECD Education at a Glance, Chapter C: Access to Education, Participation, and Progression. Pre-vocational programs are designed to introduce participants to the world of work and to prepare them for entry into further vocational programs; successful completion of such programs does not lead to a labor-market relevant vocational qualification. Vocational programs prepare participants for direct entry into specific occupations without further training. Vocational and pre-vocational programs are further divided into two categories: In school-based programs, instruction mainly takes place in a school environment; in combined school- and work-based programs, instruction and training mainly take place in work-place. The IALS data are calculated from a sample of all individuals who have completed an upper secondary education and are not currently enrolled in school. "Other" type includes secondary level equivalency and other programs.

Appendix Table A3: Nonlinear Effect of Education Type on Life-Cycle Employment: Individuals Aged 20-65

	(1) Belgium	(2) Czech Rep.	(3) Denmark	(4) Finland	(5) Germany	(6) Hungary	(7) Netherlands	(8) Norway	(9) Poland	(10) Slovenia	(11) Switzerland
General educ. type	0.004	-0.011	-0.095	-0.078	-0.026	-0.018	-0.027	0.020	-0.151	-0.062	-0.184
	(0.053)	*(0.074)*	*(0.055)**	*(0.049)*	*(0.074)*	*(0.057)*	*(0.040)*	*(0.053)*	*(0.122)*	*(0.045)*	*(0.072)***
General educ. type	-0.001	0.042	0.053	0.038	0.005	0.014	0.018	-0.089	0.168	0.030	0.139
* Cohort 31-50	*(0.058)*	*(0.089)*	*(0.060)*	*(0.057)*	*(0.082)*	*(0.071)*	*(0.047)*	*(0.056)*	*(0.124)*	*(0.052)*	*(0.077)**
General educ. type	-0.153	0.101	0.065	0.120	0.208	-0.037	-0.021	0.048	0.070	0.114	0.270
* Cohort 51-65	*(0.102)*	*(0.142)*	*(0.101)*	*(0.084)*	*(0.109)**	*(0.079)*	*(0.081)*	*(0.077)*	*(0.145)*	*(0.081)*	*(0.094)****
Observations	664	899	990	992	703	991	1,095	867	898	1,060	1,209

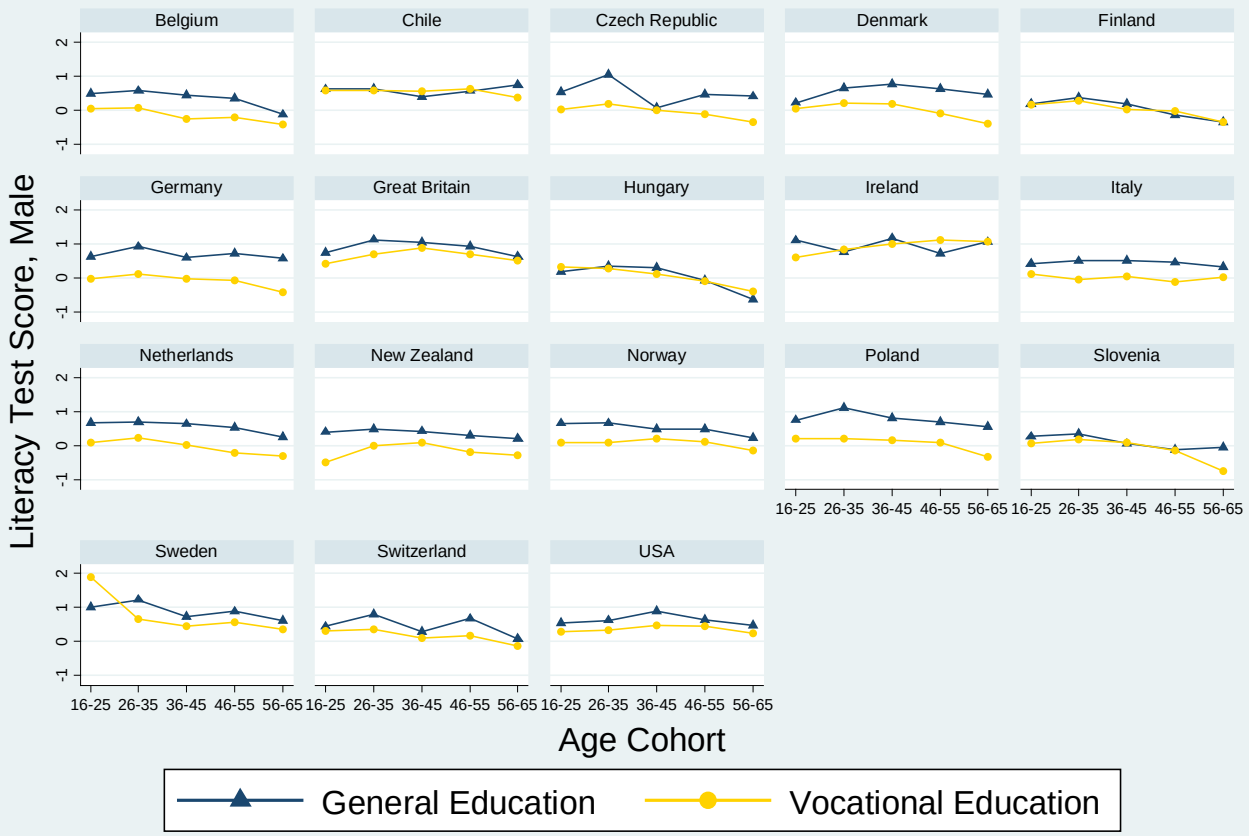
Note: Linear probability models. Each column is a separate regression. Each regression also controls for dummy variables for "other education type", age cohorts, their interactions, and all other control variables in Column 5 of Table 5. Omitted category is those aged between 20 and 30. Robust standard errors in parentheses. Significant at *** 1%, ** 5%, * 10%.

Figure 1: Share of Male Population with General Education



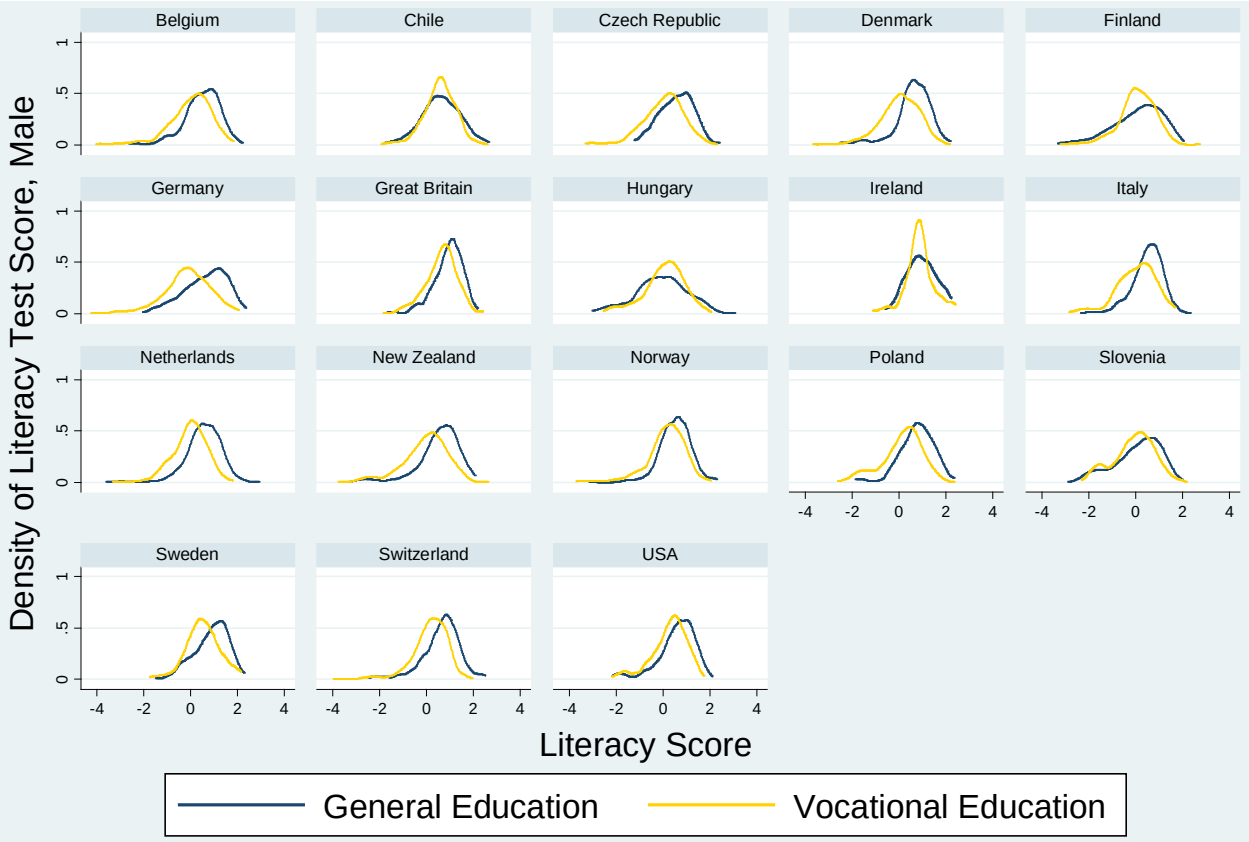
Note: See note to Table 1 for data source, sample, and definition of education types.

Figure 2: Average Literacy Test Score of Males by Education Type and Age Cohort



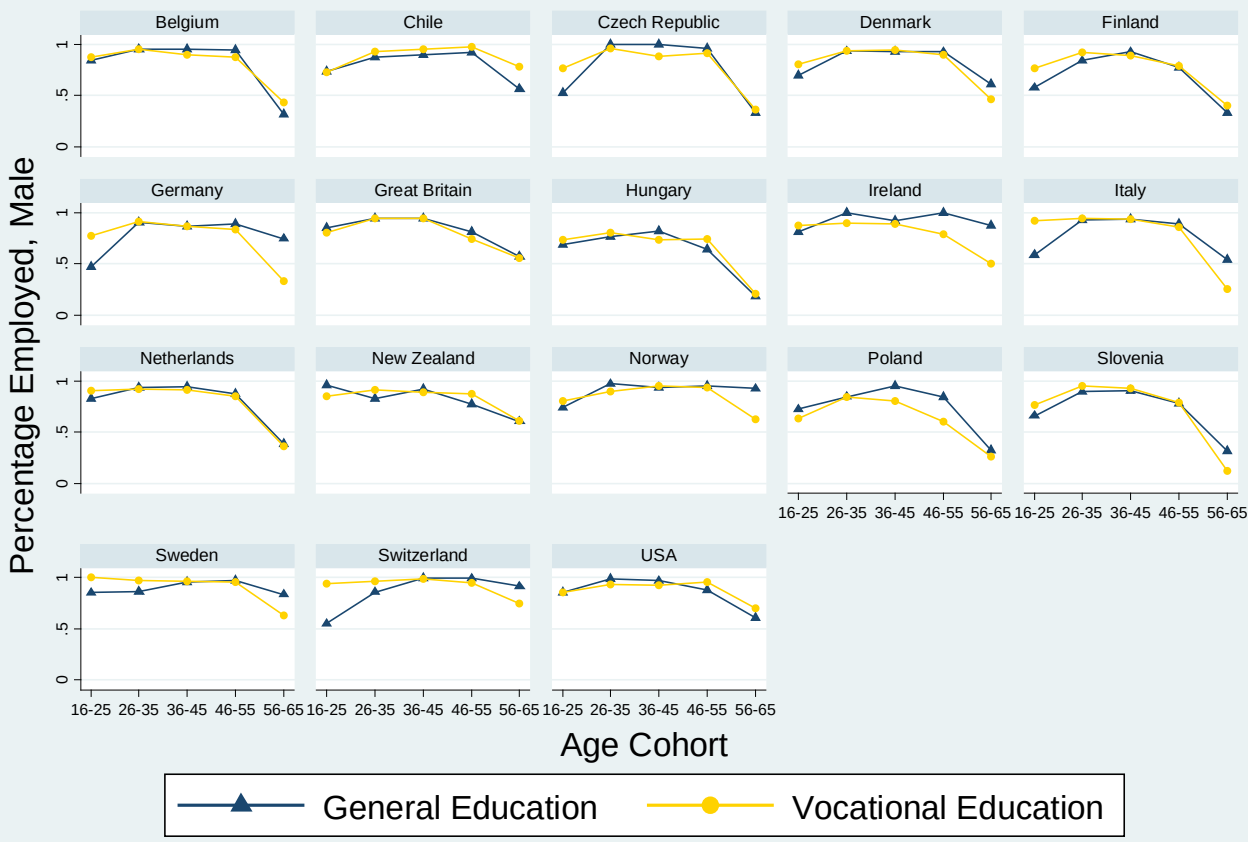
Note: See note to Table 1 for data source, sample, and definition of education types. Literacy score is the average of prose, document, and quantitative test scores and is normalized to have a mean of 0 and a standard deviation of 1 within each country.

Figure 3: Density of Literacy Test Score of Males by Education Type



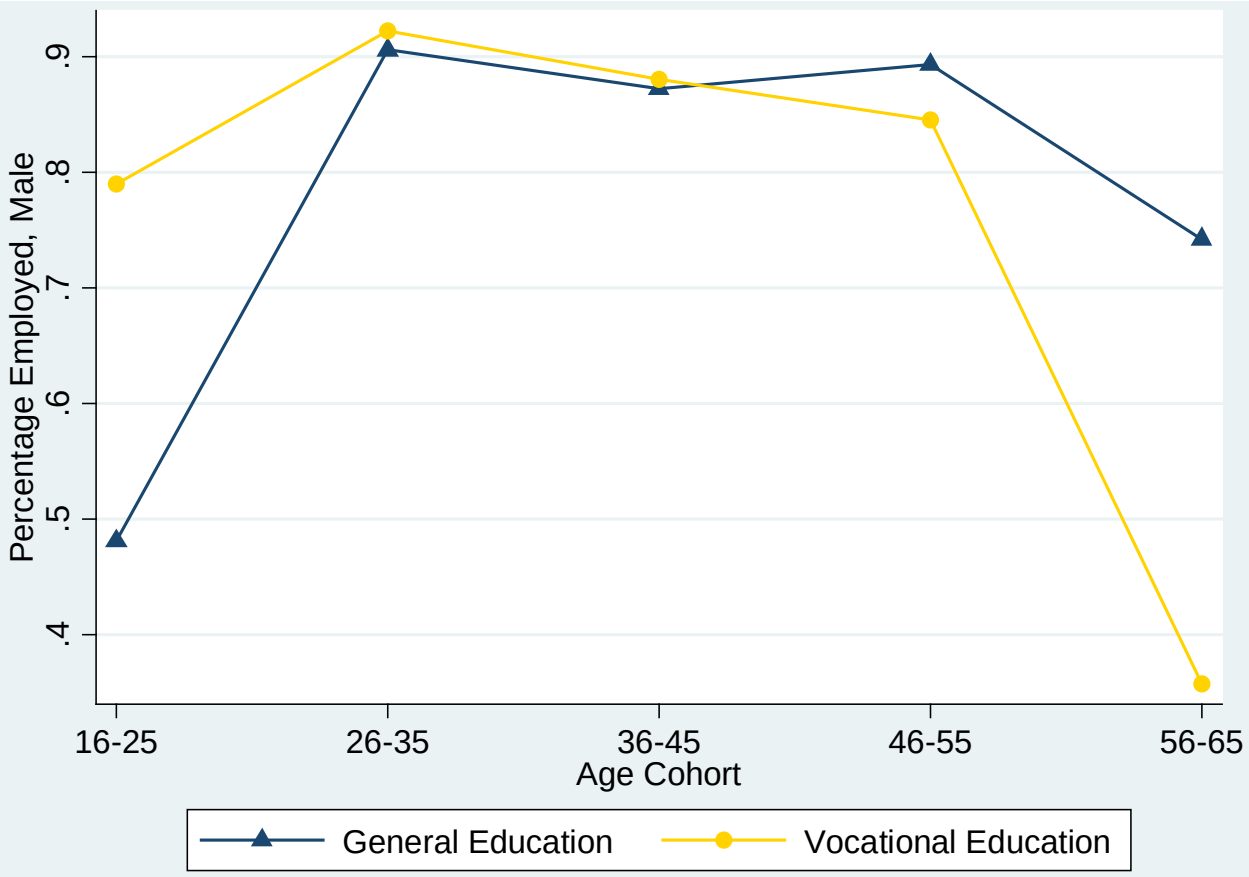
Note: See note to Figure 2.

Figure 4: Male Employment Rate by Education Type and Age Cohort



Note: Sample includes all males who finished secondary education or the first stage of tertiary education and are not currently enrolled in school. See note to Table 1 for definition of education types. Individuals employed are those who are employed at the time of the survey; individuals not employed include retired, unemployed who are looking for work, homemakers, and others. Data source: International Adult Literacy Survey (IALS).

Figure 5: Education Type and Life-Cycle Employment in Apprenticeship Countries



Note: Sample includes all males who finished secondary education or the first stage of tertiary education and are not currently enrolled in school. See note to Table 1 for definition of education types. Individuals employed are those who are employed at the time of the survey; individuals not employed include retired, unemployed who are looking for work, homemakers, and others. Apprenticeship countries are Denmark, Germany, and Switzerland. Data source: International Adult Literacy Survey (IALS).