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Abstract

We investigate the short- and long-term effects of economic conditions at high-school graduation as a source of exogenous variation in the labor-market opportunities of potential college entrants. Exploiting business cycle fluctuations across birth cohorts for 28 developed countries, we find that bad economic conditions at high-school graduation increase college enrollment and graduation. They also affect outcomes in later life, increasing cognitive skills and improving labor-market success. Outcomes are affected only by the economic conditions at high-school graduation, but not by those during earlier or later years. Recessions at high-school graduation narrow the gender gaps in numeracy skills and labor-market success.

JEL-Codes: I230, I210, J240, E320.

Keywords: business cycle, college enrollment, skill formation, labor-market outcomes, PIAAC, gender gap.

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1 Introduction

Business cycle fluctuations after completing formal education have been shown to affect individuals' career paths (Oyer 2008; Nagler, Piopiunik and West 2020). In particular, graduating from college during a recession has persistent negative wage effects (Kahn 2010; Oreopoulos, von Wachter and Heisz 2012; Altonji, Arcidiacono and Maurel 2016; Liu, Salvanes and Sørensen 2016; Schwandt and von Wachter 2019). In contrast, bad economic conditions *prior to* completing formal education may have very different effects: A lack of suitable jobs decreases the opportunity cost of continuing in the education system, thus potentially increasing educational investment.[1] However, it is unclear whether such an increase in education would transfer to the labor market since individuals who obtain more education because of bad economic conditions (i.e., marginal students) are potentially less academically prepared than students who invest in education independent of economic conditions (i.e., infra-marginal students). Thus, they may not successfully complete further education or have only minor learning gains.

Our paper is the first to provide a comprehensive assessment of the impact of economic conditions at high-school graduation on both short-term college investment and longer-term human-capital formation and labor-market outcomes. We exploit business cycle conditions at high-school graduation as a source of exogenous variation in the labor-market opportunities of potential college students. Given that the business cycle conditions at high-school graduation are exogenous to college investment decisions, our reduced-form results reflect causal effects.

We use data from the Programme for the International Assessment of Adult Competencies (PIAAC), administered by the OECD. PIAAC is a cross-sectional survey, covering representative samples of adults in 28 developed countries. We focus on individuals aged 25-39 years, most of whom have already finished their formal education and entered the labor market. Importantly, PIAAC provides internationally comparable assessments of literacy and numeracy skills among adults. This enables us – for the first time – to investigate business cycle effects on tested cognitive skills after formal schooling. Furthermore, the in-depth background questionnaire contains information on individuals' educational attainment, including college enrollment, degree, and dropout, as well as labor-market outcomes such as wages, employment, and training participation.

We identify the effects of economic conditions at high-school graduation by exploiting variation in national unemployment rates across countries over time. By including fixed effects for countries and birth years, the estimates are based on economic shocks specific to a particular birth cohort and country. Country fixed effects control for any differences between countries that are similar across cohorts. For example, they account for cross-

[1] In addition, economic conditions may also affect individuals' subjective earnings expectations, which play a key role for schooling investments (e.g., Jensen 2010; Stinebrickner and Stinebrickner 2012; Abramitzky and Lavy 2014; Wiswall and Zafar 2015).

country differences in the likelihood of attending or completing college, in numeracy and literacy skill levels, and in wage levels. Birth year fixed effects control for any differences between cohorts that are similar across countries. While these fixed effects eliminate unemployment fluctuations common to all countries in the sample, they also flexibly control for any time trends in our outcomes, such as the secular increase in college attainment, and for skill depreciation over the life cycle. We thus effectively compare individuals of the same age and within the same country who faced different economic conditions when graduating from high school. To account for the fact that unemployment rates are serially correlated, we also control for the economic conditions in the years prior to and following high-school graduation.

We find that bad economic conditions at high-school graduation positively affect college investments. An increase in the unemployment rate by 1 percentage point (pp) increases college enrollment by approx. 0.8 pp, an increase by 1.6 percent from the international mean. Another way to illustrate the magnitude of this effect is to use the difference between the lowest and highest unemployment rate in a country during our observation period; this amounts to on average of 6 pp across our sample countries. Such an increase in the unemployment rate would raise college enrollment by 4.6 pp (9 percent). Economic fluctuations at high-school graduation have a very similar impact on successfully completing college, whereas college dropout is unaffected.

We also find *positive* effects of *bad* economic conditions at high-school graduation on outcomes in later life: A 1 pp increase in unemployment at high-school graduation raises both literacy and numeracy skills by approx. 1 percent of a standard deviation and increases monthly wages by almost 1 percent. Furthermore, individuals who graduate from high school during worse economic conditions continue to invest more in human capital following formal education. More precisely, an increase in the unemployment rate by 1 pp increases the probability of participating in further training activities by 0.4 pp (0.7 percent).

Heterogeneity analyses suggest that the positive effects of recessions at high-school graduation on college investment are greater for individuals with higher socio-economic background, as proxied by parental education. One potential explanation is that the negative income effect during recessions is potentially more pronounced for families of lower socio-economic status (SES), limiting their ability to pay for college.[2] Our finding is consistent with existing evidence from the United States that college enrollment of low-income households is less countercyclical than that of high-income households (e.g., Christian 2007; Méndez and Sepúlveda 2012). This implies that recessions at high-school graduation increase educational inequality.

[2]Part-time jobs that help to finance college are also scarcer during bad economic times, further aggravating the negative income effect for individuals from lower-SES families (Kane 1994; Dellas and Koubi 2003).

Moreover, we find that the positive effect of bad economic conditions at the end of high school on cognitive skills, wages, and training participation is more than twice as large for women as for men. Women are also more likely to work full-time when exposed to bad economic conditions at high-school graduation, whereas men's labor supply is unaffected. This may explain why business cycle effects on cognitive skills and labor-market outcomes are far more pronounced for women compared to men. The stronger business cycle effects for women imply that the gender gaps narrow for these important outcomes: An increase in the unemployment rate at high-school graduation by 6 pp (i.e., the average difference between lowest and highest unemployment rate in a country) decreases the gap in numeracy skills by 16 percent, in full-time employment by 14 percent, and in monthly wages by 12 percent.

While it seems likely that the positive, reduced-form effects on cognitive skill formation and labor-market outcomes are driven by increased college education, there may also be other mechanisms at work, such as increased investments in learning (independent from college attendance) or changes in occupational choice (e.g., in favor of jobs with a work environment more conducive to skill improvement). To provide suggestive evidence that recession-induced college investment is a relevant mechanism explaining the impact on skill formation and labor-market outcomes, we apply an instrumental-variable model that instruments college enrollment with the unemployment rate at high-school graduation. This model relies on the (arguably strong) assumption that, conditional on the covariates, economic conditions at high-school graduation are orthogonal to any factors influencing cognitive skills and labor-market outcomes besides college enrollment. The instrumental-variable results suggest that college education induced by bad economic conditions at high-school graduation has sizeable positive effects on cognitive skills, wages, and training participation. Effect sizes are greater than the corresponding OLS estimates, suggesting that compliers – i.e., those individuals who only attend college as a result of bad economic conditions at high-school graduation (marginal students) – have higher returns to college education than an average individual. This is in line with previous evidence on the returns to college (e.g., Card 1993).

Our paper is related to existing studies investigating the effects of economic conditions at various points during an individual's life, most importantly at high-school graduation. The countercyclical college enrollment pattern that we identify is in line with previous evidence. Betts and McFarland (1995) identify a countercyclical pattern of community college enrollment in the United States between the late 1960s and mid-1980s; Dellas and Koubi (2003) confirm this pattern for U.S. college enrollment in the same period. Clark (2011) and Sievertsen (2016) find that higher unemployment rates at high-school gradu-

ation increase enrollment in post-secondary education (college and other post-secondary programs) in England and Denmark, respectively.[3]

These studies, like ours, estimate reduced-form effects of economic conditions on college enrollment by comparing individuals who graduated from high school in good versus bad economic times. A positive effect of bad economic conditions on college enrollment suggests that a nontrivial fraction of high-school graduates consists of academically marginal students. Since these students are likely to be of lower ability and/or have lower educational aspirations than individuals who attend college independent of economic conditions (i.e., infra-marginal students), college enrollment does not necessarily imply that marginal students will successfully complete college or benefit on the labor market as a result. Our paper fills this gap in the literature by investigating the impact of economic conditions at high-school graduation on college completion as well as on the subsequent formation of cognitive skills and labor-market outcomes.[4]

Our finding that bad economic conditions at high-school graduation positively affect long-term labor-market success complements previous studies examining the business cycle effects at college graduation (Kahn 2010; Oreopoulos, von Wachter and Heisz 2012; Altonji, Arcidiacono and Maurel 2016; Liu, Salvanes and Sørensen 2016; Schwandt and von Wachter 2019). These studies consistently find substantial negative wage effects of graduating from college during a recession, which can persist for several decades. The important difference between these studies and our study is the period under investigation. While individuals may find it difficult to avoid entering a recessionary labor market at the end of college (e.g., by enrolling in graduate school; see Bedard and Herman 2008; Johnson 2013), individuals finishing high school can more easily do so by enrolling in college. Our findings indicate that bad economic conditions can also have *positive* long-term labor-market effects if they occur at another point during an individual's lifetime.

As is apparent from the references above, the vast majority of studies on business cycle effects focuses on the United States. However, it is unclear whether evidence from the United States can be applied generally. According to OECD estimates, among all OECD countries the earnings benefits of attaining tertiary education are largest in the United States. At the same time, direct costs of tertiary education (e.g., tuition fees) are by far highest in the United States (OECD 2014).[5] Furthermore, the United States are characterized by low union density and weak employment protection (Hanushek et al.

[3]Méndez and Sepúlveda (2012); Johnson (2013); Alessandrini, Kosempel and Stengos (2015); Barr and Turner (2015), and Long (2015) investigate the effects of *contemporaneous* economic conditions on higher education decisions in the United States. Using data on 28 European countries, Ayllon and Nollenberger (2016) assess whether high unemployment rates during the Great Recession increased college enrollment and led to transitions from the labor market back to education. Adamopoulou and Tanzi (2017) study the impact of the Great Recession on college dropout in Italy.

[4]Rao (2016) studies how economic conditions at birth affect both educational decisions and labor-market outcomes in the United States.

[5]On average across OECD countries, gross earnings benefits of attaining tertiary education (compared to attaining upper secondary or post-secondary non-tertiary education) is USD 347,000 for men and USD 249,000 for women; in the United States, the monetary return to tertiary education is USD 629,000 and USD 416,000, respectively. However, an individual pursuing higher education in the United States has direct costs of approx. USD 61,000, almost six times as much as the OECD average of USD 11,000. In fact, direct costs of higher education are more than 60 percent higher in the United States than in Japan, the country with the second-highest costs among OECD countries (OECD 2014).

2015), hence individuals have little protection against job losses during recessions. These three features – substantial returns to college education, the highest college costs among developed countries, and limited employment protection – potentially affect how economic conditions influence individuals' college investment decisions. Therefore, one may expect that business cycle effects in the United States are different to other developed countries. Interestingly, while our results are based on 28 countries with substantial variation in education systems and labor-market institutions,[6] we find similar effect sizes to studies focusing exclusively on the United States. Thus, although the United States is exceptional in terms of both the college system and labor-market institutions, college investments exhibit similar levels of fluctuations over the business cycle to those observed on average internationally.

Finally, there is substantial evidence that subjective expectations are shaped by economic events experienced by individuals during their lifetime.[7] In particular, economic decisions seem to be affected not only by current economic conditions, but also by conditions experienced earlier in life (Malmendier and Nagel 2011; Rao 2016). Despite this evidence, studies investigating the effect of economic conditions on college enrollment almost exclusively focus on the conditions in the high-school graduation year. This leaves open the question whether high-school graduates decide to enroll in college based on current economic conditions, or whether their decisions were also affected by previous conditions (which may be correlated with the current situation). We find that college investment decisions – as well as outcomes in later life – are only affected by the economic conditions at high-school graduation, rather than by the conditions in earlier or later years. Knowledge of the time at which economic conditions are most relevant for college enrollment decisions is important for policy-makers when designing policies to increase the transition rates from secondary to tertiary education. In particular, our results suggest that one way for policy-makers to increase college attendance is to target students at the end of high school, especially during economic booms.

The paper proceeds as follows. Section 2 describes the international PIAAC data and the business cycle information we exploit. Section 3 presents the empirical strategy. Section 4 provides the main results, heterogeneity analyses, robustness checks, and the instrumental variable results. Section 5 concludes.

[6]For instance, direct costs of education across our sample countries vary between USD 690 (Greece) and USD 61,135 (United States) (OECD 2014). According to recent OECD statistics, trade union density (i.e., the share of wage and salary earners who are trade union members) varies between 7 percent in Estonia and 67 percent in Denmark, Finland, and Sweden.

[7]For instance, personal experiences of economic conditions affect individuals' willingness to take financial risks (Malmendier and Nagel 2011; Malmendier, Tate and Yan 2011; Aizenman and Noy 2015), consumption behavior (Malmendier and Steiny 2017; Malmendier and Shen 2018), employment decisions (de Mello, Waisman and Zilberman 2014), as well as preferences for redistribution and political parties (Giuliano and Spilimbergo 2014; Roth and Wohlfahrt 2018).

2 Data

2.1 PIAAC Data

We use cross-sectional data from the Programme for the International Assessment of Adult Competencies (PIAAC), administered by the Organisation for Economic Co-operation and Development (OECD, 2016). PIAAC has been designed to provide internationally comparable measures of literacy and numeracy skills for adults aged 16 to 65 years.[8] In each of the participating countries, a representative sample of at least 5,000 adults participated in the PIAAC assessment.[9] An extensive background questionnaire contains detailed information on respondents' demographic characteristics, education, and labor-market outcomes.

Our empirical analysis is based on 28 countries, all of which are OECD members. From the 33 PIAAC countries, we exclude Indonesia and the Russian Federation because the samples are not representative of the target population (in the Russian Federation, the population of the (large) Moscow municipal area is not included; in Indonesia, only adults from Jakarta participated). Furthermore, we exclude Cyprus, Lithuania, and Singapore given that national unemployment rates are missing for a substantial fraction of our analysis period.

To assess the impact of economic conditions at high-school graduation on college decisions, we consider three distinct outcomes: Attending college, obtaining a college degree, and dropping out of college. The binary indicator *college degree* equals 1 if a respondent's highest level of formal education is ISCED level 5 or 6; 0 otherwise. The binary indicator *college dropout* equals 1 if the respondent has started, but not completed tertiary education; 0 otherwise.[10] The binary indicator *college enrollment* equals 1 if the respondent is currently enrolled in college, holds a college degree, or has dropped out of college; 0 otherwise.[11]

In addition to investigating business cycle effects on college investment and cognitive skills, we also consider several labor-market outcomes. Our primary outcome is the logarithm of gross monthly wages (incl. bonuses) for wage and salary workers, and for self-employed.[12] As wage information is only available for individuals active on the labor

[8] PIAAC also assessed ICT skills in the domain "*problem solving in technology-rich environments*." However, several countries (Cyprus, France, Indonesia, Italy, and Spain) did not assess ICT skills. Furthermore, in the countries that tested ICT skills, not all respondents took part in the assessment, raising concerns about sample selectivity. Reasons for not participating in the test were a lack of any computer experience, failing a short initial ICT test, and opting out of the ICT skills assessment (see Falck, Heimisch and Wiederhold 2016 for details). Therefore, we focus on the two main skill domains, literacy and numeracy, which were assessed in all participating countries and among all respondents. See OECD (2013) for a detailed description of the tested skill domains.

[9] 24 countries participated in the first round of PIAAC in 2011/12 and 9 countries participated in the second round in 2014/15.

[10] Note that this information is not available for individuals who were enrolled in formal education at the time of the PIAAC interview. Furthermore, the United States does not provide any information about uncompleted educational qualifications in the PIAAC Public Use File; therefore, the United States is excluded from the college dropout analyses.

[11] In the United States, *college enrollment* indicates either being currently enrolled in college or holding a college degree since we cannot identify individuals who dropped out of college in the past (see previous footnote).

[12] The PIAAC Public Use File reports monthly wages for Austria, Canada, Germany, Sweden, and the United States only in the form of worker's decile rank in the country-specific wage distribution. For Germany, we obtained the Scientific Use File, which contains continuous wage information. For the remaining countries, we follow Hanushek et al. (2015) in

market, the composition of the wage sample may vary depending on economic conditions. However, Appendix Figure A1 shows that the unemployment rate five years before up to six years following high-school graduation is unrelated to the availability of wage information; this suggests no issue of sample selectivity with respect to economic conditions. Finally, we measure investments in human capital following formal schooling with a binary indicator that equals 1 if the respondent has participated in training activities during the 12 months prior to the survey; 0 otherwise. Training activities include on-the-job training, seminars/workshops, private lessons, as well as open/distance education.

2.2 Business Cycle Information

Following the literature on business cycle effects (e.g., Genda, Kondo and Ohta 2010; Kahn 2010; Kondo 2012; Maclean 2014; Oreopoulos, von Wachter and Heisz 2012), we measure economic conditions using national unemployment rates. Unemployment data come from the OECD's Annual Business Cycle Indicators. As explained in detail below, our focus is on the unemployment rate at high-school graduation, but we also consider the unemployment rates several years before and after an individual's graduation. In order to do so, we assign annual country-specific unemployment rates to respondents according to their year of birth.

Figure A2 portrays the development of the national unemployment rates for all 28 sample countries from 1990 until 2009.[13] First, we observe that mean unemployment rates differ substantially across countries, from 5.3 percent in Japan to 24.2 percent in Spain. Second, and more importantly for our identification, business cycles across countries are only partially synchronized. The correlation of annual unemployment rates over the period 1990–2009 between any country pair ranges from -0.85 (Japan–Netherlands) to 0.96 (Australia–Canada). Furthermore, the unemployment rate volatility differs strongly across countries, with the difference between minimum and maximum unemployment rate during our sample period varying from 2.2 pp in Austria to 13.6 pp in Estonia. With the inclusion of year-of-birth fixed effects, we identify the impact of economic conditions at high-school graduation by using differential unemployment rate fluctuations between countries after netting out annual unemployment changes common to all countries.

assigning the decile median of monthly wages to each survey participant belonging to the respective decile of the country-specific wage distribution. Using wages in coarse categories in some countries is unlikely to affect our results as Hanushek et al. (2015) show that using decile medians instead of continuous wages has no substantive impact on their returns-to-skills estimates. Moreover, in each country, we trim the bottom and top 1 percent of the wage distribution to limit the influence of outliers. In auxiliary analysis, we also use gross hourly wages, for which we make an analogous adjustment for missing continuous wage information. Turkey reports monthly wages only in deciles, but we were not able to retrieve decile means for the Turkish wage distribution. We thus exclude Turkey from all wage analyses. Additionally, wage information is missing for some respondents who report to be employed (7.5 percent).

[13] This period covers the high-school graduation years of the individuals in our sample; see also description of sample restrictions in Section 2.4.

2.3 Hypothetical Age of College Decision-Making

An important aspect when estimating the effect of economic conditions on college investments is the timing of the decision whether to enroll in college or to enter the labor market. We hypothesize, and provide evidence, that college-enrollment decisions are usually taken in the period at high-school graduation. However, PIAAC does not provide information about the actual year, or age, when respondents finished high school.[14] We thus calculate the *hypothetical* age at high-school graduation, defined as the official school enrollment age in a country, plus the number of years required to complete upper secondary education in that country, as reported by official statistics. We use the number of years to complete ISCED 3, which is the final stage of secondary education in most OECD countries.[15]

The advantage of using the *hypothetical* age at high-school graduation lies in the fact that it is exogenous to economic conditions. In contrast, individuals' *actual* graduation age may be affected by the labor-market conditions at the end of high school (see, e.g., Kahn 2010; Rao 2016). In particular, students wanting to directly enter the labor market without attending college may postpone their high-school graduation when economic conditions are unfavorable. Similarly, students may try to expedite high-school graduation (or even leave high school without a degree) during good economic times.

The hypothetical age at high-school graduation according to our definition varies between 18 and 19 years across countries in our sample. OECD data on actual enrollment by age are consistent with these hypothetical high-school graduation ages (Figure 1). The share of students attending high school in the year prior to our hypothetical high-school graduation age is normalized to 100 in each country (point -1 on the horizontal axis). Panel A demonstrates that approx. 70 percent of those students have completed (or left) high school when they reached the hypothetical high-school graduation age. During the few years afterwards, the share of students finishing/leaving high school increases substantially: Two years after the hypothetical graduation age, the average high-school enrollment rate is merely 3.4 percent. Notably, each country in our sample exhibits this pattern, although there is some variation in the exact share of enrollment in the years around the hypothetical high-school graduation age (Panel B).

Importantly, a drop in high-school enrollment from 100 percent to 0 percent at precisely the hypothetical high-school graduation age, cannot be expected for various reasons. First, some students do not start primary school at the official school entrance age, but instead enroll one year later. Second, (repeated) grade retention increases high-school

[14] Respondents report only the year of finishing the highest education level, which is typically vocational training or college education.

[15] Our primary source for this information is OECD (1999), which allows the mapping of national education levels to ISCED levels. Additional information on the mapping come from the UNSECO Institute for Statistics, see http://uis.unesco.org/en/isced-mappings.

graduation age, with the likelihood of grade retention varying across countries.[16] On the other hand, students may also skip a grade and graduate from school earlier (which occurs much less frequently than grade retention). Our derived *hypothetical* high-school graduation age can therefore be regarded as a lower bound of the *actual* age at high-school graduation.[17]

Some countries draft citizens for compulsory military service, which typically takes place immediately after high-school graduation. Therefore, the age when individuals decide whether to enter college varies across countries not only because of differences in the high-school graduation age, but also because of differences in the existence and length of compulsory military service. In all countries with compulsory military service (with the exception of Israel), conscription is limited to men, which introduces variation in the timing of the decision whether to go to college within countries across gender. Figure 2 shows the hypothetical (gender-specific) age of college decision-making that we use in the empirical analysis. This hypothetical age is computed as the hypothetical age at high-school graduation (which varies across countries) plus the length of compulsory military service (which varies across countries and gender).[18] Australia, Canada, Ireland, Japan, New Zealand, the United Kingdom, and the United States did not have compulsory military service during our period of interest. In some countries, only some (male) cohorts were obliged to complete compulsory military service since compulsory conscription was abolished in the Netherlands (in 1991), Belgium (1992), the Czech Republic (1992), France (1996), Spain (2001), Slovenia (2003), and Italy (2004).[19] Consequently, in these countries, the hypothetical age of college decision-making differs for males across cohorts. Compulsory military service has been limited to approximately one year in most countries. The only countries with more than one year of compulsory military service are Israel, Norway, and South Korea.[20] Taking all factors into account, implies that the hypothetical age of college decision-making varies between 18 and 21 years.

Our explanatory variable of interest, the economic conditions at college decision-making, is constructed as follows: Each individual is assigned the national annual unemployment rate of the year in which they reached the hypothetical age of college decision-

[16] According to the PISA 2009 student questionnaire, repeating grades is rare in Finland, the Slovak Republic, Slovenia, Sweden, and the United Kingdom. In contrast, in Germany, Chile, and the Netherlands more than 20 percent of students repeat at least one grade in primary or secondary school. In Belgium, almost 35 percent of students repeat a grade at least once during their school career (Ikeda and García, 2014).

[17] PIAAC contains information on the actual age at high-school graduation only for the subgroup of respondents whose *highest* education level is upper secondary education (48 percent of our sample). Since it is likely that this group is negatively selected with respect to ability, we refrain from using this information as a proxy for the (average) actual high-school graduation age in a country. Still, both mean and median age at high-school completion in this subgroup are consistent with our hypothetical high-school graduation age in each country.

[18] Information on national compulsory military services comes from the CIA factbook (https://www.cia.gov/library/publications/the-world-factbook/fields/333.html) as well as from various national data sources.

[19] Therefore, means of the hypothetical age of college decision-making in Figure 2 are float numbers, rather than integers, in these countries.

[20] For each cohort in a country, we round the length of military service, expressed in years, to the closest integer value (that is, one or two years). Furthermore, in some countries compulsory military service depends on religion, educational attainment, or other factors that we cannot account for. We are also unable to consider the fact that some individuals were exempt from compulsory military service due to health issues.

making (shown in Figure 2).[21] Three of the 28 countries in our sample (Canada, New Zealand, and the United States) do no report the exact age of respondents, but rather only provide the age information in five-year intervals.[22] These individuals are assigned the average annual unemployment rate across the five years that correspond to the respective five-year age interval. This introduces some measurement error in the economic conditions at high-school graduation. However, we show that our results are robust to simultaneously excluding the three countries without exact age information (Section 4.5).

2.4 Sample

We limit our sample to individuals aged 25 to 39 years. We apply the minimum age restriction since most individuals (87 percent) have completed their education by age 25, allowing us to observe individuals on the labor market. We implement the maximum age restriction in order to retain as many countries in our sample as possible. The former communist countries – the Czech Republic, Estonia, Poland, the Slovak Republic, and Slovenia – did not report reliable unemployment rates before the fall of the Iron Curtain in 1989. Thus, we would lose observations for these countries due to missing information about economic conditions around the time of high-school graduation. Furthermore, education decisions in communist countries were presumably less free than those in market economies, and instead depending more on political attitudes and personal connections than on market incentives (see, e.g., Hanushek, Piopiunik and Wiederhold 2019). Another reason for including only individuals below age 40 in the baseline sample is to have a closer link between potential college attendance and subsequent cognitive skills and labor-market outcomes.[23]

Furthermore, we exclude individuals who obtained their highest educational degree in a different country (excluding less than two percent of individuals).[24] Finally, since we want to investigate whether economic conditions at high-school graduation are more (or less) relevant for college decisions than the conditions in previous or later years, our sample is restricted such that unemployment rates five years prior until six years after the hypothetical age of college decision-making can be assigned to all individuals (see

[21] PIAAC contains the age of the respondent, but not the year of birth. We calculate year of birth by subtracting the age of the respondent at the time of the survey from the year in which the survey has been conducted. This creates some measurement error since neither the exact date of the interview nor the exact date of birth are reported. Since this measurement error is supposed to be classical in nature, our estimates of business cycle effects are likely to be attenuated.

[22] Similarly, the Austrian PIAAC Public Use File does not contain the exact age of respondents. However, we have obtained access to the Austrian Scientific Use File from the national data center, which provides the exact age.

[23] In Appendix Table A1, we show that results are qualitatively similar when also including older individuals up to age 59. As expected – because of the larger time lag between high-school graduation and time of observation in PIAAC – business cycle effects are somewhat weaker.

[24] Due to this sample restriction, we also exclude individuals who were exposed to the economic conditions in the PIAAC test country, but obtained a college degree abroad. While we would prefer to keep these individuals in the sample, it is not possible to identify them since PIAAC reports only the country in which the highest educational degree has been obtained.

Section 3 for details).[25] The final estimation sample includes 51,241 individuals from 28 countries.

Table A2 reports the means of all outcome variables and the unemployment rate at the hypothetical year of college decision-making, separately by country and for the pooled sample (last row).[26] On average, 51 percent of individuals are either currently enrolled in college (at the time of the PIAAC interview), or have previously attended college. While the share of college attendees exceeds two-thirds in Canada and South Korea, it is only one-quarter in Turkey. Overall, 42 percent of individuals have obtained a college degree, with similar cross-country differences as regards college enrollment. College dropout also differs considerably across countries: In Chile and Italy, more than 25 percent of individuals who ever attended a college eventually dropped out; in contrast, dropout rates are lower than ten percent in Japan, Korea, and Greece. This pattern is consistent with official statistics, which reveal that Japan has the lowest share, and Italy the highest share of students who enter a tertiary program but leave before completing a degree (see OECD 2008, Chart A4.1).

Table A2 also reports average literacy and numeracy skills, which are measured on a 500-point scale.[27] Individuals in Japan perform best in literacy (309 PIAAC points) and rank second in numeracy, with only slightly lower average numeracy scores than Finland (301). Average skills are lowest in Turkey for literacy (232) and in Chile for numeracy (220). The average unemployment rate in the hypothetical year of college decision-making ranges from 3.6 percent in South Korea to 17.7 percent in the Slovak Republic (last column), illustrating the wide variation in economic conditions across the countries in our sample.

Table A3 reports the means of all control variables. 50 percent of individuals are female and 13 percent are first-generation migrants, hence individuals born in a country other than the PIAAC test country. The mean age in post-communist countries is slightly lower than in other countries due to absentunemployment information at the beginning of the 1990s (which leads to the exclusion of the oldest birth cohorts). We condition on family background characteristics determined before individuals reached the hypothetical age at high-school graduation. These include the education level of both parents, as well as the number of books at home (at age 15), a common proxy for socio-economic background. Parents' highest level of education is measured in three categories: Low (ISCED 1, 2, and 3C), which means lower secondary education is the highest education level; intermediate

[25] This restriction excludes slightly less than 7 percent of individuals from our sample because unemployment rates are not available in Slovenia before 1996, in the Slovak Republic before 1994, in the Czech Republic and Poland before 1990, and in Estonia before 1989.

[26] The sample size for Canada is substantially larger than for any other country because Canada oversampled to obtain regionally representative adult skills. We use the sampling weights provided by PIAAC and adjust them for the national sample sizes to account for sample size differences across countries (see Section 3 for more information on weights).

[27] In the econometric analysis, we standardize skills to have mean 0 and standard deviation 1 within each country. To illustrate, an increase in literacy/numeracy skills by one standard deviation corresponds to an improvement by one (out of five) proficiency levels. One standard deviation is also roughly twice the skill gap between individuals with lower secondary education and individuals with upper secondary education (see also Hanushek et al. 2017). Results are similar when we standardize skills across the entire international sample.

(ISCED 3 and 4), which corresponds to upper secondary and post-secondary non-tertiary education; and high (ISCED 5 and 6), which includes all types of college degrees. The number of books at home at age 15 is reported in six categories, ranging from "10 books or less" to "more than 500 books".[28]

3 Empirical Strategy

Using the cross-sectional PIAAC data, we investigate the impact of economic conditions at high-school graduation on college investment decisions and outcomes in later life. We start our empirical analysis by estimating the following regression:

$$Y_{ict} = \beta_0 + \beta_1 UER_{ct} + \boldsymbol{X_{ict}}\boldsymbol{\beta_2} + \mu_c + \delta_{birthyear} + \varepsilon_{ict}, \tag{1}$$

where Y_{ict} denotes the outcome of individual i in country c who hypothetically makes her/his college decision in year t. The outcomes of interest, Y_{ict}, are binary indicators for whether an individual has (i) ever been enrolled in college, (ii) obtained a college degree, and (iii) dropped out of college; literacy and numeracy skills; and the labor-market outcomes log monthly wages and participation in training activities.[29] Our coefficient of interest, β_1, measures the effect of the national unemployment rate at the hypothetical college decision-making age t on these outcomes.

$\boldsymbol{X_{ict}}$ is a vector of individual-level covariates, including gender and migrant status, as well as variables reflecting individuals' socio-economic background (i.e., the education level of both parents and number of books at home when the individual was 15 years old). All specifications include country fixed effects, μ_c, and year-of-birth fixed effects, $\delta_{birthyear}$.[30] The error term, ε_{ict}, is clustered at the country $\times$ year-of-birth level, that is, the level at which the treatment variable varies. We employ the sample weights provided in PIAAC, adjusted such that each country $\times$ year-of-birth cell receives the same weight.[31]

The coefficient β_1 is identified based on differential changes in unemployment rates across birth years and countries. We isolate this variation by including fixed effects for countries and birth years. Country fixed effects control for any time-invariant differences across countries (e.g., quality of education systems, labor-market institutions, or government policies). For example, they absorb cross-country differences in college attendance or completion rates, cognitive skills, and wage levels. These fixed effects also account for

[28] As is common in large-scale surveys such as PIAAC, a small share of respondents with available information on outcome variables has missing values for some background characteristics. Since we consider various control variables and given that a portion of these variables is missing for some individuals, excluding all observations with any missing value would result in a sizeable sample reduction. We therefore imputed values for missing control variables (migrant status, education of both parents, and number of books at home) by using the country means of each variable. To ensure that the imputed data are not driving our results, all regressions include an indicator for each variable with missing data that equals 1 for imputed values and 0 otherwise.

[29] In additional specifications, we also consider labor supply (i.e., full-time employment and hours worked).

[30] Note that year of birth is not perfectly collinear with the decision year t because t varies by gender in some countries (see Section 2).

[31] In the countries without exact age information (Canada, New Zealand, and the United States), we use five-year age groups and thus each five-year cohort receives five times the weight of a single-year cohort.

the persistent component of economic conditions within a country. Year-of-birth fixed effects account for shocks and characteristics across countries that are common to all individuals who are born in the same year. Including these fixed effects controls very flexibly for general time trends across cohorts in our outcomes, such as a secular increase in educational attainment or rising wage levels (e.g., due to inflation), and for skill depreciation over the lifecycle. They also eliminate any business cycle fluctuations similar across countries.

Interpreting β_1 in Equation (1) as a causal effect is based on the assumption that the unemployment rate at the hypothetical age of college decision-making age is not correlated with other factors affecting our outcomes. Since unemployment rates are correlated across years (Figure A2), we may in particular be worried that β_1 might pick up the effects of economic conditions in years before or after high-school graduation. For instance, Rao (2016) shows that human capital investment decisions are shaped by economic events experienced by people early in life, suggesting that β_1 may reflect the influence of economic conditions (long) before high-school graduation. Moreover, the estimated β_1 may in principle capture the impact of economic conditions *after* high-school graduation. First, people who entered the labor market directly after high school may lose their jobs during a period of recession and re-enter formal education as a response (see, e.g., Barr and Turner 2015; Ayllon and Nollenberger 2016). Second, concerning our cognitive skills and labor-market outcomes, there is ample evidence that economic conditions at college graduation affect subsequent wages and other labor-market outcomes (e.g., Kahn 2010; Oreopoulos, von Wachter and Heisz 2012; Altonji, Kahn and Speer 2016; Liu, Salvanes and Sørensen 2016; Schwandt and von Wachter 2019). To account for the persistence of economic conditions, we also estimate models that augment Equation (1) by including the unemployment rates in several periods before and after the hypothetical age of college decision-making.[32]

In our preferred specification, we apply average unemployment rates across several years around the hypothetical age of college decision-making (more precisely, from *t-1* until *t+2*). One reason to extend the time period of potentially relevant economic conditions beyond the single hypothetical year of college decision-making is that PIAAC does not report the exact year when individuals completed high school. The actual graduation age may differ from the hypothetical age if students enrolled in primary school earlier or later than the official school starting age or if they repeated or skipped a grade. Furthermore, in countries with compulsory military service, not all males (females and males in Israel) actually serve in the military. There is also variation in the length of service with respect to religion and health, which we are unable to observe. Additionally, according

[32]Note that reverse causality is unlikely to threaten our identification strategy because college investment decisions of individuals at high-school graduation age – potentially affecting future economic conditions by altering the stock of human capital and distribution of skills of the workforce (see, e.g., Romer 1990; Hanushek et al. 2015) – do not influence the unemployment rate facing present-day high-school graduates.

to the National Postsecondary Student Aid Study, more than one-third of undergraduate students in the United States (in 1992–93 and in 2011–12) have waited one year or more following high-school graduation before enrolling in college. The observed time gap prior to college enrollment may also be caused by sickness, marriage, or pregnancy (Bozick and DeLuca, 2005). Lin (2019) further highlights that many U.S. universities increasingly promote a so-called "gap year". Most of these reasons would imply that making an actual decision on whether to go to college takes place *later* than the hypothetical age suggests. Therefore, our preferred specification uses the average unemployment rate over four successive years, covering the period from one year before the hypothetical age of college decision-making up to two years afterwards, in order to measure the labor-market conditions which have the greatest potential impact on individuals' higher education decisions. Similarly, we use four-year averages to depict the economic conditions before or after the hypothetical age of college decision-making. Hence, our preferred specification reads as follows:

$$\begin{aligned} Y_{ict} = \alpha_0 + \alpha_1 UER_{c,before} + \alpha_2 UER_{c,around} + \alpha_3 UER_{c,after} \\ + \boldsymbol{X_{ict}}\boldsymbol{\alpha_4} + \mu_c + \delta_{birthyear} + \epsilon_{ict}, \end{aligned} \tag{2}$$

where $UER_{c,before}$, $UER_{c,around}$, and $UER_{c,after}$ represent, respectively, the average national unemployment rates from five to two years prior to the hypothetical age of college decision-making, from one year prior to two years after the hypothetical age of college decision-making, and from three years to six years after the hypothetical age of college decision-making.[33] The coefficient of interest, α_2, reflects the impact of the business cycle at the (presumably) most sensitive period of college decision-making (between *t-1* until *t+2*). For simplicity and better comprehension, we will refer to the average unemployment rate in this period as the unemployment rate "around high-school graduation".

4 Results

This section presents the results of the impact of economic conditions at high-school graduation on college investment decisions (Section 4.1), cognitive skill formation (Section 4.2), and labor-market success (Section 4.3). Section 4.4 explores the heterogeneity of these effects by gender and socio-economic background. Section 4.5 reports robustness analyses. Finally, Section 4.6 presents instrumental-variable estimations of the contribution that college education has on the formation of cognitive skills and labor-market success, using economic conditions around high-school graduation as an instrument.

[33] In a robustness analysis, we control for yearly unemployment rates up to ten years prior to the official high-school graduation age (Section 4.5). To avoid losing birth cohorts, the main specification considers only the average unemployment rate across the four years preceding the period around high-school graduation.

4.1 The Impact of Economic Conditions on College Investment

First, we investigate the effect of labor-market conditions around high-school graduation on investments in college education. Figure 3 shows business cycle effects on college enrollment, college degree, and college dropout. In the left-hand graphs, t denotes the year of hypothetical college decision-making and each dot represents a coefficient from a separate regression of the respective outcome on the unemployment rate in the period indicated on the horizontal axis. All regressions include the full set of covariates.[34] Panel A shows that the impact of the unemployment rate on college enrollment is positive and strongest in the hypothetical year of college decision-making, t. An increase in the unemployment rate of 10 pp is associated with a 6.4 pp higher enrollment probability. Relative to the mean college enrollment rate in our sample (51 percent), this corresponds to a 12.5 percent higher enrollment probability.

While the effect of the unemployment rate in year t is strongest, unemployment rates in previous and subsequent years also seem to affect college investment decisions. As discussed in detail in Section 3, this is likely to reflect the serial correlation of unemployment rates as well as individuals actually deciding about college enrollment before or after the hypothetical college decision-making year t. The right-hand graphs in Figure 3 show results using the unemployment rates averaged over four years around the hypothetical college decision year ("around HS graduation"), the pre-period ("before HS graduation"), and the post-period ("after HS graduation") (see Equation 2). All three unemployment rates are included simultaneously to rule out erroneously attributing effects of economic conditions in earlier or later periods to those of the period around high-school graduation.[35] Panel A shows that the unemployment rate around high-school graduation has a significantly positive impact on college enrollment, while the economic conditions in the pre-period or post-period do not appear to influence college enrollment. The coefficient on the unemployment rate around high-school graduation differs statistically significantly (at the 1 percent level) from the coefficients on the unemployment rates in the pre-period and post-period. This indicates that economic conditions around high-school graduation are most relevant for college investment decisions.

Table 1 shows our baseline regression results. In Columns 1–3, average unemployment rates in each of the periods enter separately. In Column 4, the three average unemployment rates are included simultaneously, corresponding to the right-hand graphs in Figure 3. In Panel A, a 10 pp increase in the average unemployment rate around high-school graduation leads to a 7.7 pp (or 15.1 percent) increase in college enrollment. Another way to interpret effect magnitudes is to use the maximum spread in unemployment rates within a country. In other words, the difference between the lowest and highest annual

[34] Table A4 reports the corresponding regression results.

[35] Due to serious multicollinearity of unemployment rates within countries over time, we refrain from estimating the effect of the single-year unemployment rates between (t-5) to (t+6) in the same regression. See also Dellas and Sakellaris (2003).

unemployment rate during our sample period. An increase in unemployment similar to the international mean in the country-specific unemployment spread, that is, 6 pp, would raise college enrollment by 4.6 pp (or 9 percent).

Our estimates are of a similar order of magnitude to those found in U.S. studies: Méndez and Sepúlveda (2012) find that a 1 pp increase in the unemployment rate is associated with an increase between 0.6 and 0.9 pp in the likelihood of being in formal education, Dellas and Koubi (2003) document a 0.8 pp increase in college enrollment and Betts and McFarland (1995) estimate a rise of 0.5 pp in full-time college attendance. Our effect size is even larger than the effect across 28 European countries estimated by Ayllon and Nollenberger (2016), who find an increase in the probability of being enrolled in education between 0.28 and 0.42 pp.

While we observe that more students enroll in college when labor-market conditions are bad at the end of high school, this does not necessarily imply that these academically marginal students also successfully finish college. For example, if academic requirements in college are too high, academically marginal students may eventually drop out without obtaining a degree. Furthermore, marginal students may react more strongly to changing economic conditions while studying, dropping out of college to enter the labor market as soon as employment opportunities improve. However, we find very similar business cycle effects on college completion to those on college enrollment (see Panel B of Figure 3). In fact, the estimated coefficient in the baseline specification in Column 4 of Table 1 (Panel B) indicates that a 10 pp increase in the average unemployment rate around high-school graduation leads to a 7.7 pp increase in college completion, which translates to an 18.3 percent increase from the international mean (42 percent).

Analogous to these findings, a higher unemployment rate around high-school graduation does not affect the probability of dropping out of college (Panel C of Figure 3 and of Table 1, respectively). One interpretation of the zero effect on college dropout is that the probability of successfully completing college does not significantly differ between academically marginal students and infra-marginal students. However, it could also be that the larger inflow of marginal students due to bad economic conditions at high-school graduation increases college dropout, which is compensated by a lower dropout rate of infra-marginal students. A lower dropout rate among infra-marginal may materialize for at least two reasons. First, infra-marginal students who experience bad economic conditions immediately before college entry may increase their study effort to elevate their chances of successfully completing college, and thus decreasing future unemployment risk. Second, they may also choose different fields of study associated with a higher college completion probability. Unfortunately, we cannot disentangle these channels because we

do not observe student effort, and because PIAAC provides only very coarse measures of field of study.[36]

Overall, labor-market conditions at high-school graduation significantly affect subsequent human capital investment decisions. When graduating in bad economic times, high-school students are more likely to enroll in college and to obtain a college degree. By contrast, college dropout seems to be unaffected by the labor-market conditions at high-school graduation.[37]

4.2 The Impact of Economic Conditions on Cognitive Skills

Moving beyond the short-term effects on college investment decisions, we investigate whether economic conditions at high-school graduation also affect longer-term human capital formation, as measured by tested cognitive skills. Skills are assessed when our sample of individuals are between 25 and 39 years old, which for most individuals is several years after finishing college. Figure 4 presents the business cycle effects on literacy skills (Panel A) and numeracy skills (Panel B). We find that bad economic conditions around high-school graduation – but not in the pre-period or post-period – lead to significantly higher cognitive skills up to 20 years later.

Table 2 reports the regression results. As in Table 1, average unemployment rates before, around, and after high-school graduation are first included separately and then simultaneously (corresponding to the coefficients shown in the right-hand graphs in Figure 4). In our preferred specification in Column 4, an increase in the unemployment rate around high-school graduation of 10 pp raises literacy skills by 0.09 standard deviations (Panel A) and numeracy skills by 0.08 standard deviations (Panel B). Hence, economic conditions at high-school graduation not only affect immediate college investment decisions, but also have lasting impacts on the formation of cognitive skills.

4.3 The Impact of Economic Conditions on Labor-Market Outcomes

Almost 90 percent of the individuals in our sample of 25–39-year olds have already completed formal education. This allows us to assess the impact of economic conditions at high-school graduation on two important labor-market outcomes: Monthly wages and participation in training activities. In these analyses, current students are excluded because they have not yet entered the labor market. In the wage analysis, we additionally exclude all individuals who do not report a wage.

Panel A of Figure 5 (and the corresponding regression results in Panel A of Table 3) shows that individuals who faced worse economic conditions at the end of high school

[36] Due to the very coarse classification of field of study in PIAAC, we are unable to assess whether economic conditions at high-school graduation affect field-of-study choices. For business cycle effects on field of study, see Blom, Cadena and Keys (2015), Altonji, Arcidiacono and Maurel (2016), and Liu, Sun and Winters (2017).

[37] Since business cycle effects on college dropout are close to 0 and statistically insignificant, we do not present heterogeneity results or robustness checks for this outcome in Sections 4.4 and 4.5.

earn higher wages several years later. While unemployment rates before and after high-school graduation are unrelated to monthly earnings, a 10 pp higher unemployment rate around high-school graduation increases monthly wages by approx. 8 percent.[38]

In a further analysis, we separate the positive earnings effect into a labor-supply effect and a "productivity" effect (Table A5). An increase in the unemployment rate around high-school graduation by 10 pp increases the probability of working full-time (that is, at least 30 hours per week) by 4 pp (Panel A) and raises weekly working time by approx. 1.2 hours (Panel B).[39] Since hourly wages are a more reliable productivity measure for workers with strong labor-market attachment (Hanushek et al. 2015), we limit the estimation sample in the hourly wage analysis to full-time employees.[40] We do not find robust evidence that economic conditions at high-school graduation raise hourly wages (Panel C).[41] This suggests that bad economic conditions at high-school graduation mainly affect monthly wages due to an increase in labor supply, while there is no strong evidence that hourly wages (a measure of productivity) are also affected.

Economic conditions at high-school graduation also affect the likelihood of participating in training activities (see Panel B of Figure 5 for graphical evidence and Panel B of Table 3 for regression results). In our baseline specification in Column 4 of Table 3, a 10 pp increase in the unemployment rate around high-school graduation leads to a 3.7 pp increase in training participation. This effect size translates into a 7 percent increase from the international mean (52 percent). The probability of being engaged in training is unaffected by the economic conditions prior to or following high-school graduation. Our results suggest that bad economic conditions at high-school graduation not only influence human capital formation due to their (immediate) effect on college education, but also due to an increased propensity to participate in learning activities while individuals are active on the labor market.

One potential driver of the business cycle effects on labor-market outcomes is college education since college graduates earn more and are more likely to participate in training activities. We explore this possibility in Section 4.6.

4.4 Heterogeneity by Gender and Socio-Economic Background

The impact of economic conditions at high-school graduation on college investment decisions, skill formation, and labor-market outcomes may differ across socio-economic groups. We assess potential effect heterogeneity with respect to individuals' gender and

[38] The coefficient on the unemployment rate around high-school graduation is statistically significantly different from the pre-period and post-period coefficients at the 15 percent and 13 percent level, respectively.

[39] We do not find a significant impact of the unemployment rate around high-school graduation on being employed (either part-time or full-time) (results not shown).

[40] This analysis excludes self-employed individuals because they do not report hourly wages.

[41] Ignoring labor-market conditions before and after high-school graduation (Column 2 of Table A5, Panel C), a 10 pp increase in the unemployment rate increases hourly wages of full-time employed workers by 4.6 percent (statistically significant at the 10 percent level).

socio-economic background, proxied by parents' education level.[42] For each of our six main outcomes, we augment our baseline specification (Equation 2) by adding an interaction term of the unemployment rate around high-school graduation with the respective subsample indicator (female or high-SES background).[43]

Economic conditions around high-school graduation affect college investment decisions among men and women to a similar degree (Column 1 of Table 4, Panels A and B). If anything, women tend to react slightly stronger to adverse labor-market conditions at the end of high school, but the interaction term is not statistically significant at conventional levels. However, we find heterogeneity in business cycle effects with respect to socio-economic background (Column 2). Experiencing a 10 pp higher unemployment rate around high-school graduation increases both college enrollment and completion of individuals with low-SES background by 7 pp, but even by 11 pp for individuals with high-SES background.

The finding that economic conditions at high-school graduation have a greater influence on the college investment decisions of individuals with high-SES background are in line with ability-to-pay considerations (Dellas and Koubi 2003; Christian 2007). Low-educated parents are more likely than high-educated parents to lose their jobs during economic downturns because low-skilled jobs are typically more severely hit by recessions. Thus, the lower (family) income during recessions could prevent some individuals – especially those with lower-educated parents – from attending college due to liquidity constraints.

Concerning heterogeneous business cycle effects on cognitive skills, we find substantial gender differences (Panels C and D of Table 4). The impact on both literacy and numeracy skills is roughly twice as large for women compared to men. These findings suggest that women benefit more from recessions at high-school graduation in terms of cognitive skill formation, owing to, for instance, gender-differences in recession-induced field-of-study choices at college, differences in occupational choices on the labor market, or differential employment effects. While cognitive skills of individuals with high-SES parents also seem to increase slightly more in the unemployment rate around high-school graduation than the skills of individuals with low-SES parents, these interaction effects are not statistically significant.

The stronger business cycle effects on cognitive skills for women also translate into better labor-market outcomes (Panels E–G of Table 4). The effect of economic conditions around high-school graduation on both wages and training participation is more than twice as large for women as for men. Women are also more likely to work full-time when exposed to bad economic conditions around high-school graduation; in contrast,

[42] High-SES background is defined as having at least one parent with a college degree; low-SES background means that neither parent has a college degree. Based on this definition, 32 percent of individuals in our sample have high-SES background.

[43] Results are qualitatively similar when we additionally interact the unemployment rates before and after high-school graduation with the subsample indicators (results not shown).

there seems to be no impact on men. One potential explanation is that the labor supply of men is rather inelastic with respect to education, while the labor supply of women is more responsive to education level. The stronger business cycle effects on full-time employment for women compared to men may also explain the gender differences in the business cycle effects on cognitive skills and labor-market outcomes.[44] These differential effects also imply that gender gaps decrease for several important outcomes. In terms of magnitude, an increase in the unemployment rate around high-school graduation by 6 pp (i.e., the mean difference between lowest and highest unemployment rate in a country) narrows the gap in numeracy skills by 0.035 standard deviations (16 percent), in full-time employment by 3.7 pp (14 percent), and in monthly wages by approx. 3 pp (from 24.4 percent to 21.4 percent).

4.5 Robustness Analysis

In this section, we show that our results are robust to changes in the empirical specification and are not driven by specific countries or birth cohorts.

Changes in Empirical Specification and Definition of Sensitive Period

Table A6 shows that our results are not affected by the individual-level control variables. For all main outcomes, the coefficients on the unemployment rate around high-school graduation differ very little across specifications without individual-level covariates (odd columns) and those with covariates (even columns). These findings reassure us that our estimates are not biased due to unobserved individual-level characteristics. Furthermore, Figure A3 shows that these covariates are not systematically related to annual unemployment rates five years before up to six years after high-school graduation: None of the covariates reveals a pattern similar (or opposite) to the business cycle effects on our outcome variables. Moreover, most coefficients are individually insignificant, and the covariates are never jointly significant at the 5 percent level when the unemployment rate in a given period is regressed on them.[45]

What is more, we estimate business cycle effects when we do not correct the hypothetical age of college decision-making for compulsory military service. While results are qualitatively similar, the estimated business cycle effects on all main outcome variables are somewhat mitigated, consistent with higher measurement error in the relevant unemployment rate (Table A8).[46] These results corroborate our baseline definition of the year

[44] Business cycle effects on wages and full-time employment do not differ by SES background. However, bad economic conditions around high-school graduation lead to a stronger increase in training participation for individuals with high-SES background compared to those with low-SES background.

[45] Only the gender composition seems to be somewhat related to the unemployment rate during the years around high-school graduation. To test whether the (slight) change in the gender composition of the sample affects our findings, we add to our baseline specification gender-specific cohort fixed effects. This does not affect our results (see Table A7).

[46] In the estimations that do not incorporate compulsory military service, coefficients are between 8 percent (literacy skills) and 19 percent (training) smaller than in our baseline specifications. The coefficient in the wage regression is even reduced by 40 percent and is much less precisely estimated.

of college decision-making that accounts for the (country-specific and gender-specific) compulsory military service.[47]

Given that we are interested in business cycle effects around high-school graduation, an obvious alternative to using the unemployment rate of the entire working-age population is to use the youth unemployment rate. Reassuringly, the pattern of results is similar when using the unemployment rate of 15–24 year olds (see Table A9). However, effect sizes are attenuated by approx. 50 percent compared to the baseline results. One likely explanation is that high-school graduates are much less aware of the youth unemployment rate in their country because the media only tend to report the general unemployment rate.

Our preferred specification controls for the economic conditions in the periods before and after high-school graduation. With this specification, we account for both the serial correlation of unemployment rates and the common finding that economic decisions and beliefs are affected by conditions experienced early in life (Malmendier and Nagel 2011; Rao 2016). While we limit our preferred model to incorporate six years prior to high-school graduation, Table A10 also adds the unemployment rate seven to ten years before high-school graduation. Despite extensively controlling for economic conditions in many years before high-school graduation, the impact of the unemployment rate experienced in the sensitive period (one year prior up to two years after high-school graduation) remains sizeable and statistically significant for all outcomes.[48] While coefficients somewhat decrease for college investment, business cycle effects on numeracy skills and, in particular, on labor-market outcomes actually increase. Strikingly, economic conditions in all years under consideration prior to high-school graduation are never significantly related to the respective outcome.[49] This finding substantiates our interpretation that individuals adjust their college investment decisions due to the economic conditions *around* high-school graduation, rather than in earlier periods.

Excluding Country Groups and Birth Cohorts

The estimated countercyclical pattern of college investments and outcomes in later life is also robust to changes in the sample. Table A11 excludes all countries without exact age information, that is, Canada, New Zealand, and the United States. The effects on college investments, cognitive skill formation, and training participation barely change. We even observe somewhat stronger effects on wages, which may be due to the reduction

[47] Heterogeneity analyses using the hypothetical college-decision age not adjusted for compulsory military service reveal that women are affected by economic conditions earlier than men, and that individuals in countries with compulsory military service are affected later than individuals in countries without conscription (results not shown). Hence, these findings also indicate that a meaningful definition of the age of college decision-making should account for (gender-specific) compulsory military service.

[48] In this analysis, we lose 6 percent of observations because some countries do not report unemployment rates for early years. Results are qualitatively similar when we include unemployment rates of all years until birth (results not shown).

[49] Exceptions are the unemployment rates in *t-6* (*t-5*), which are significantly positively (negatively) correlated with wages. Importantly, the economic conditions in these years are unrelated to all other outcomes. Hence, we consider these results as statistical artefacts since a few coefficients are expected to be statistically significant by chance when considering 6*9=54 pre-period coefficients (as we do in Table A10).

in measurement error since wages in Canada and the United States are not reported continuously, but instead approximated by decile means (see Section 2).

Furthermore, former communist countries could be special cases owing to their status as transition economies or because college decision-making may still be different than in other developed countries as a result of their communist heritage. When excluding the five former communist countries from our sample (the Czech Republic, Estonia, Poland, the Slovak Republic, and Slovenia), business cycle effects on college investments and wages remain unchanged, while effects on cognitive skills and training participation become considerably larger than in the full sample.

Finally, we exclude each country and each age group separately.[50] Figures A4 and A5 indicate that none of our main results is driven by specific countries or age groups.[51] However, wage effects are substantially smaller once we exclude Chile, suggesting that wages have a particularly strong countercyclical pattern in this country. Assuming that wage effects of bad economic conditions at high-school graduation arise due to increased skills (Hanushek et al., 2015), one potential explanation for this result is that Chile has by far the highest wage returns to cognitive skills among all countries in our sample (Hanushek et al., 2017).[52]

4.6 Do Bad Economic Conditions at High-School Graduation Affect Later-Life Outcomes Through Increased College Investments? Instrumental-Variable Results

In this section, we provide suggestive evidence concerning the mechanisms that underlie the effect of economic conditions at high-school graduation on cognitive skill formation and labor-market outcomes. In particular, we explore the role of recession-induced college investments in explaining the reduced-form impact on outcomes in later life. To do so, we estimate an instrumental-variable (IV) model, in which college enrollment is instrumented with the unemployment rate around high-school graduation. (Results are very similar when instrumenting college degree instead.) This exercise relies on the (arguably strong) assumption that, conditional on the covariates, business cycle conditions at the time of high-school graduation are orthogonal to all factors besides college enrollment that influence later-life outcomes. Although it seems unlikely that the positive (reduced-form) effects on skill formation and labor market outcomes are entirely driven by college education, our results provide suggestive evidence on the importance of recession-induced college education for long-term human capital formation and labor-market success.

Results of the two-stage least squares estimations of the effects of college education on cognitive skills and labor-market success are shown in Panels B and C of Table 5. Panel A provides OLS results for comparison. In the OLS estimations, college enrollment

[50] Since we cannot exclude single age groups for Canada, New Zealand, and the United States due to the lack of precise age information, we always omit the respective five-year age cohort in these countries.

[51] Tables A12 and A13 provide detailed regression results.

[52] Results are also robust to excluding first-generation immigrants from the analysis (results not shown).

is associated with 0.62 standard deviations higher literacy and numeracy skills, 30 percent higher wages, and a 22 pp higher participation in adult learning activities. The corresponding IV results suggest substantially larger positive effects of college enrollment on later-life outcomes (Panel B), even when conditioning on economic conditions in the periods prior to and following high-school graduation (Panel C).[53] Controlling for the average unemployment rate after high-school graduation is particularly important in the IV specification. Since a growing literature shows that recessions at the time of labor-market entry have strong and persistent negative effects on career outcomes, we could assume that without this control the exclusion restriction is violated due to the serial correlation of unemployment rates. However, reassuringly, results are scarcely affected.

One potential explanation for the larger IV coefficients, compared to their OLS counterparts, is that the complier population whose effect is identified in the IV model has higher returns to college education than the average individual. Our complier population consists of marginal students, and hence individuals who would not have attended college when graduating from high school in good economic times. Previous evidence by Card (1993) shows that the returns to college education are higher for marginal students than for the average student, since marginal students require higher expected returns to be drawn to college than is the case for infra-marginal students (Kaufmann, 2014).

5 Conclusion

We investigate the short- and long-term effects of economic conditions at high-school graduation by exploiting variation in national unemployment rates over a 20-year period across 28 developed countries. We find that economic conditions at high-school graduation affect college investments: An increase in the unemployment rate at high-school graduation increases both college enrollment and college completion.

This is the first paper that illustrates that economic conditions at high-school graduation also affect longer-term outcomes. Our findings indicate a positive effect of bad economic conditions at high-school graduation on literacy and numeracy skills as well as on wages and training participation. Instrumental-variable estimates provide suggestive evidence that college education is one important mechanism through which bad economic conditions at high-school graduation affect cognitive skill formation and labor-market outcomes.

Importantly, all outcomes are most affected by the economic conditions at high-school graduation, whereas economic conditions in earlier or later years have no impact whatsoever. This suggests that academically marginal students, who are the focus group of many policy programs aiming to increase college attendance rates, seem to make college

[53] First-stage F-statistics reveal that the instrument is strong, with values of around 25 in the cognitive-skills and training samples and values of 10–13 in the (much smaller) wage sample. Thus, weak-instrument bias (Staiger and Stock 1997; Stock, Wright and Yogo 2002) is unlikely to be a problem in our context.

investment decisions toward the end of high school. This has important implications for the timing of policy measures to foster the transition between high school and college.

Finally, we also find that business cycle effects are larger for individuals of higher socio-economic background. This suggests that bad economic conditions at high-school graduation tend to increase educational inequality by widening the education gap between less and more disadvantaged individuals. Furthermore, the effects of economic conditions at high-school graduation on outcomes in later life tend to be substantially stronger for women than for men, thus narrowing the gender gaps in numeracy skills, full-time employment, and monthly wages.

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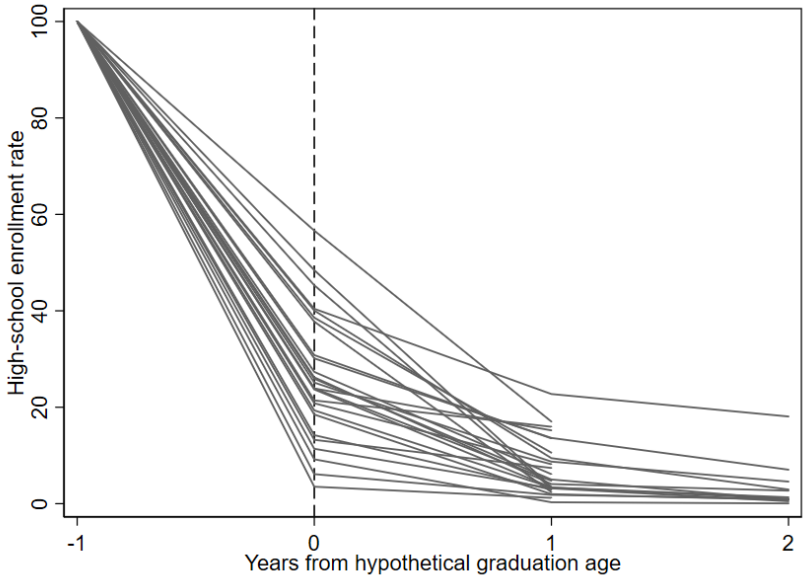
Figure 1: High-School Enrollment Rates by Distance from Hypothetical Graduation Age

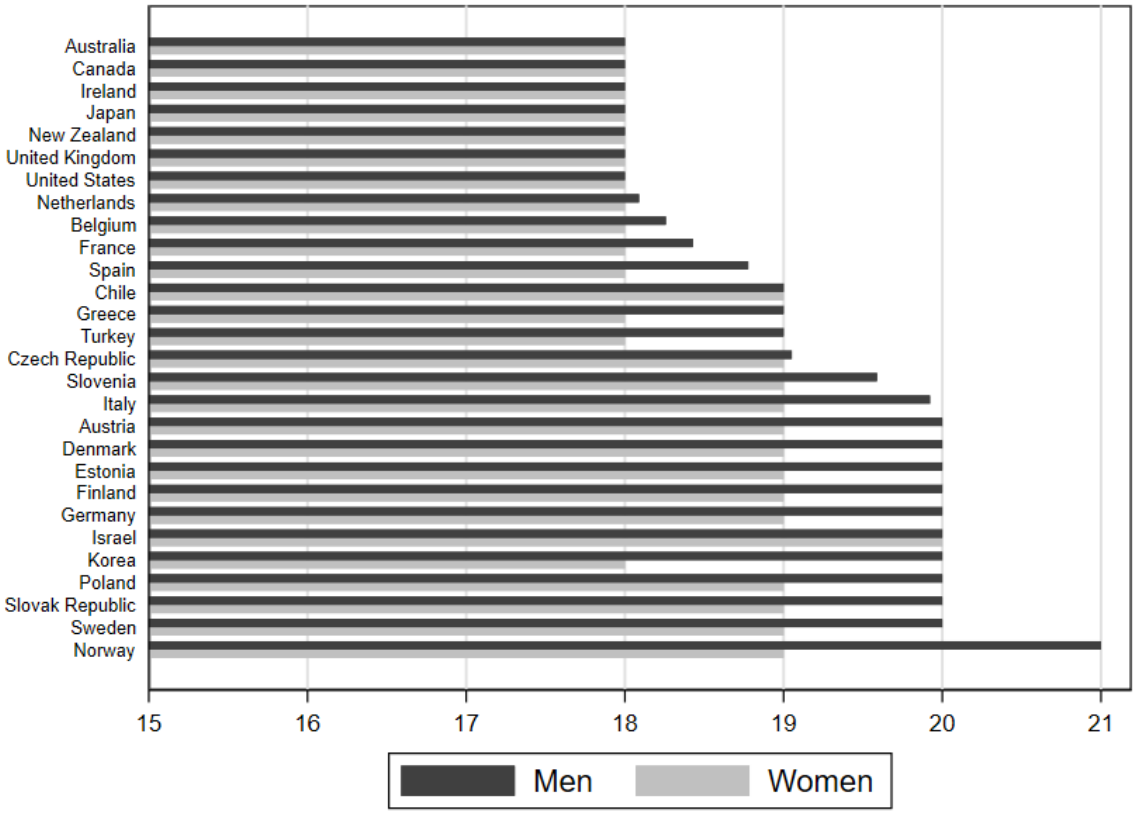
Panel A: Pooled Sample

Panel B: By Country



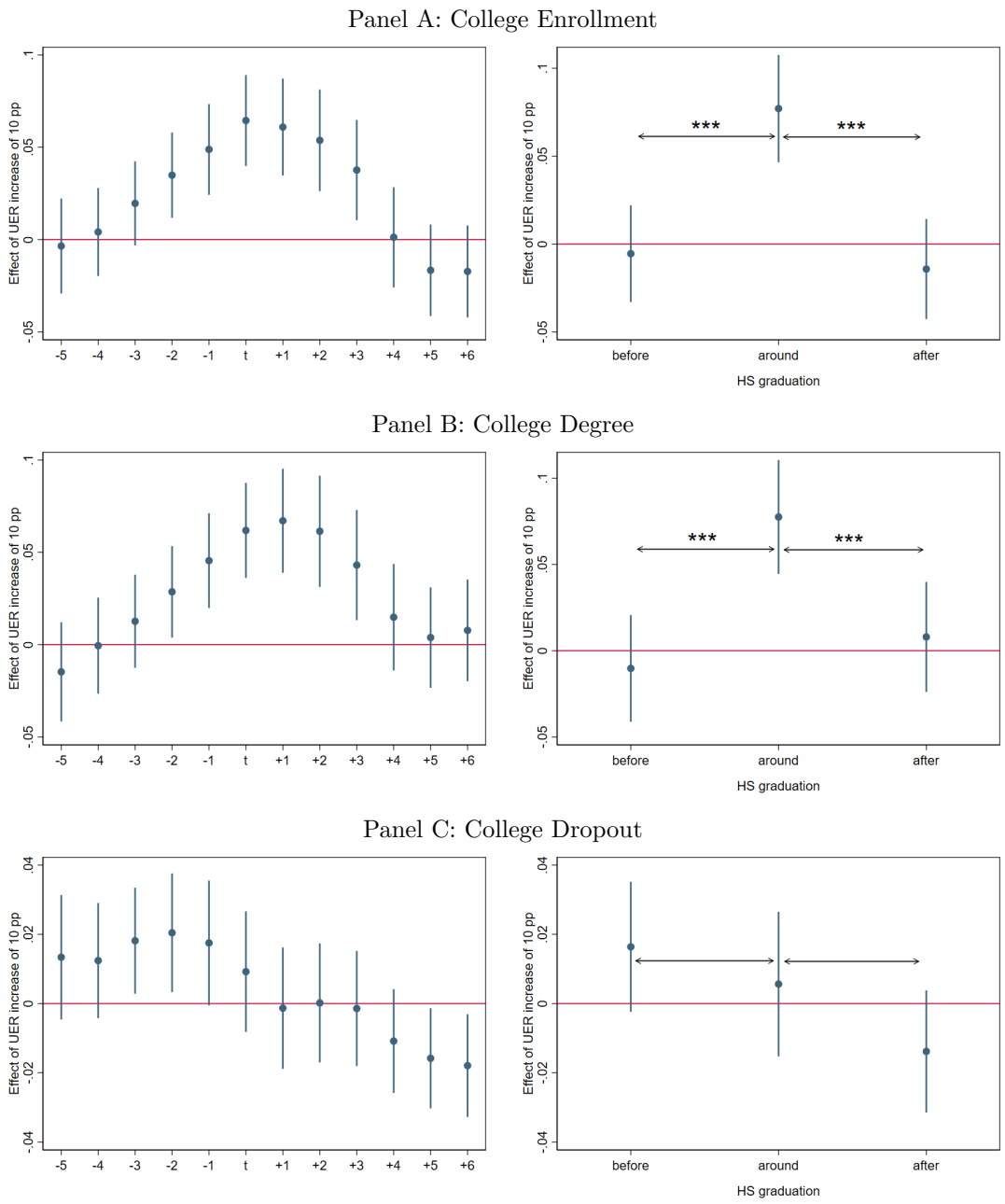
Notes: Figure reports actual enrollment rates in upper secondary education (high school), by annual distance from hypothetical graduation age. Enrollment rate one year prior to the hypothetical graduation age (-1) is set to 100 in each country. Panel A reports average enrollment rates across all countries in our sample. Panel B reports enrollment rates for each country separately. Information on enrollment rates is not available for Canada and the United States. *Data source:* OECD (1999), Classifying Educational Programmes – Manual for ISCED-97 Implementation in OECD Countries, see http://www.oecd.org/education/1841854.pdf; OECD Education at a Glance (2015); UNESCO Institute for Statistics.

Figure 2: Hypothetical Age of College Decision-Making



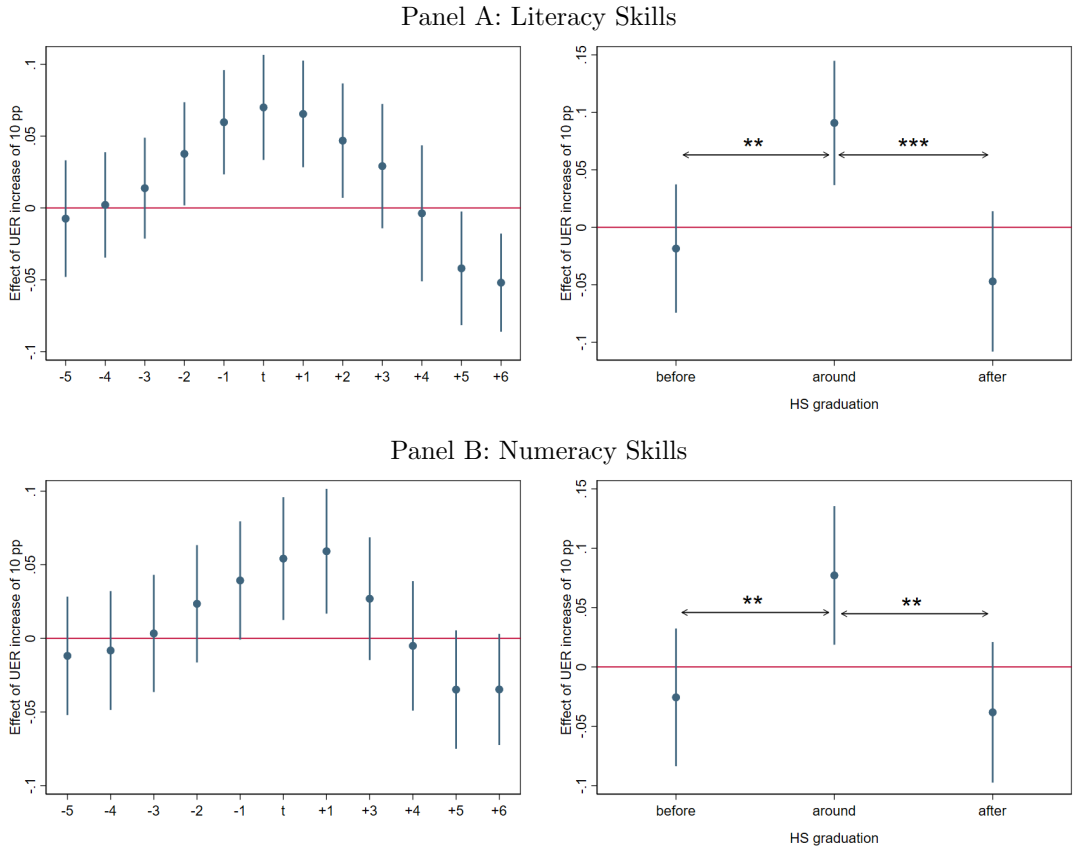
Notes: Figure reports our hypothetical age of college decision-making, separately by country and gender. Hypothetical age of college decision-making = hypothetical age at high-school graduation plus length of compulsory military service. In all countries with compulsory military service, except Israel, only men are considered for conscription. During our observational period, compulsory military service has been abolished in the Netherlands (1991), Belgium (1992), the Czech Republic (1992), France (1996), Spain (2001), Slovenia (2003), and Italy (2004). Therefore, the country means of the hypothetical age of college decision-making are float numbers, rather than integers, in these countries. Sample: PIAAC respondents 25–39 years old, excluding individuals who achieved their highest educational level abroad. *Data source:* CIA Factbook; country-specific information about compulsory military service; OECD (1999), Classifying Educational Programmes – Manual for ISCED-97 Implementation in OECD Countries, see http://www.oecd.org/education/1841854.pdf; UNESCO Institute for Statistics.

Figure 3: Business Cycle Effects on College Investments



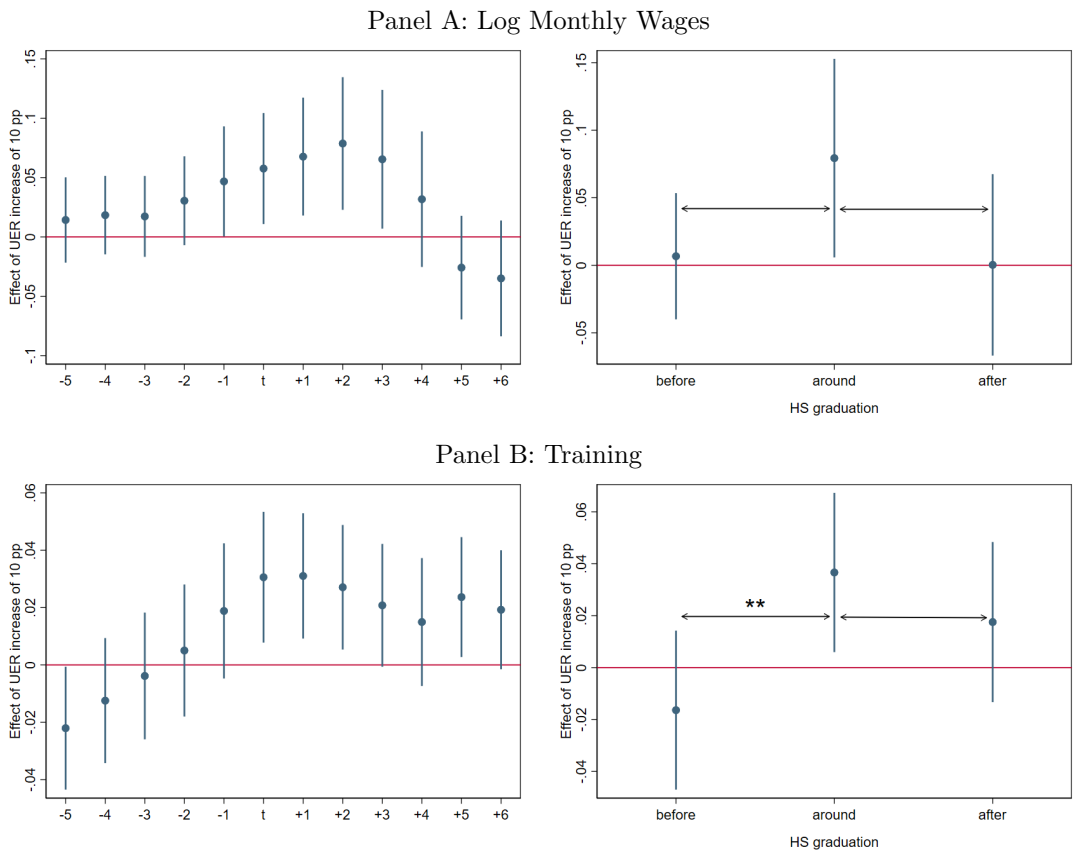
Notes: The plot shows coefficients from OLS regres-sions of indicated outcome on unemployment rate in year indicated on the horizontal axis (where t denotes the hypothetical year of college decision-making; see Figure 2). Dependent variable: college enrollment (Panel A), college degree (Panel B), and college dropout (Panel C). Sample: PIAAC respondents 25–39 years old, excluding individuals who achieved their highest educational level abroad. Unemployment rate is divided by 10 throughout. Dots indicate the estimated coefficients, vertical lines the 95 percent confidence intervals (based on standard errors clustered at the country × year-of-birth level). Plots on left-hand side: each coefficient comes from a separate regression. Plots on right-hand side: coefficients come from a regression that simultaneously includes the following unemployment rates: "before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2; "around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Two-sided tests of the equality of coefficients on the unemployment rate "around HS graduation" and on the unemployment rates "before HS graduation" and "after HS graduation", respectively, have been conducted; level of statistical significance is indicated above horizontal arrows: * p<0.10, ** p<0.05, *** p<0.01. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. In regressions using college dropouts, currently enrolled students as well as individuals in the United States are excluded due to missing information. *Data source:* PIAAC 2012/2015.

Figure 4: Business Cycle Effects on Cognitive Skills



Notes: The plot shows coefficients from OLS regressions of indicated outcome on unemployment rate in year indicated on the horizontal axis (where t denotes the hypothetical year of college decision-making; see Figure 2). Dependent variable: literacy skills (Panel A) and numeracy skills (Panel B). Skills are standardized to have mean 0 and standard deviation 1 within each country. Sample: PIAAC respondents 25–39 years old, excluding individuals who achieved their highest educational level abroad. Unemployment rate is divided by 10 throughout. Dots indicate the estimated coefficients, vertical lines the 95 percent confidence intervals (based on standard errors clustered at the country × year-of-birth level). Plots on left-hand side: each coefficient comes from a separate regression. Plots on right-hand side: coefficients come from a regression that simultaneously includes the following unemployment rates: "before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2; "around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Two-sided tests of the equality of coefficients on the unemployment rate "around HS graduation" and on the unemployment rates "before HS graduation" and "after HS graduation", respectively, have been conducted; level of statistical significance is indicated above horizontal arrows: * p<0.10, ** p<0.05, *** p<0.01. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. *Data source:* PIAAC 2012/2015.

Figure 5: Business Cycle Effects on Labor-Market Outcomes



Notes: The plot shows coefficients from OLS regressions of indicated outcome on unemployment rate in year indicated on the horizontal axis (where t denotes the hypothetical year of college decision-making; see Figure 2). Dependent variable: log monthly wage (Panel A), participation in adult learning activities (Panel B). Sample: PIAAC respondents 25–39 years old, excluding individuals who achieved their highest educational level abroad and current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. Unemployment rate is divided by 10 throughout. Dots indicate the estimated coefficients, vertical lines the 95 percent confidence intervals (based on standard errors clustered at the country × year-of-birth level). Plots on left-hand side: each coefficient comes from a separate regression. Plots on right-hand side: coefficients come from a regression that simultaneously includes the following unemployment rates: "before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2; "around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Two-sided tests of the equality of coefficients on the unemployment rate "around HS graduation" and on the unemployment rates "before HS graduation" and "after HS graduation", respectively, have been conducted; level of statistical significance is indicated above horizontal arrows: * p<0.10, ** p<0.05, *** p<0.01. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. *Data source:* PIAAC 2012/2015.

Table 1: Business Cycle Effects on College Investments

	(1)	(2)	(3)	(4)
Panel A: College Enrollment				
UER – before HS graduation	.018			−.006
	(.013)			*(.014)*
UER – around HS graduation		.073***		.077***
		(.015)		*(.016)*
UER – after HS graduation			−.000	−.014
			(.015)	*(.014)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	51241	51241	51241	51241
Panel B: College Degree				
UER – before HS graduation	.009			−.010
	(.015)			*(.016)*
UER – around HS graduation		.076***		.077***
		(.016)		*(.017)*
UER – after HS graduation			.023	.008
			(.016)	*(.016)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	51241	51241	51241	51241
Panel C: College Dropout				
UER – before HS graduation	.021**			.016*
	(.009)			*(.010)*
UER – around HS graduation		.009		.006
		(.010)		*(.011)*
UER – after HS graduation			−.017*	−.014
			(.009)	*(.009)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	43149	43149	43149	43149

Notes: Ordinary least squares estimates. Dependent variable: college enrollment (Panel A), college degree (Panel B), and college dropout (Panel C). "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making; see Figure 2); "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Sample: PIAAC respondents aged 25–39, excluding individuals who achieved their highest educational level abroad. In regressions using college dropouts, currently enrolled students as well as individuals in the United States are excluded due to missing information. Robust standard errors, clustered at the country × year-of birth-level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table 2: Business Cycle Effects on Cognitive Skills

	(1)	(2)	(3)	(4)
Panel A: Literacy Skills				
UER – before HS graduation	.015			−.018
	(.025)			*(.028)*
UER – around HS graduation		.078***		.091***
		(.025)		*(.027)*
UER – after HS graduation			−.027	−.047
			(.030)	*(.031)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	51241	51241	51241	51241
Panel B: Numeracy Skills				
UER – before HS graduation	.002			−.026
	(.028)			*(.029)*
UER – around HS graduation		.063**		.077***
		(.029)		*(.030)*
UER – after HS graduation			−.019	−.038
			(.029)	*(.030)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	51241	51241	51241	51241

Notes: Ordinary least squares estimates. Dependent variable: literacy skills (Panel A) and numeracy skills (Panel B). Skills are standardized to have mean 0 and standard deviation 1 within each country. "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making; see Figure 2); "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Sample: PIAAC respondents aged 25–39, excluding individuals who achieved their highest educational level abroad. Robust standard errors, clustered at the country × year-of-birth-level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table 3: Business Cycle Effects on Labor-Market Outcomes

	(1)	(2)	(3)	(4)
Panel A: Log Monthly Wage				
UER – before HS graduation	.025			.007
	(.023)			*(.024)*
UER – around HS graduation		.081**		.079**
		(.036)		*(.037)*
UER – after HS graduation			.012	.000
			(.035)	*(.034)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	30638	30638	30638	30638
Panel D: Training				
UER – before HS graduation	–.010			–.016
	(.016)			*(.016)*
UER – around HS graduation		.034**		.037**
		(.015)		*(.016)*
UER – after HS graduation			.028*	.018
			(.015)	*(.016)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	44488	44488	44488	44488

Notes: Ordinary least squares estimates. Dependent variable: log monthly wage (Panel A), participation in adult learning activities (Panel B). "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making; see Figure 2); "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Sample: PIAAC respondents aged 25–39, excluding individuals who achieved their highest educational level abroad and current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. Robust standard errors, clustered at the country × year-of birth-level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table 4: Heterogeneity in Business Cycle Effects

	(1)	(2)
Panel A: College Enrollment		
UER – around HS graduation	.067***	.070***
	(.017)	*(.016)*
Female × UER – around HS graduation	.020	
	(.013)	
Uni Parents × UER – around HS graduation		.039***
		(.012)
Panel B: College Degree		
UER – around HS graduation	.070***	.072***
	(.018)	*(.018)*
Female × UER – around HS graduation	.015	
	(.013)	
Uni Parents × UER – around HS graduation		.040***
		(.012)
Panel C: Literacy Skills		
UER – around HS graduation	.063**	.094***
	(.030)	*(.028)*
Female × UER – around HS graduation	.054**	
	(.025)	
Uni Parents × UER – around HS graduation		.032
		(.025)
Panel D: Numeracy Skills		
UER – around HS graduation	.048	.081**
	(.033)	*(.032)*
Female × UER – around HS graduation	.058**	
	(.026)	
Uni Parents × UER – around HS graduation		.017
		(.023)
Panel E: Log Monthly Wage		
UER – around HS graduation	.050	.075*
	(.037)	*(.039)*
Female × UER – around HS graduation	.064**	
	(.032)	
Uni Parents × UER – around HS graduation		.029
		(.020)
Panel F: Training		
UER – around HS graduation	.022	.029*
	(.017)	*(.016)*
Female × UER – around HS graduation	.029**	
	(.013)	
Uni Parents × UER – around HS graduation		.037**
		(.015)
Country FE	✓	✓
Cohort FE	✓	✓
Panel G: Full-Time Employment		
UER – around HS graduation	.008	.039**
	(.019)	*(.019)*
Female × UER – around HS graduation	.062***	
	(.018)	
Uni Parents × UER – around HS graduation		.019
		(.012)
Country FE	✓	✓
Cohort FE	✓	✓

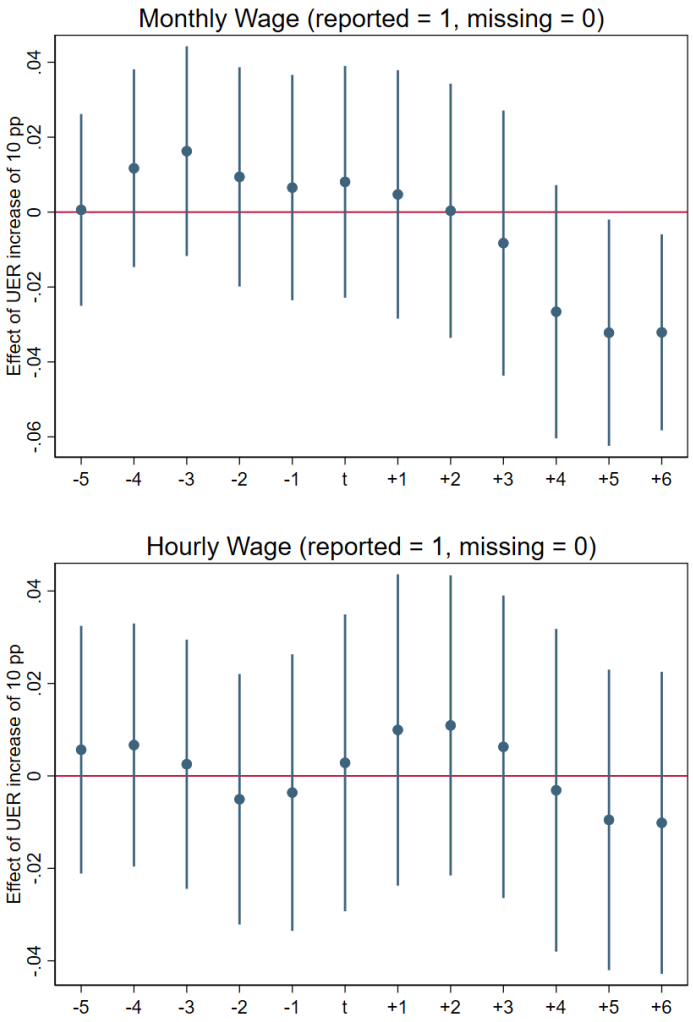
Notes: Ordinary least squares estimates. Dependent variable: college enrollment (Panel A), college degree (Panel B), literacy skills (Panel C), numeracy skills (Panel D), log monthly wage (Panel E), participation in adult learning activities (Panel F), and full-time employment (Panel G). "UER – around HS graduation" is the simple average of the national unemployment rates in years t-1, t, t+1, t+2 (where t denotes the hypothetical year of college decision-making; see Figure 2). Unemployment rate is divided by 10 throughout. All specifications include controls for unemployment rates before and after HS graduation, gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Sample: PIAAC respondents aged 25–39, excluding individuals who achieved their highest educational level abroad. Specifications with labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. Robust standard errors, clustered at the country × year-of birth-level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table 5: Instrumental-Variable Analysis – Effect of Recession-Induced College Education on Cognitive Skills and Labor-Market Outcomes

	Literacy	Numeracy	Wage	Training
Panel A: OLS				
College Enrollment	.617***	.623***	.297***	.217***
	(.011)	*(.011)*	*(.013)*	*(.006)*
Panel B: 2SLS				
College Enrollment	1.066***	.867**	1.121**	.440**
	(.326)	*(.373)*	*(.538)*	*(.193)*
Instrument F stat.	24.75	24.75	10.28	22.45
Observations	51241	51241	30638	44488
Panel C: 2SLS, conditional on UER before & after				
College Enrollment	1.178***	1.000***	.940**	.438**
	(.346)	*(.378)*	*(.445)*	*(.187)*
Instrument F stat.	24.65	24.65	13.32	24.37
Observations	51241	51241	30638	44488

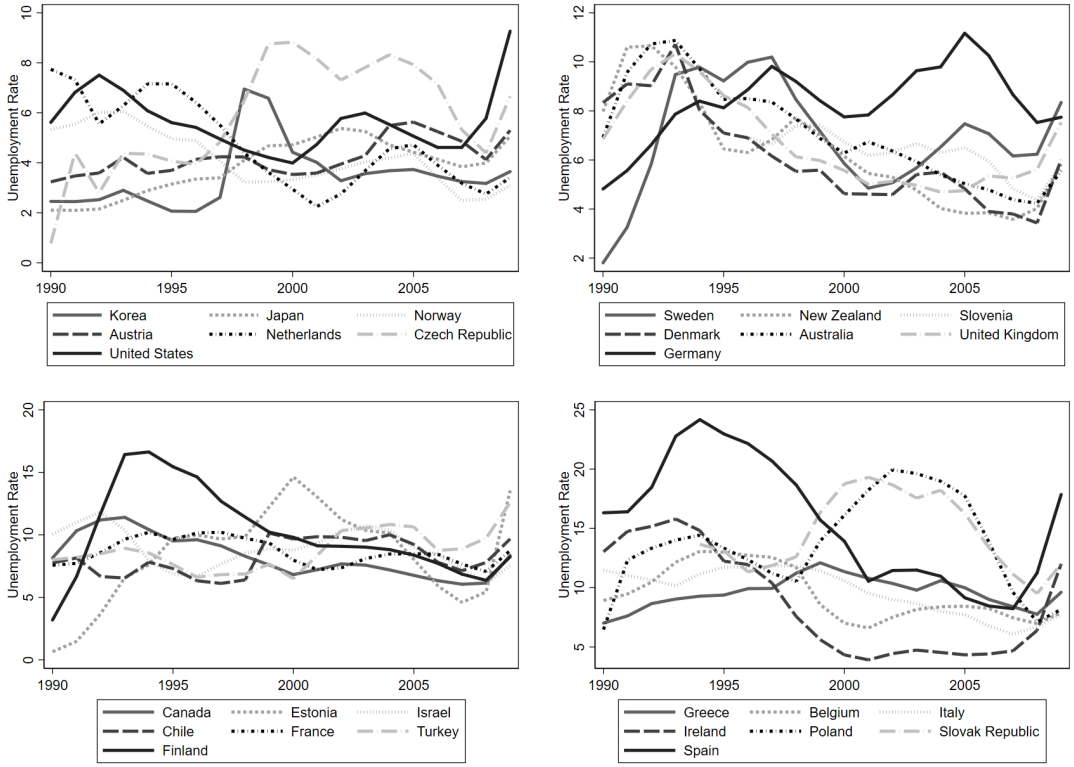
Notes: Ordinary least squares estimates in Panel A, two-stage least squares estimates in Panels B and C. Dependent variable: literacy skills (column 1), numeracy skills (column 2), log monthly wage (column 3), and participation in adult learning activities (column 4). Instrumental variable for college enrollment: "UER – around HS graduation", i.e., the simple average of the unemployment rates in years t-1, t, t+1, t+2 (where t denotes the hypothetical year of college decision-making; see Figure 2). All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Panel C also controls for unemployment rates before and after HS graduation. Sample: PIAAC respondents aged 25–39, excluding individuals who achieved their highest educational level abroad. Specifications with labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. Robust standard errors, clustered at the country × year-of-birth-level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Figure A1: Balancing of Availability of Wage Information



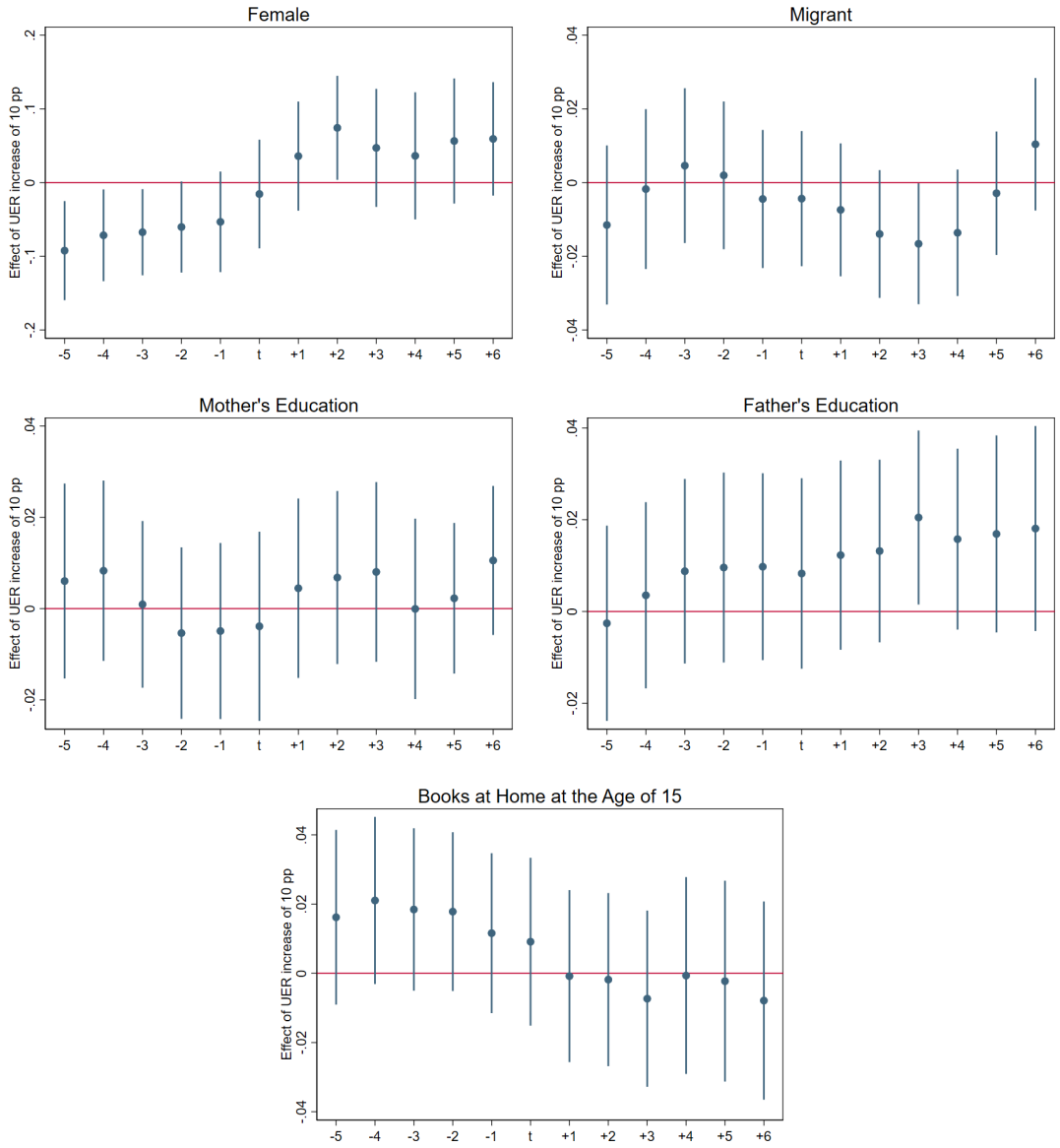
Notes: The plot shows coefficients from separate OLS regressions of binary indicators of wage information availability on the unemployment rate in the year indicated on the horizontal axis (where t denotes the hypothetical year of college decision-making; see Figure 2). Dependent variables in top/bottom panel: binary indicator for whether monthly/hourly wage has been reported (=1) or is missing (=0). The bottom panel (hourly wage information) considers only full-time employed individuals. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Unemployment rate is divided by 10 throughout. Dots indicate the estimated coefficients, vertical lines the 95 percent confidence intervals (based on standard errors clustered at the country × year-of-birth level). All specifications include country and birth-year fixed effects. *Data source:* PIAAC 2012/2015.

Figure A2: Variation in Unemployment Rates Across Countries and Over Time



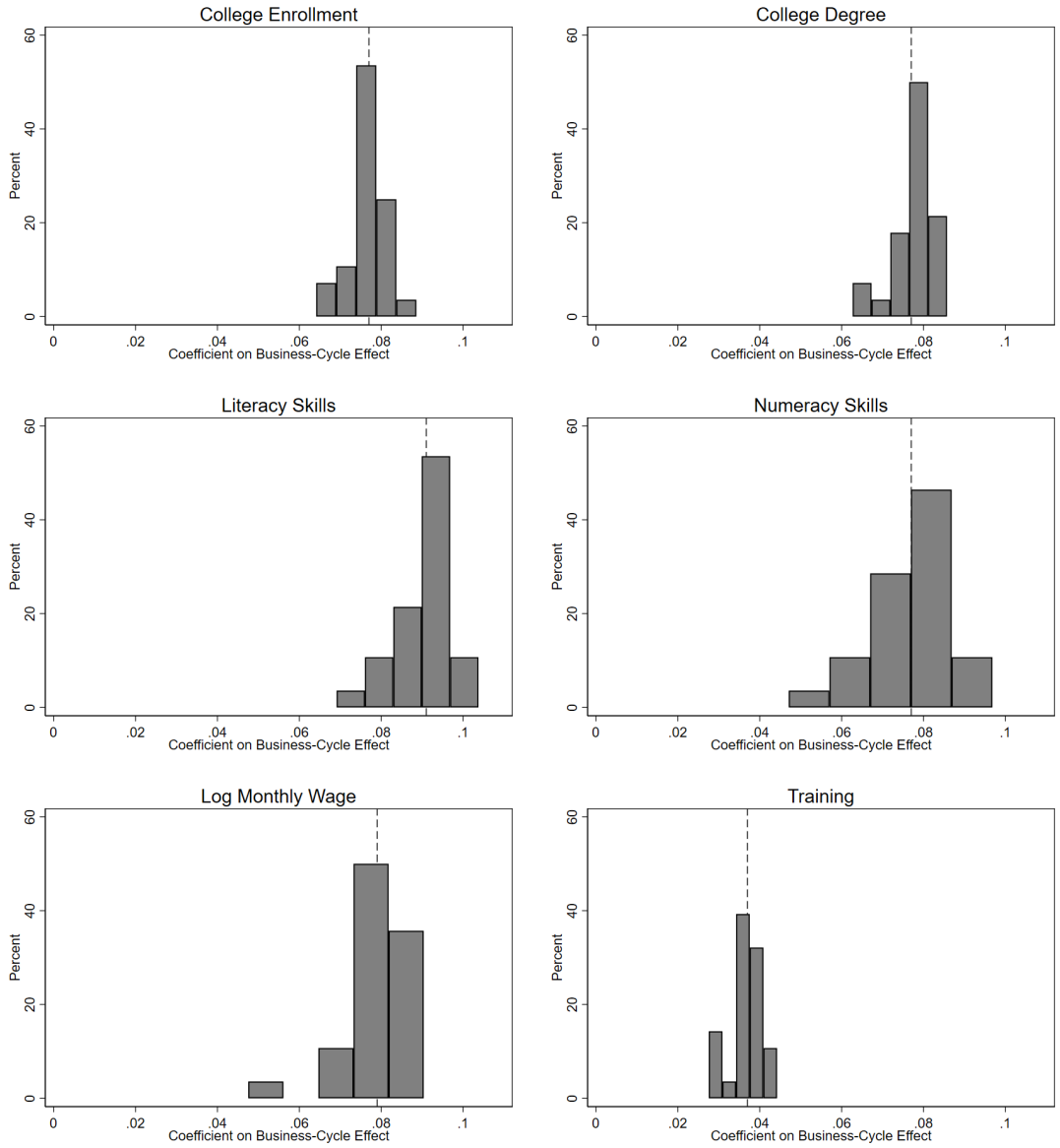
Notes: Figure denotes development of annual national unemployment rate between 1990 until 2009 for each of the 28 countries in our sample. Partly missing information on unemployment rates in the Slovak Republic (before 1994) and Slovenia (1996). Countries are displayed in ascending order of the mean unemployment rate across the observational period (lowest quartile of countries in upper left panel, highest quartile in lower right panel). *Data source:* OECD.

Figure A3: Balancing of Covariates



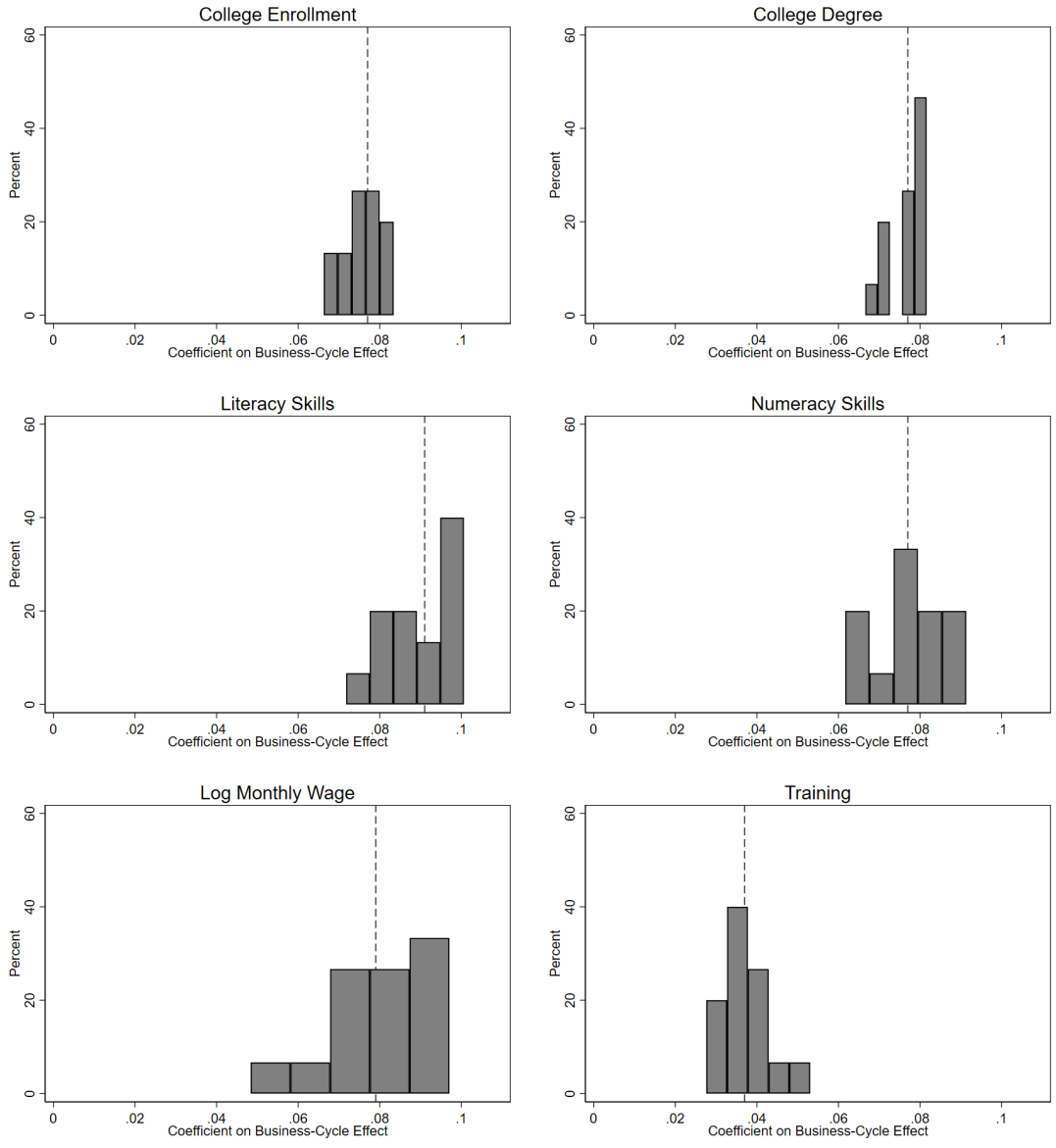
Notes: The plot shows coefficients from separate OLS regressions of the indicated covariates on the unemployment rate in the year indicated on the horizontal axis (where t denotes the hypothetical year of college decision-making; see Figure 2). Dependent variables: mother's and father's education is a dummy that takes the value 1 if the mother/father holds a college degree; 0 otherwise; books at home at the age of 15 is a dummy which takes the value 1 if the respondent reported that his/her household had more than 100 books at home when he/she was 15 years old; 0 otherwise. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Unemployment rate is divided by 10 throughout. Dots indicate the estimated coefficients, vertical lines the 95 percent confidence intervals (based on standard errors clustered at the country × year-of-birth level). All specifications include country and birth-year fixed effects. *Data source:* PIAAC 2012/2015.

Figure A4: Robustness Check: Excluding Individual Countries



Notes: Histogram plots the estimated coefficients from Table A12, using 5 bins. The dependent variable is indicated in each panel header. Vertical dashed lines represent the baseline coefficient when no country is excluded. *Data source:* PIAAC 2012/2015.

Figure A5: Robustness Check: Excluding Age Cohorts



Notes: Histogram plots the estimated coefficients from Table A13, using 5 bins. The dependent variable is indicated in each panel header. Vertical dashed lines represent the baseline coefficient when no age cohort is excluded. *Data source:* PIAAC 2012/2015.

Table A1: Business Cycle Effects – Including Older Individuals

	Enrollment	Degree	Literacy	Numeracy	Wage	Training
Panel A: Age group 25–39						
UER – around HS graduation	.077***	.077***	.091***	.077***	.079**	.037**
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.037)*	*(.016)*
Observations	51241	51241	51241	51241	30638	44488
Panel B: Age group 25–59						
UER – around HS graduation	.041***	.038***	.059**	.060**	.021	.022*
	(.012)	*(.013)*	*(.026)*	*(.026)*	*(.023)*	*(.012)*
Observations	111766	111766	111766	111766	70050	102296

Notes: Ordinary least squares estimates. Dependent variable is indicated in the column header. Sample: PIAAC respondents aged 25–39 (Panel A, baseline), respondents aged 25–59 (Panel B), excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2 (where t denotes the hypothetical year of college decision-making). Unemployment rate is divided by 10 throughout. All specifications include controls for unemployment rates before and after HS graduation, gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A2: Descriptive Statistics – Main Variables

Country	Obs.	Enrollment	Degree	Dropout (abs.)	Dropout (rel.)	Literacy skills	Numeracy skills	Monthly wage (nat. curr.)	Training	Unemplomet rate (t)
Australia	2185	0.56	0.46	0.09	0.16	291.9	280.2	5.3	0.56	7.9
Austria	1267	0.33	0.21	0.07	0.18	283.2	289.4	2.6	0.56	4.2
Belgium	1281	0.57	0.48	0.12	0.20	291.5	295.4	3.1	0.54	10.2
Canada	7189	0.68	0.60	0.13	0.22	284.6	276.2	4.2	0.59	8.8
Chile	1610	0.52	0.38	0.13	0.27	231.5	220.0	697.2	0.54	8.3
Czech Republic	1446	0.39	0.28	0.11	0.26	287.1	286.0	25.5	0.53	6.9
Denmark	1572	0.58	0.49	0.09	0.15	283.9	288.9	83.5	0.67	6.3
Estonia	1727	0.59	0.45	0.13	0.22	285.2	282.7	1.2	0.61	10.4
Finland	1516	0.62	0.48	0.10	0.15	308.5	301.1	2.8	0.69	11.3
France	1839	0.46	0.41	0.07	0.13	276.4	268.8	2.1	0.38	8.9
Germany	1417	0.34	0.23	0.07	0.18	280.2	281.3	2.4	0.53	8.6
Greece	1535	0.41	0.35	0.04	0.09	255.9	256.1	1.0	0.25	10.0
Ireland	2209	0.53	0.44	0.10	0.17	274.7	264.3	2.8	0.49	9.5
Israel	1845	0.66	0.51	0.12	0.19	266.1	263.2	19.4	0.47	8.4
Italy	1374	0.34	0.21	0.08	0.27	258.0	258.9	1.8	0.27	10.3
Japan	1555	0.58	0.55	0.03	0.04	309.0	297.5	302.2	0.46	3.7
Korea	2004	0.69	0.59	0.06	0.07	288.5	278.7	2,533.8	0.60	3.6
Netherlands	1246	0.52	0.41	0.10	0.18	297.7	292.5	3.0	0.68	5.1
New Zealand	1641	0.64	0.54	0.10	0.18	288.6	279.5	15.3	0.66	5.9
Norway	1411	0.55	0.46	0.08	0.13	290.0	287.3	35.3	0.66	4.3
Poland	2194	0.54	0.45	0.08	0.15	277.3	269.4	3.4	0.43	15.6
Slovak Republic	859	0.40	0.30	0.08	0.18	278.6	279.9	1.7	0.34	17.7
Slovenia	804	0.63	0.33	0.17	0.25	270.4	273.7	1.3	0.49	5.9
Spain	1892	0.49	0.40	0.10	0.19	263.4	257.5	2.3	0.50	16.9
Sweden	1201	0.45	0.39	0.06	0.12	290.0	288.0	26.6	0.66	7.4
Turkey	2147	0.25	0.21	0.03	0.10	232.0	227.4		0.24	8.6
United Kingdom	2783	0.56	0.49	0.08	0.13	281.8	269.8	2.2	0.53	7.1
United States	1492	0.44	0.44			275.0	259.9	3.8	0.59	5.6
Total	51241	0.51	0.42	0.09	0.16	278.5	273.6	153.8	0.52	8.3

Notes: Country means reported. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. *College enrollment* and *college degree* indicate whether the individual ever attended college and completed college, respectively. *College dropout* indicates whether the individual dropped out of college, as overall share (*abs.*) and as percentage of enrolled students (*rel.*). *Literacy skills* and *numeracy skills* are measured on a 500-point scale. *Monthly wages* (gross) include bonuses and are available for wage and salary earners as well as self-employed; wages are reported in national currency and divided by 1000. *Training* is a dummy that takes the value 1 if the individual has taken part in any kind of adult learning activities during the year prior to the interview; 0 otherwise. *Unemployment rate (t)* is the unemployment rate in the hypothetical year of college decision-making; see Figure 2). Statistics are weighted by sampling weights. *Data source:* PIAAC 2012/2015.

Table A3: Descriptive Statistics – Control Variables

Country	Obs.	Female	Migrant	Age	Education mother	Education father	Books at home
Australia	2185	0.51	0.25	31.9	1.80	1.85	3.52
Austria	1267	0.50	0.07	32.0	1.75	1.99	3.36
Belgium	1281	0.49	0.06	32.0	1.88	1.97	2.82
Canada	7189	0.51	0.28	32.0	2.15	2.13	3.28
Chile	1610	0.50	0.06	32.0	1.64	1.75	2.22
Czech Republic	1446	0.48	0.04	30.0	1.98	2.10	3.99
Denmark	1572	0.50	0.14	32.0	1.99	2.04	3.88
Estonia	1727	0.50	0.06	30.5	2.24	2.15	4.15
Finland	1516	0.49	0.06	32.0	1.90	1.86	3.84
France	1839	0.51	0.11	32.0	1.66	1.78	3.21
Germany	1417	0.48	0.18	32.0	2.06	2.21	3.59
Greece	1535	0.50	0.09	32.0	1.50	1.56	2.56
Ireland	2209	0.52	0.26	32.0	1.67	1.62	3.12
Israel	1845	0.50	0.18	32.0	2.10	2.06	3.37
Italy	1374	0.49	0.11	32.0	1.34	1.37	2.86
Japan	1555	0.49	0.00	32.0	2.17	2.16	2.92
Korea	2004	0.47	0.02	32.0	1.51	1.76	3.18
Netherlands	1246	0.50	0.13	32.0	1.56	1.82	3.54
New Zealand	1641	0.53	0.28	31.9	1.88	1.97	3.52
Norway	1411	0.49	0.18	32.1	1.98	2.06	4.07
Poland	2194	0.50	0.00	30.0	1.98	2.01	3.30
Slovak Republic	859	0.48	0.00	28.0	1.89	1.94	3.20
Slovenia	804	0.46	0.10	28.5	1.91	1.95	2.93
Spain	1892	0.50	0.17	32.0	1.31	1.45	3.18
Sweden	1201	0.50	0.18	32.0	2.03	1.95	4.08
Turkey	2147	0.49	0.00	32.0	1.08	1.18	1.80
United Kingdom	2783	0.50	0.19	32.0	1.91	2.00	3.36
United States	1492	0.51	0.18	31.9	2.13	2.11	2.98
Total	51241	0.50	0.13	31.7	1.81	1.87	3.27

Notes: Country means reported for all control variables. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. *Migrant* is a dummy variable that takes the value 1 if the individual is a first-generation migrant. *Education mother* and *education father* include 3 categories: 1 (ISCED 1, 2, and 3C short), 2 (ISCED 3 and 4), and 3 (ISCED 5 and 6). *Books at home* is the number of books at home when the individual was 15 years old; 6 categories, ranging from "10 books or less" to "more than 500 books". Statistics are weighted by sampling weights. *Data source:* PIAAC 2012/2015.

Table A4: Business Cycle Effects – Unemployment Rates in Single Years

	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5	t+6
Panel A: College Enrollment												
UER	−.003	.004	.020*	.035***	.049***	.064***	.061***	.054***	.038***	.001	−.017	−.017
	(.013)	*(.012)*	*(.012)*	*(.012)*	*(.012)*	*(.013)*	*(.013)*	*(.014)*	*(.014)*	*(.014)*	*(.013)*	*(.013)*
Observations	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241
Panel B: College Degree												
UER	−.015	−.001	.013	.029**	.045***	.062***	.067***	.061***	.043***	.015	.004	.008
	(.014)	*(.013)*	*(.013)*	*(.013)*	*(.013)*	*(.013)*	*(.014)*	*(.015)*	*(.015)*	*(.015)*	*(.014)*	*(.014)*
Observations	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241
Panel C: Literacy Skills												
UER	−.007	.002	.014	.038*	.060***	.070***	.065***	.047*	.029	−.004	−.042*	−.052**
	(.025)	*(.022)*	*(.021)*	*(.022)*	*(.022)*	*(.022)*	*(.023)*	*(.024)*	*(.026)*	*(.029)*	*(.024)*	*(.021)*
Observations	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241
Panel D: Numeracy Skills												
UER	−.012	−.008	.003	.023	.039	.054**	.059**	.045*	.027	−.005	−.035	−.035
	(.024)	*(.024)*	*(.024)*	*(.024)*	*(.024)*	*(.025)*	*(.026)*	*(.025)*	*(.025)*	*(.027)*	*(.024)*	*(.023)*
Observations	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241	51241
Panel E: Log Monthly Wage												
UER	.014	.018	.017	.030	.047*	.058**	.068**	.079**	.065*	.032	−.026	−.035
	(.022)	*(.020)*	*(.021)*	*(.023)*	*(.028)*	*(.028)*	*(.030)*	*(.034)*	*(.035)*	*(.035)*	*(.026)*	*(.030)*
Observations	30638	30638	30638	30638	30638	30638	30638	30638	30638	30638	30638	30638
Panel F: Training												
UER	−.022*	−.012	−.004	.005	.019	.031**	.031**	.027**	.021	.015	.024*	.019
	(.013)	*(.013)*	*(.013)*	*(.014)*	*(.014)*	*(.014)*	*(.013)*	*(.013)*	*(.013)*	*(.014)*	*(.013)*	*(.013)*
Observations	44488	44488	44488	44488	44488	44488	44488	44488	44488	44488	44488	44488

Notes: Ordinary least squares estimates. Dependent variable: college enrollment (Panel A), college degree (Panel B), literacy skills (Panel C), numeracy skills (Panel D), log monthly wage (Panel E), and participation in adult learning activities (Panel F). Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications with labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. Unemployment rate is measured in the year indicated in the column header, where t denotes the hypothetical year of college decision-making; see Figure 2). Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, and number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A5: Business Cycle Effects on Employment, Hours Worked, and Hourly Wage

	(1)	(2)	(3)	(4)
Panel A: Full-Time Employment				
UER – before HS graduation	–.025			–.036**
	(.017)			*(.017)*
UER – around HS graduation		.028*		.039**
		(.017)		*(.017)*
UER – after HS graduation			.012	–.003
			(.016)	*(.017)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	38315	38315	38315	38315
Panel B: Hours worked				
UER – before HS graduation	.623			.380
	(.420)			*(.417)*
UER – around HS graduation		1.278***		1.154**
		(.479)		*(.488)*
UER – after HS graduation			.176	.134
			(.570)	*(.598)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	30882	30882	30882	30882
Panel C: Log Hourly Wage (full-time employed workers only)				
UER – before HS graduation	.038*			.036
	(.021)			*(.022)*
UER – around HS graduation		.046*		.033
		(.026)		*(.027)*
UER – after HS graduation			.018	.023
			(.024)	*(.026)*
Country FE	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓
Observations	21224	21224	21224	21224

Notes: Ordinary least squares estimates. Dependent variable: dummy for full-time employment (Panel A), weekly hours worked (Panel B), log hourly wage (Panel C). Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad and current students. Canada is excluded from the analysis because of missing information on full-time employment and hours worked. Hours worked is not reported for PIAAC respondents in Australia and Austria, hence these countries are excluded in Panel B. Specifications using hourly wage are restricted to full-time employed workers. "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making); "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A6: Business Cycle Effects – Coefficients on Control Variables

	Enrollment	Enrollment	Degree	Degree	Literacy	Literacy	Numeracy	Numeracy	Wage	Wage	Training	Training
UER – before HS graduation	−.009	−.006	−.015	−.010	−.014	−.018	−.004	−.026	.043*	.007	−.010	−.016
	(.015)	*(.014)*	*(.017)*	*(.016)*	*(.031)*	*(.028)*	*(.032)*	*(.029)*	*(.026)*	*(.024)*	*(.016)*	*(.016)*
UER – around HS graduation	.080***	.077***	.081***	.077***	.097***	.091***	.078**	.077***	.083*	.079**	.040**	.037**
	(.016)	*(.016)*	*(.018)*	*(.017)*	*(.030)*	*(.027)*	*(.033)*	*(.030)*	*(.043)*	*(.037)*	*(.016)*	*(.016)*
UER – after HS graduation	−.007	−.014	.016	.008	−.044	−.047	−.044	−.038	−.013	.000	.018	.018
	(.016)	*(.014)*	*(.017)*	*(.016)*	*(.033)*	*(.031)*	*(.035)*	*(.030)*	*(.037)*	*(.034)*	*(.016)*	*(.016)*
Female		.061***		.084***		−.036***		−.235***		−.350***		−.054***
		(.005)		*(.006)*		*(.010)*		*(.011)*		*(.013)*		*(.006)*
Migrant		.036***		.037**		−.599***		−.548***		−.124***		−.081***
		(.013)		*(.016)*		*(.027)*		*(.031)*		*(.016)*		*(.010)*
Mother Educ. – upper secondary		.092***		.080***		.173***		.151***		.077***		.049***
		(.008)		*(.007)*		*(.013)*		*(.014)*		*(.013)*		*(.008)*
Mother Educ. – tertiary		.182***		.173***		.296***		.291***		.108***		.075***
		(.009)		*(.009)*		*(.017)*		*(.017)*		*(.016)*		*(.010)*
Father Educ. – upper secondary		.089***		.075***		.119***		.123***		.055***		.041***
		(.007)		*(.007)*		*(.013)*		*(.014)*		*(.012)*		*(.008)*
Father Educ. – tertiary		.230***		.225***		.270***		.272***		.149***		.100***
		(.009)		*(.009)*		*(.019)*		*(.018)*		*(.014)*		*(.010)*
Books at home – 11 to 25		.109***		.089***		.314***		.311***		.063***		.055***
		(.009)		*(.008)*		*(.020)*		*(.020)*		*(.020)*		*(.010)*
Books at home – 26 to 100		.214***		.178***		.525***		.532***		.138***		.119***
		(.009)		*(.008)*		*(.017)*		*(.018)*		*(.016)*		*(.009)*
Books at home – 101 to 200		.286***		.233***		.696***		.716***		.183***		.155***
		(.011)		*(.010)*		*(.020)*		*(.020)*		*(.018)*		*(.010)*
Books at home – 201 to 500		.345***		.283***		.857***		.847***		.197***		.187***
		(.011)		*(.011)*		*(.022)*		*(.023)*		*(.021)*		*(.012)*
Books at home – more than 500		.349***		.291***		.882***		.880***		.196***		.189***
		(.012)		*(.012)*		*(.025)*		*(.026)*		*(.024)*		*(.015)*
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	51241	51241	51241	51241	51241	51241	51241	51241	30638	30638	44488	44488

Notes: Ordinary least squares estimates. Dependent variables are indicated in the column header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making); "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. Omitted category for mother's and father's education is "primary or lower secondary education". Omitted category for number of books at home at age 15 is "less than 10 books". Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A7: Robustness Check: Adding Gender-Specific Cohort Fixed Effects

	Enrollment	Degree	Literacy	Numeracy	Wage	Training
UER – before HS graduation	−.006	−.009	−.019	−.026	.006	−.015
	(.014)	*(.016)*	*(.028)*	*(.029)*	*(.024)*	*(.015)*
UER – around HS graduation	.077***	.075***	.090***	.075**	.074**	.035**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.037)*	*(.016)*
UER – after HS graduation	−.014	.011	−.046	−.034	.010	.021
	(.015)	*(.016)*	*(.031)*	*(.030)*	*(.033)*	*(.016)*
Observations	51241	51241	51241	51241	30638	44488

Notes: Ordinary least squares estimates. Dependent variable is indicated in the column header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making); "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A8: Robustness Check: Hypothetical Year of College Decision-Making Not Adjusted for Compulsory Military Service

	(1)	(2)	(3)	(4)
Panel A: College Enrollment				
UER – before HS graduation	.018			−.003
	(.013)			*(.015)*
UER – around HS graduation		.064***		.066***
		(.015)		*(.016)*
UER – after HS graduation			.007	−.005
			(.015)	*(.015)*
Observations	51241	51241	51241	51241
Panel B: College Degree				
UER – before HS graduation	.003			−.014
	(.015)			*(.016)*
UER – around HS graduation		.062***		.065***
		(.015)		*(.017)*
UER – after HS graduation			.026	.011
			(.016)	*(.016)*
Observations	51241	51241	51241	51241
Panel C: Literacy Skills				
UER – before HS graduation	.017			−.015
	(.025)			*(.030)*
UER – around HS graduation		.074***		.083***
		(.025)		*(.028)*
UER – after HS graduation			−.012	−.030
			(.030)	*(.033)*
Observations	51241	51241	51241	51241
Panel D: Numeracy Skills				
UER – before HS graduation	.005			−.018
	(.027)			*(.029)*
UER – around HS graduation		.056*		.065**
		(.029)		*(.030)*
UER – after HS graduation			−.003	−.018
			(.029)	*(.030)*
Observations	51241	51241	51241	51241
Panel E: Log Monthly Wage				
UER – before HS graduation	.028			.017
	(.023)			*(.024)*
UER – around HS graduation		.055		.047
		(.036)		*(.038)*
UER – after HS graduation			.015	.012
			(.033)	*(.032)*
Observations	30638	30638	30638	30638
Panel F: Training				
UER – before HS graduation	−.010			−.016
	(.015)			*(.015)*
UER – around HS graduation		.027*		.030*
		(.016)		*(.016)*
UER – after HS graduation			.029*	.020
			(.016)	*(.017)*
Observations	44488	44488	44488	44488

Notes: Ordinary least squares estimates. Dependent variable is indicated in the panel header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2. Importantly, in this table, t denotes the hypothetical year of high-school graduation. "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A9: Economic Conditions Measured by Youth Unemployment Rate (15–24-year Olds)

	Enrollment	Degree	Literacy	Numeracy	Wage	Training
Youth UER – before HS graduation	−.002	−.002	−.001	−.014	.004	−.009
	(.008)	*(.009)*	*(.016)*	*(.017)*	*(.013)*	*(.009)*
Youth UER – around HS graduation	.030***	.032***	.055***	.038**	.026	.023**
	(.009)	*(.010)*	*(.016)*	*(.018)*	*(.017)*	*(.009)*
Youth UER – after HS graduation	−.006	.007	−.011	−.005	.012	.010
	(.008)	*(.009)*	*(.016)*	*(.016)*	*(.017)*	*(.008)*
Observations	48948	48948	48948	48948	29161	42390

Notes: Ordinary least squares estimates. Dependent variables are indicated in the column header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. "Youth UER – before HS graduation" is the simple average of youth unemployment rates (15–24-year olds) in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making); "Youth UER – around HS graduation" is the simple average of the youth unemployment rates (15–24-year olds) in years t-1, t, t+1, t+2; "Youth UER – after HS graduation" is the simple average of youth unemployment rates (15–24-year olds) in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A10: Robustness Check: Adding Earlier Unemployment Rates

	Enrollment	Degree	Literacy	Numeracy	Wage	Training
UER (t-10)	−.002	−.006	−.005	.001	−.002	.004
	(.003)	*(.004)*	*(.005)*	*(.006)*	*(.005)*	*(.003)*
UER (t-9)	.003	.009	.010	.008	.005	.000
	(.006)	*(.007)*	*(.009)*	*(.009)*	*(.010)*	*(.005)*
UER (t-8)	.001	−.006	−.010	−.010	−.005	−.008
	(.007)	*(.008)*	*(.010)*	*(.012)*	*(.011)*	*(.006)*
UER (t-7)	−.006	−.004	−.006	−.004	−.008	.003
	(.007)	*(.006)*	*(.010)*	*(.011)*	*(.011)*	*(.006)*
UER (t-6)	.005	.003	.011	.007	.027**	.002
	(.006)	*(.006)*	*(.009)*	*(.009)*	*(.011)*	*(.006)*
UER (t-5)	−.003	−.007	−.007	−.003	−.028**	−.003
	(.005)	*(.006)*	*(.010)*	*(.010)*	*(.011)*	*(.006)*
UER (t-4)	.001	.007	.007	.001	.020	.001
	(.006)	*(.006)*	*(.010)*	*(.011)*	*(.012)*	*(.006)*
UER (t-3)	.001	−.004	−.009	−.003	−.004	.003
	(.005)	*(.006)*	*(.010)*	*(.010)*	*(.011)*	*(.005)*
UER (t-2)	−.001	.000	.003	−.002	−.007	−.005
	(.004)	*(.004)*	*(.007)*	*(.008)*	*(.007)*	*(.004)*
UER – around HS graduation	.058**	.057**	.086**	.100**	.112**	.073***
	(.023)	*(.025)*	*(.040)*	*(.043)*	*(.043)*	*(.024)*
UER – after HS graduation	−.004	.016	−.051	−.060*	−.047	.009
	(.016)	*(.019)*	*(.034)*	*(.033)*	*(.037)*	*(.019)*
Country FE	✓	✓	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓	✓	✓
Observations	48324	48324	48324	48324	28963	41862

Notes: Ordinary least squares estimates. Dependent variable is indicated in the column header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, and t+2 (where t denotes the hypothetical year of college decision-making); "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A11: Robustness Check: Excluding Country Groups

	Enrollment	Degree	Literacy	Numeracy	Wage	Training
Panel A: exclude countries without precise age information (Canada, New Zealand, United States)						
UER – before HS graduation	−.010	−.011	−.024	−.036	.008	−.016
	(.014)	*(.016)*	*(.029)*	*(.030)*	*(.023)*	*(.016)*
UER – around HS graduation	.076***	.076***	.090***	.076**	.085**	.038**
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.037)*	*(.016)*
UER – after HS graduation	−.012	.009	−.048	−.037	.022	.018
	(.015)	*(.017)*	*(.031)*	*(.031)*	*(.033)*	*(.016)*
Country FE	✓	✓	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓	✓	✓
Observations	40919	40919	40919	40919	23849	35678
Panel B: exclude former communist countries (Czech Republic, Estonia, Poland, Slovak Republic, Slovenia)						
UER – before HS graduation	−.023	−.036**	−.034	−.034	.001	−.013
	(.015)	*(.018)*	*(.032)*	*(.034)*	*(.028)*	*(.018)*
UER – around HS graduation	.074***	.077***	.113***	.085**	.077*	.053***
	(.017)	*(.018)*	*(.032)*	*(.035)*	*(.046)*	*(.019)*
UER – after HS graduation	−.009	.021	−.054	−.053	−.012	.004
	(.016)	*(.019)*	*(.035)*	*(.035)*	*(.040)*	*(.019)*
Country FE	✓	✓	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓	✓	✓
Observations	44211	44211	44211	44211	26846	38544

Notes: Ordinary least squares estimates. Dependent variable is indicated in the column header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. In Panel A, all countries without precise age information are excluded (Canada, New Zealand, and the United States). In Panel B, all former communist countries are excluded (the Czech Republic, Estonia, Poland, the Slovak Republic, and Slovenia). "UER – before HS graduation" is the simple average of unemployment rates in years t-5, t-4, t-3 and t-2 (where t denotes the hypothetical year of college decision-making); "UER – around HS graduation" is the simple average of unemployment rates in years t-1, t, t+1, t+2; "UER – after HS graduation" is the simple average of unemployment rates in years t+3, t+4, t+5, and t+6. Unemployment rate is divided by 10 throughout. All specifications include controls for gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A12: Robustness Check: Excluding Countries Individually

	Enrollment	Degree	Literacy	Numeracy	Wage	Training
Australia	.078***	.078***	.088***	.074**	.081**	.035**
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.037)*	*(.016)*
Austria	.079***	.082***	.090***	.077**	.072*	.038**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.038)*	*(.016)*
Belgium	.077***	.077***	.086***	.065**	.077*	.031*
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.039)*	*(.016)*
Canada	.076***	.077***	.090***	.076**	.078**	.037**
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.037)*	*(.016)*
Chile	.071***	.075***	.079***	.074**	.048	.035**
	(.015)	*(.017)*	*(.028)*	*(.030)*	*(.030)*	*(.016)*
Australia	.077***	.076***	.093***	.065**	.074*	.039**
	(.016)	*(.017)*	*(.028)*	*(.029)*	*(.038)*	*(.016)*
Denmark	.080***	.081***	.092***	.078**	.078**	.037**
	(.015)	*(.017)*	*(.028)*	*(.030)*	*(.038)*	*(.016)*
Estonia	.080***	.078***	.104***	.071**	.077**	.041**
	(.016)	*(.018)*	*(.027)*	*(.031)*	*(.039)*	*(.016)*
Finland	.068***	.063***	.102***	.095***	.071*	.030*
	(.016)	*(.017)*	*(.029)*	*(.031)*	*(.039)*	*(.017)*
France	.080***	.080***	.086***	.076**	.082**	.037**
	(.015)	*(.017)*	*(.028)*	*(.030)*	*(.038)*	*(.016)*
Germany	.077***	.080***	.095***	.081***	.072*	.038**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.039)*	*(.016)*
Greece	.082***	.083***	.089***	.077***	.074**	.044***
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.037)*	*(.016)*
Ireland	.089***	.086***	.081***	.083***	.088**	.034**
	(.016)	*(.018)*	*(.029)*	*(.031)*	*(.038)*	*(.016)*
Israel	.079***	.079***	.092***	.079**	.090**	.033**
	(.016)	*(.017)*	*(.028)*	*(.031)*	*(.039)*	*(.016)*
Italy	.079***	.079***	.092***	.078***	.082**	.037**
	(.016)	*(.017)*	*(.028)*	*(.029)*	*(.038)*	*(.016)*
Japan	.077***	.075***	.094***	.082***	.087**	.029*
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.040)*	*(.016)*
Korea	.077***	.082***	.093***	.078***	.088**	.040**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.039)*	*(.015)*
Netherlands	.076***	.076***	.091***	.082***	.080**	.039**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.038)*	*(.016)*
New Zealnd	.077***	.077***	.091***	.077***	.079**	.037**
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.037)*	*(.016)*
Norway	.080***	.081***	.096***	.085***	.086**	.036**
	(.015)	*(.017)*	*(.028)*	*(.030)*	*(.038)*	*(.016)*
Poland	.064***	.070***	.081***	.097***	.086**	.042**
	(.016)	*(.018)*	*(.031)*	*(.033)*	*(.041)*	*(.016)*
Slovak Republic	.081***	.085***	.097***	.082***	.080**	.035**
	(.015)	*(.017)*	*(.028)*	*(.030)*	*(.038)*	*(.016)*
Slovenia	.077***	.077***	.092***	.077**	.080**	.037**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.037)*	*(.016)*
Spain	.069***	.076***	.095***	.058*	.088**	.028
	(.018)	*(.020)*	*(.032)*	*(.034)*	*(.042)*	*(.017)*
Sweden	.079***	.077***	.101***	.091***	.079**	.038**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.038)*	*(.016)*
Turkey	.071***	.063***	.069**	.047	.079**	.042***
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.037)*	*(.016)*
United Kingdom	.076***	.078***	.088***	.076**	.077**	.038**
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.037)*	*(.016)*
United States	.076***	.078***	.088***	.076**	.077**	.038**
	(.016)	*(.017)*	*(.027)*	*(.030)*	*(.037)*	*(.016)*
Country FE	✓	✓	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓	✓	✓

Notes: Ordinary least squares estimates. Dependent variable is indicated in the column header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. The country indicated in the first column is excluded from the sample. Each cell reports the coefficient on "UER – around HS graduation", the simple average of unemployment rates in years t-1, t, t+1, t+2 (where t denotes the hypothetical year of college decision-making). Unemployment rate is divided by 10 throughout. All specifications include controls for unemployment rates before and after HS graduation, gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.

Table A13: Robustness Check: Excluding Age Groups

	Enrollment	Degree	Literacy	Numeracy	Wage	Training
25	.083***	.079***	.096***	.081**	.068*	.037**
	(.016)	*(.017)*	*(.027)*	*(.031)*	*(.038)*	*(.017)*
26	.076***	.079***	.101***	.088***	.094**	.035**
	(.017)	*(.018)*	*(.029)*	*(.031)*	*(.038)*	*(.016)*
27	.075***	.076***	.079***	.062*	.097***	.032*
	(.016)	*(.018)*	*(.029)*	*(.031)*	*(.037)*	*(.017)*
28	.069***	.070***	.072**	.063**	.080**	.028*
	(.015)	*(.017)*	*(.028)*	*(.032)*	*(.037)*	*(.016)*
29	.077***	.078***	.099***	.076**	.078**	.035**
	(.017)	*(.017)*	*(.030)*	*(.031)*	*(.038)*	*(.016)*
30	.079***	.082***	.097***	.091***	.094**	.053***
	(.016)	*(.017)*	*(.029)*	*(.030)*	*(.038)*	*(.015)*
31	.080***	.079***	.097***	.075**	.092**	.039**
	(.016)	*(.017)*	*(.028)*	*(.031)*	*(.037)*	*(.016)*
32	.075***	.077***	.093***	.080***	.084**	.034**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.037)*	*(.016)*
33	.075***	.079***	.083***	.072**	.080**	.036**
	(.016)	*(.017)*	*(.028)*	*(.030)*	*(.039)*	*(.016)*
34	.079***	.076***	.099***	.087***	.088**	.034**
	(.017)	*(.018)*	*(.029)*	*(.032)*	*(.041)*	*(.017)*
35	.066***	.067***	.087***	.065**	.075*	.039**
	(.016)	*(.018)*	*(.030)*	*(.031)*	*(.041)*	*(.017)*
36	.070***	.072***	.089***	.082**	.067**	.038**
	(.016)	*(.018)*	*(.028)*	*(.032)*	*(.031)*	*(.017)*
37	.081***	.079***	.082***	.079**	.072*	.032**
	(.016)	*(.018)*	*(.029)*	*(.031)*	*(.041)*	*(.016)*
38	.072***	.072***	.087***	.076**	.087**	.044***
	(.017)	*(.018)*	*(.028)*	*(.030)*	*(.040)*	*(.016)*
39	.080***	.079***	.088***	.077**	.048	.041**
	(.015)	*(.017)*	*(.027)*	*(.030)*	*(.030)*	*(.016)*
Country FE	✓	✓	✓	✓	✓	✓
Cohort FE	✓	✓	✓	✓	✓	✓

Notes: Ordinary least squares estimates. Dependent variable is indicated in the column header. Sample: PIAAC respondents 25–39 years old, excluding individuals who obtained their highest educational level abroad. Furthermore, individuals of the age indicated in the first column are excluded from the sample. In countries without precise age information, the 5-year age cohort that includes the indicated age is excluded. Specifications on labor-market outcomes additionally exclude current students. Monthly wages are not reported for PIAAC respondents in Turkey, hence the country is excluded in specifications using monthly wages. Each cell reports the coefficient on "UER – around HS graduation", the simple average of unemployment rates in years t-1, t, t+1, t+2 (where t denotes the hypothetical year of college decision-making). Unemployment rate is divided by 10 throughout. All specifications include controls for unemployment rates before and after HS graduation, gender, migrant status, mother's and father's education, number of books at home at age 15, as well as country and birth-year fixed effects. Robust standard errors, clustered at the country × year-of-birth level, in parentheses. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. *Data source:* PIAAC 2012/2015.