



Predicting the Skill Proficiency of Central European Adults: The Role of Higher Education, Work Experience, and Socioeconomic Background in “Credential Societies”

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Abstract

In this study, I use data from the PIAAC 2012 survey and instrumental variable regression to identify predictors of adult skill proficiency in three Central European countries. I find that higher education attainment and work experience are both predictive of cognitive skill proficiency, and that even after accounting for differences in socioeconomic background, higher education credentials in Central Europe capture important information about adult skills.

Keywords: higher education, cognitive skills, international survey, human capital, Central Europe

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Introduction

Skills can be defined as “personal qualities” that are “expendable”, “productive”, and “socially determined” (Green, 2013, p. 10). Skill formation is endorsed as an effective policy for increasing individual and societal well-being by national governments and influential intergovernmental organizations alike (e.g., UNESCO, 2012; World Bank, 2011). The Organisation for Economic Co-operation and Development (OECD) calls skills “the global currency of 21st-century economies” and warns that “without adequate investment in skills, people languish on the margins of society, technological progress does not translate into economic growth, and countries can no longer compete in an increasingly knowledge-based global society” (OECD, 2012, p. 10).

Higher education attainment is frequently used as a measure of skill supply, both at the individual and at the societal level (e.g., Barro & Lee, 2013; OECD, 2014). However, using higher education attainment as a proxy for the stock of highly skilled individuals in any given country is problematic for at least two reasons. First, focusing on higher education attainment “does not take account of the skills and experience gained after formal education” (Barro & Lee, 2013, p. 192). In addition, it is not just an individuals’ desire to increase their future earnings through increased productivity but also societal forces that influence higher education attainment (Perna, 2006). An individuals’ socioeconomic background plays an important role in determining who enrolls in, and completes, tertiary education programs.

Understanding the extent to which higher education attainment captures information about differences in individual productivity rather than about socioeconomic background or work experience may be especially important in “credential societies.” Collins (1979) proposed the concept of the credential society to describe the increasing reliance on educational credentials for hiring in twentieth century United States as a mechanism to limit access to well-paid or “elite” positions to individuals from high socioeconomic background. Findings from prior research suggest that Central European countries fit Collins’ (1979) characterization of the credential society at least to some extent. Matějů and Anýžova (2014) found that the association between socioeconomic background and formal education, and the association between formal education and earnings were stronger in the Czech Republic, Poland, and Slovakia compared to Belgium, Denmark, and the Netherlands.

It is unclear to what extent higher education attainment in Central Europe sends signals to prospective employers about one’s socioeconomic background, and to what extent about one’s productivity, as measured by skill proficiency. In this study, I compare and contrast predictors of adult skill proficiency in three Central European countries - Czech Republic, Poland, and Slovakia - to address this knowledge gap.

Guiding Perspectives

The economic theory of human capital assumes that individuals develop skills because doing so increases their productivity, and increased productivity is rewarded by higher wages in the labor market (Becker, 1993). The two primary sites of skill formation in modern societies are schools and firms; individuals may develop their skills through formal education or through on-the job training and work experience (Becker, 1993; Hillmert, 2008). All else being equal, individuals with higher levels of educational attainment and more work experience are expected to have higher skill proficiency (Edin & Gustavsson, 2008; Hanushek et al., 2015; Mellander, 2014).

When empirically testing the relationship between educational attainment, work experience, and adult skills, the expectation that a higher level of educational attainment and more work experience will be positively associated with skill proficiency may be confounded by the negative relationship between the attainment of higher education and work (Mellander, 2014). While many individuals participate in paid employment during higher education, a substantial proportion of university students either fully or partially abstains from paid employment during their studies (Passaretta & Triventi, 2015; Perna, 2010; Weiss et al., 2014). Without accounting for the endogeneity of work experience in explaining variation in adult skill, estimates of the strength of association between educational attainment and adult skill, and between work experience and adult skill may be biased (Mellander, 2014).

Prior research assessed the extent to which adult cognitive skill proficiency is determined by a combination of formal education and labor market experiences. In a study of the four Nordic countries, Mellander (2014) found evidence that higher education attainment and paid work experience were positively associated in all four countries, and across most skill domains. He also found that a certain type of cognitive skill (numeracy) was associated with experience in work settings and in formal educational settings to a comparable degree, while other types of cognitive skills (literacy and problem-solving in technology-rich environments) were more strongly associated with higher educational attainment than with comparable years of paid work experience (Mellander, 2014).

While there is evidence that both educational attainment and work experience are predictive of adult skill proficiency (Mellander, 2014), theory and prior research also suggest the need to account for variation in demographic characteristics and the nature of the work experience to better estimate the strength of the association between higher education attainment and adult skill. Moreover, age must be accounted for, since older individuals tend to have higher levels of educational attainment and more work experience than young adults (Mellander, 2014). Differences in gender and number of children must be accounted as well due to the differences in typical patterns of female and male employment in European countries. In the Nordic countries, number of children was inversely related to years of paid work experience among women but positively related

to years of paid work experience among men, after accounting for differences in age and educational attainment (Mellander, 2014).

Findings from prior research suggest that socioeconomic status (SES) is positively associated with higher levels of educational attainment and occupational prestige in many countries (Collins, 1979; Matějů & Anýžova, 2014; Marginson, 2016). The type of labor force participation is important to account for, because findings from prior research suggest that time out of work may be associated with a decline in cognitive skills (Edin & Gustavsson, 2008). Lastly, findings from prior research suggest that work experience in occupations that typically employ highly skilled workers may provide more opportunities for skills development than low-skilled or unskilled occupations, suggesting the importance of accounting for differences in workers' occupation (Green, 2013; Mellander, 2014).

Empirical Approach

To compare predictors of skill proficiency among Central European adults, I used instrumental variable regression to answer two research questions:

1. What are the relationships between higher education attainment, work experience, and adult skill proficiency in the selected Central European countries, after controlling for differences in socioeconomic background, demographic characteristics, employment status and occupation type?
2. How do the relationships between higher education attainment, work experience, and adult skill proficiency vary across the selected Central European countries?

Data

I used data from the Programme for the International Assessment of Adult Competencies (PIAAC) 2012 International Survey of Adult Skills to identify predictors of adult skill proficiency among adults who live in one of three Central European nations: Czech Republic, Poland, and Slovakia. The PIAAC survey was developed by the OECD and is administered to adults aged 16 to 65 by authorities in participating countries. The selection of Central European nations for this study is based on data availability: only three of the four Visegrad countries participated in PIAAC 2012.²

To implement PIAAC, participating countries are required to sample a minimum of 5,000 individuals in their country based on a multi-stage, random sampling design (OECD, 2013a). The resulting PIAAC samples are nationally representative when sample weights are applied. PIAAC measures adult skills in three domains: literacy, numeracy, and problem-solving in technology-rich environments. The surveys are administered in

² The fourth Visegrad country, Hungary, is scheduled to participate in the third round of PIAAC, which will conclude in 2019 (Education Counts, n.d.).

national languages and, depending on the country, may involve administering the survey in multiple languages within the same country. Survey items were developed to be valid cross-culturally and cross-nationally. Public use data files from PIAAC 2012 are available for researchers on the OECD's website.

Methods

I modelled my study based on a study conducted by Mellander (2014), who used PIAAC 2012 data to test the relationships between work experience and adult skills in the four Nordic countries. I fit instrumental variable regression models very similar to the ones Mellander (2014) proposed, with minor differences, to the data from the three Visegrad countries.³

The analytical samples in this study consist of adults aged 20 to 65 who had at least one year of paid work experience. Similarly to Mellander (2014), I excluded adults without work experience to be able to account for the indirect role of educational attainment on skills through its direct link to work experience. I excluded adults aged 16 to 19 from the analytic samples, because even if these young adults have paid work experience, it is likely qualitatively different from the work experiences available to adults once they conclude upper secondary education (Mellander, 2014). I also excluded from the analytic samples all observations that had missing values on any of the variables included in the regression models.

The instrumental variable regression approach involves fitting two equations per model: one equation to predict work experience, and another equation to predict adult skill proficiency (Mellander, 2014). In the second equation, the predicted values of the endogenous variable from the first equation (i.e., work experience) are used as an instrument. In the first equation, work experience is a function of age, the quadratic term of age⁴, educational attainment, gender, number of children, and an interaction term between gender and number of children:

Equation (1)

$$\text{Work Experience} = g(\text{Age} + \text{Age}^2 + \text{Educational Attainment} + \text{Gender} + \text{Number of children} + \text{Gender} \times \text{Number of children}) + \varepsilon_1$$

³ The difference between the models fitted in this study and that of Mellander's (2014) is that I did not control for differences in receipt of on-the-job training and differences in the industry where PIAAC participants were employed. The focus of Mellander's study is on the role of work experience in explaining adult skill proficiency, while the focus of my study is on the role of higher education attainment.

⁴ The relationship between age and adult skill may not be perfectly linear if cognitive skills deteriorate as individuals age; the quadratic term is included to capture potential nonlinearity in this relationship.

In the second equation, adult skill proficiency is the function of age, the quadratic term of age, parental education, educational attainment, employment status, the predicted value of work experience from the first equation, and occupational type:

Equation (2)

$$\text{Skill} = h(\text{Age} + \text{Age}^2 + \text{Parental Education} + \text{Educational Attainment} + \text{Employment Status} + \text{Predicted Work Experience} + \text{Occupation Type}) + \varepsilon_2$$

Work experience in Equation (1) is operationalized as years of part-time or full-time paid work experience during the individual's lifetime.⁵ The outcome variable in Equation (2), adult skill proficiency, is operationalized as the individuals' PIAAC 2012 proficiency score in the three domains of literacy, numeracy, and problem-solving in technology-rich environments. Predicted work experience in Equation (2) is not a measure of actual work experience, but the predicted years of work experience instrumented on number of children and its interaction with gender from Equation (1).

Instrumental variable regression is a method used for mitigating omitted variable bias (Schneider et al., 2007). Work experience and adult cognitive skills are both presumed to be correlated with ability, i.e., cognitive capacity that pre-dates the cognitive development that is hypothesized to occur in formal and informal educational settings and at work. Since ability is not observed in the PIAAC data, the omission of this variable biases the ordinary least square estimate of the relationship between work experience and adult cognitive skill proficiency. To mitigate this bias, I used the number of children and its interaction with gender as instruments in a two-stage least squares regression framework. Following the example of Mellander (2014), I selected these variables for instrumenting work experience because they are correlated with paid work experience in my analytic dataset, and because I assume that they are not correlated with (unobserved) ability.⁶ If my assumption is correct, then the estimate of the relationship between predicted work experience and adult skill proficiency in Equation (2) will be unbiased by pre-existing differences in ability (Schneider et al., 2007).

I used STATA 13 software to process and analyze publicly available PIAAC 2012 data files. I ran a total of 12 regressions: three first-stage equations, one each for the Czech Republic, Poland, and Slovakia; and nine second-stage equations for the three countries in each of the three skill domains. All analyses of PIAAC data must account for the fact that the PIAAC dataset includes so-called "plausible values". The use of "plausible values" is an approach

⁵ The question corresponding to variable "C_Q09" was: "In total, approximately how many years have you had paid work? Only include those years where 6 months or more was spent in either full-time or part-time work." (OECD, n.d.)

⁶ Using number of children and its interaction with gender for instrumenting work experience would be problematic under the assumption that high-/low-ability individuals of a particular gender self-select into having fewer/more children. Mapping the relationship between ability, gender, and fertility decisions falls outside the scope of this research.

common to large-scale surveys that involves statistical imputation to minimize missing information (Wu, 2005). To mitigate concerns about bias in the estimation of population parameters that may result from imputation, I followed best practices in averaging across the ten “plausible values” of the outcome variables when calculating point estimates and standard errors. In all analyses, I used sample weights and bootstrap replications for variance estimation in line with OECD guidelines for using PIAAC data (OECD, 2013a).

Findings

In this section, I report the results of the regression models. The findings are based on analytic samples that represent 3.2 million adults in Slovakia, 6.1 million adults in the Czech Republic, and 21.4 million adults in Poland. Analytic samples exclude adults younger than 20 years old, adults with no work experience, and observations with missing values on variables used in the regression models.

Predictors of skill proficiency among Central European adults

Table 1 reports results from Equation (2) in the three Central European countries by skill domain; the dependent variable is adult skill proficiency in the respective domain. The analytic samples used in these regressions were created by combining all three country samples into one. While the analytic samples of the models used in the literacy and numeracy domains are identical, the analytic sample size for the problem-solving domain is substantially smaller, because groups of respondents who were determined by PIAAC staff as not meeting minimum computer literacy requirements to display proficiency in problem-solving in technology-rich environments were excluded from the imputation of plausible values for this domain. As such, regression results from Models 1 and 2 (literacy and numeracy) can be readily compared with each other, but comparison of coefficients between Models 1 and 2 on the one hand, and Model 3 on the other hand, should be avoided.

Table 1. Results from regression analyses predicting skill proficiency among Central European adults, by skill domain

	Model 1: Literacy			Model 2: Numeracy			Model 3: Problem-solving		
	Coefficient	P > t	Sign. Lev.	Coefficient	P > t	Sign. Lev.	Coefficient	P > t	Sign. Lev.
Predicted years of work experience	0.419	0.233		2.495	0.000	***	5.032	0.000	***
Age	-0.792	0.240	*	-2.359	0.000	***	-5.371	0.000	***
Age squared	0.004	0.188		-0.007	0.128		-0.021	0.000	***
Parental education									
Upper secondary	9.855	0.000	***	10.489	0.000	***	9.948	0.000	***
Tertiary	16.294	0.000	***	21.222	0.000	***	23.422	0.000	***
Employment status									
Unemployed	0.178	0.845		1.226	0.524		7.129	0.000	***
Out of the labor force	-1.347	0.129		-0.181	0.909		6.177	0.001	**
Not known	-4.454	0.779		-2.572	0.767		6.278	0.700	
Occupation type									
Semi-skilled white collar	-9.163	0.000	***	-9.716	0.000	***	-9.057	0.000	***
Semi-skilled blue collar	-17.783	0.000	***	-17.558	0.000	***	-19.874	0.000	***
Elementary	-18.877	0.000	***	-18.502	0.000	***	-17.219	0.000	***
Has not worked more than five years	-12.961	0.000	***	-3.818	0.261		16.842	0.001	**
Educational attainment									
Lower secondary or less	-16.73	0.000	***	-18.81	0.000	***	-5.646	0.014	*
Post-secondary, non-tertiary	7.911	0.000	***	4.978	0.001	**	3.700	0.043	*
Tertiary - professional	17.198	0.000	***	13.246	0.010	**	8.755	0.000	***
Tertiary - bachelor's degree	15.022	0.000	***	15.678	0.000	***	11.710	0.000	***
Tertiary - master/research degree	23.749	0.000	***	24.899	0.000	***	25.975	0.000	***
Cons.	274.634	0.000	***	297.764	0.000	***	390.910	0.000	***
n (unweighted)	15382			15382			9718		
R2	0.24			0.20			0.03		

Source: PIAAC 2012.

* denotes significant association at alpha level=0.05, ** denotes significant association at alpha level=0.01, and *** denotes significant association at alpha level=0.001. The reference categories are: "below upper secondary education" for parental education; "employed" for employment status; "skilled occupation" for occupation type; and "completed upper secondary education" for educational attainment.

Perhaps as a result of differences in the composition of the analytic samples across domains, the independent variables explain 24% and 20% of the variation in the dependent variable in the literacy and numeracy domains, respectively, while the same independent variables explain only about 3% of the variation in the problem-solving domain. The direction of association between higher education attainment and skill proficiency is positive, as predicted by the conceptual framework. Central European adults who attained some form of tertiary credential scored, on average, 8 to 25 points higher on PIAAC than individuals who had the same observable socioeconomic and demographic characteristics and work experiences but only attained upper secondary education. These differences in mean scores correspond to about one fifth to over one-half of a standard deviation in skill proficiency between adults with and without tertiary educational attainment.

After accounting for differences in demographic and socioeconomic background, educational attainment, employment status and occupational type, the predicted years of paid work experience among Central European adults is positively associated with proficiency in numeracy and problem-solving in technology-rich environments. However, it is not associated with proficiency in literacy. Parental education, a proxy for socioeconomic background, is strongly predictive of adult skill proficiency across all three skill domains. Parental attainment of a tertiary education credential is associated with 16 to 23 higher scores on PIAAC across the three skill domains, compared to the PIAAC scores of adults whose parents had not attained upper secondary education.

Country-by-country variation in predictors of skill proficiency

Figures 1.a. through 1.c. report regression results from Equation (2) in the three Central European countries separately by skill domain. The outcome variable is adult skill proficiency (as measured by PIAAC 2012) in the respective domain. Thus, the dots represent the regression coefficients for each predictor variable, while the whiskers around the dots represent 95% confidence intervals around the point estimates.

Figure 1.a. Regression results in the literacy skill domain. Data: PIAAC 2012.

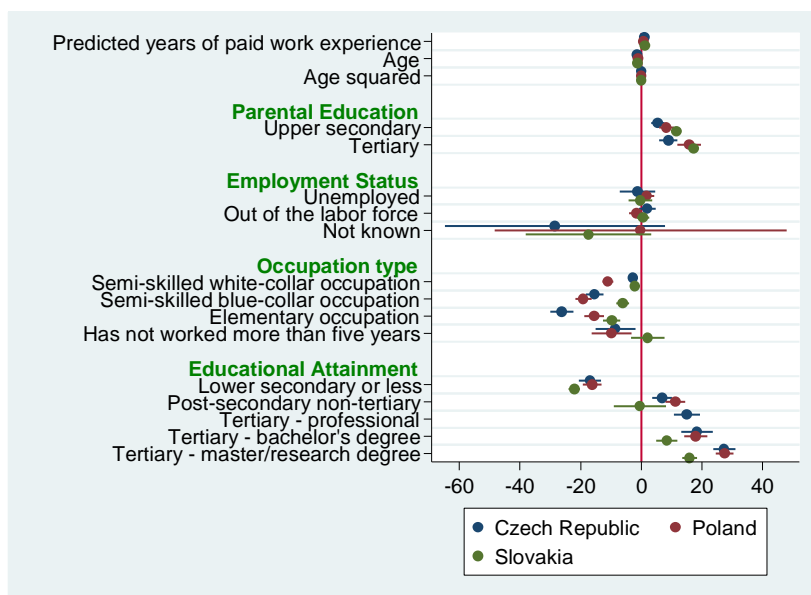


Figure 1.b. Regression results in the numeracy skill domain. Data: PIAAC 2012.

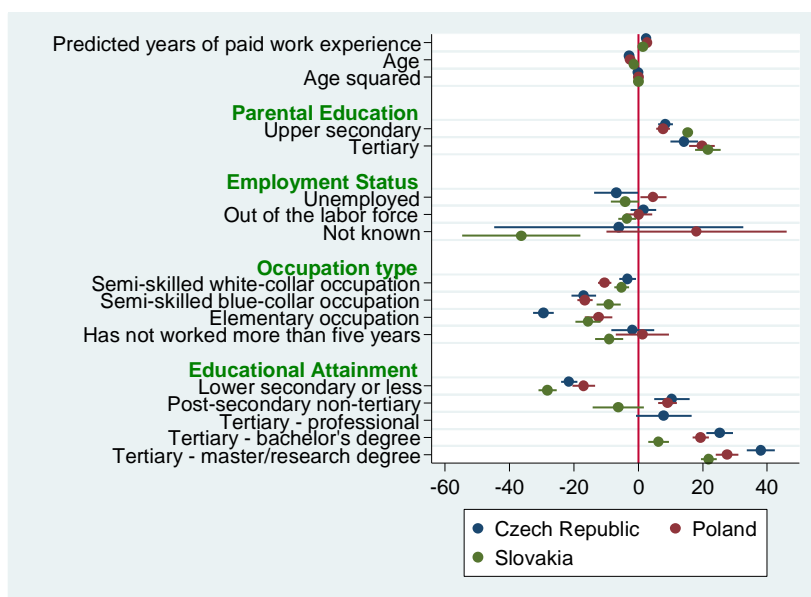
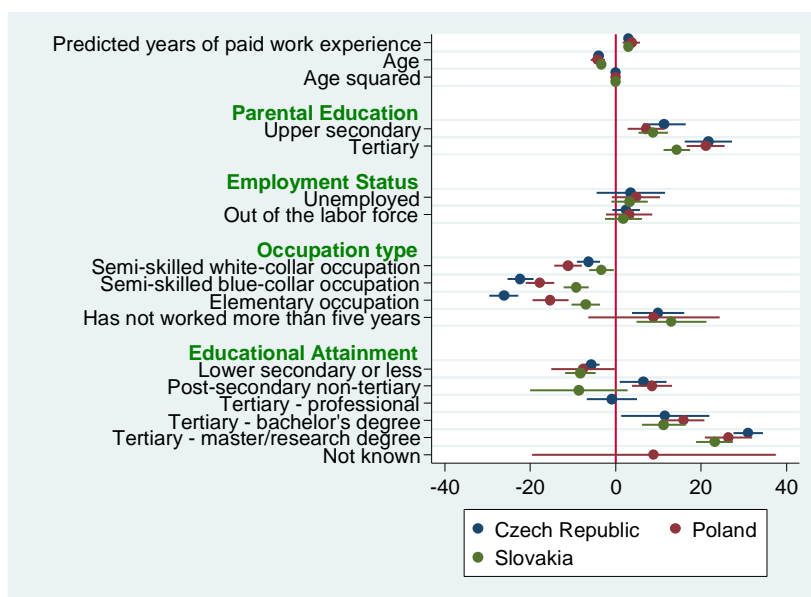


Figure 1.c. Regression results in the problem-solving skill domain. Data: PIAAC 2012.



Note: Cross-country comparisons within the ‘problem-solving in technology-rich environments’ domain must be undertaken with the caveat that “the populations for whom proficiency scores for problem solving in technology-rich environments are reported are not identical across countries” (OECD, 2013b, p. 72).

There is a country-based variation in the relationship between higher education attainment and adult skill proficiency. Table 2 reports the unstandardized and standardized regression coefficients for higher education attainment by country and skill domain from Equation (2). While holders of bachelor’s and master degrees in all three Visegrad countries performed better on the PIAAC 2012 test in all three skill domains than adults who only attained upper secondary education, the skill proficiency advantage associated with having a bachelor’s or a master degree is greater in Poland and the Czech Republic than in Slovakia in the literacy and numeracy domains. For example, Slovak

adults with a bachelor's degree on average scored only 0.14 standard deviations (SD) higher in the numeracy domain compared to other Slovak adults with only upper secondary attainment, compared to a 0.39 SD score difference in Poland and a 0.59 SD score difference in the Czech Republic. Similarly, Slovak adults with a bachelor's degree outperformed other Slovak adults with only upper secondary attainment with an average of only 0.22 SD in literacy, compared to a 0.38 SD score

Table 2. Relationship between higher education attainment and adult skill proficiency in the three Central European countries. Data: PIAAC 2012.

Skill domain	Country	CoefBachelor	β Bachelor	CoefMaster	β Master
Literacy	CZ	18.41	0.46	27.36	0.68
	PL	17.92	0.38	27.44	0.57
	SK	8.42	0.22	15.93	0.41
Numeracy	CZ	25.29	0.59	38.09	0.88
	PL	19.38	0.39	27.6	0.55
	SK	6.33	0.14	21.93	0.48
Problem-solving	CZ	11.61	0.26	31.07	0.69
	PL	15.97	0.32	26.46	0.54
	SK	11.28	0.30	23.19	0.62

Note: "Coefs" denote the unstandardized regression coefficient, while " β s" denote the standardized regression coefficient, of having attained a bachelor's degree or a master / research degree, compared to the reference category of upper secondary educational attainment. The full regression output is available from the author upon request.

Discussion and Conclusion

Findings from this study provide evidence that: 1) Central European adults with higher education attainment and more work experience display higher cognitive skill proficiency than comparable adults without tertiary degrees and less work experience; and 2) higher education credentials capture important information about adult cognitive skill proficiency in Central Europe, even after accounting for differences in work experience and socioeconomic background. These findings are discussed in more detail in the following sections.

Credential and work experience are both predictive of skills, to varying degrees

Both levels of higher education attainment (bachelor's and master / research degree) are predictive of higher skill proficiency among Central European adults across all three cognitive skill domains. Moreover, an additional year of paid work experience (as predicted by gender and number of children) is predictive of higher skill proficiency in the numeracy and problem-solving domains, but not universally and not substantially so in the literacy domain.⁷ These findings are similar to the pattern found in the Nordic countries (Mellander, 2014).

⁷ The association between paid work experience and adult literacy is significant at alpha level=0.05 in the Czech Republic and in Slovakia, but the association is not substantial. Czech and Slovak adults with an additional year of work experience scored, on average, less than one-tenth of a standard deviation higher on the literacy proficiency test than comparable adults with less work experience.

Findings from this and other studies (Matějů & Anýžova, 2014; Mellander, 2014) suggest that work experience is a better predictor of adult skill proficiency in the numeracy and problem-solving skill domains than it is of proficiency in the literacy skill domain. In contrast, higher education attainment is predictive of higher adult skill proficiency across all three cognitive skill domains measured in PIAAC 2012. A possible interpretation of these findings is that adult literacy proficiency in Central Europe and in the Nordic region may be predominantly developed through institutions of formal education rather than through on-the-job training or informal learning at work. Meanwhile, numeracy and problem-solving skills may be developed both at institutions of formal education, as well as (formally and informally) through paid work.⁸

Higher education credentials capture important information about skills

The findings from this study provide evidence that adults with bachelor's and master / research degrees display higher skill proficiency across all three cognitive skill domains than comparable adults without such credentials. The observational nature of this study does not allow for causal inference. It is possible that instead of developing skills, institutions of higher education in Central Europe are simply effective in selecting individuals who already display higher than average cognitive skill proficiency. Alternatively, an interplay of causation and selection may explain the observed strong positive association between higher educational attainment and adult skill proficiency. Future research should establish the relative contribution of each mechanism to variation in adult skill proficiency.

While findings from this study are not appropriate for arbitrating between the competing explanations offered by human capital theory and credentialism, they do provide evidence that higher education credentials in Central Europe capture important information about the skill proficiency of university graduates. Similarly to Matějů and Anýžova (2014), I also found that parental education is highly predictive of adult skill proficiency across all three domains in the Central European countries. Nevertheless, the strength of association between higher education attainment and adult skill proficiency in Central European countries indicates that university graduates perform at levels of skill proficiency that are even higher than what is predicted by their (typically high) socioeconomic status. Specifically, Central European adults with a bachelor's degree performed 0.14 to 0.59 standard deviation higher than comparable adults with upper secondary attainment, depending on the country and skill domain. Adults with master / research degrees performed 0.41 to 0.88 standard deviation higher than comparable adults with upper secondary attainment, depending on the country and skill domain.

Findings from this study shed light on cross-country variation in the relationship between higher education and adult cognitive skills in Central Europe. The skill advantage of

⁸ The significant and substantive association between adult literacy proficiency and parental education also suggests the important role of informal education that occurs within the family.

having a bachelor's degree was smaller in Slovakia in both the literacy and numeracy domains compared to the skill advantage of having a bachelor's degree in the Czech Republic and Poland in 2012. In the recent past, higher education policies and practices in Slovakia differed from those in the Czech Republic and Poland: the tertiary participation rate in Slovakia was lower, while the proportion of total public expenditure on higher education that is provided directly to households was higher than in the other two countries (Czarnecki, 2014). It is unclear whether either of these differences may be related to the relatively lower skill advantage of having a bachelor's degree in Slovakia. Future research should explore what characteristic of the national context in Slovakia may explain this distinct pattern within the region.

Concluding thoughts

To conclude, findings from this study contribute to the evidence base for higher education policy in Central Europe. The finding that Central European adults with higher education credentials tend to display higher cognitive skill proficiency than comparable adults without such credentials is perhaps not surprising. However, the study makes a novel contribution to understanding the process of skill formation in the Central European region in three ways.

First, this study mitigates bias in estimating the relationship between higher education attainment and adult skill proficiency by accounting for the confounding effect of socioeconomic background and work experience, and provides standardized estimates of the skill advantage of having a bachelor's or master / research degree, compared to upper secondary attainment. Secondly, findings from this study shed light on differences in predictors of adult skill proficiency across domains. A possible interpretation of study findings is that skill formation in Central European countries may take place in both formal educational settings and at work, and that work experience may be particularly important for developing numeracy skills and problem-solving skills in technology-rich environments. Lastly, by documenting cross-country differences in predictors of adult skill proficiency in this region, findings from this study confirm the important role of national context in understanding how adult cognitive skills are formed in Central Europe, and elsewhere.

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