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Working Paper

How Did EU Membership of Eastern Europe Affect Student Achievement?

ifo Working Paper, No. 299

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Bergbauer, Annika B. (2019) : How Did EU Membership of Eastern Europe Affect Student Achievement?, ifo Working Paper, No. 299, ifo Institute - Leibniz Institute for Economic Research at the University of Munich, Munich

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Imprint:

ifo Working Papers

Publisher and distributor: ifo Institute – Leibniz Institute for Economic Research at the University of Munich

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An electronic version of the paper may be downloaded from the ifo website:

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How Did EU Membership of Eastern Europe Affect Student Achievement? *

Abstract

The accession of Eastern European countries to the European Union increased family wealth and the returns to schooling. I analyze the change in student achievement due to the EU accession of Eastern Europe building on a panel of six PISA waves covering more than 1 million students in 32 countries. Using a difference-in-differences approach I find a positive and statistically significant link of EU membership to reading scores by one decile of a standard deviation. Mediation analysis suggests school efficiency, family wealth, and family structure as key transmitters of EU membership to student achievement.

JEL Code: I28, H52, L15, D82, P5

Keywords: European Union, student achievement, PISA

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* I gratefully acknowledge comments from seminar participants of the ifo Center for the Economics of Education. I thank especially Ludger Wößmann, Natalie Obergruber, and Lukas Mergele for their suggestions.

1. Introduction

While we currently experience Euroscepticism with the Brexit and increasing vote shares of nationalistic parties, research agrees on the economic benefits of European Union (EU) membership at the country level (Darvas 2018)¹. Individual-level consequences of EU membership for adults have been investigated (Sinn et al. 2001; Crespo Cuaresma, Ritzberger-Grünwald & Silgoner 2008; Dobson 2009; Baldwin & Wyplosz 2012), but empirical evidence on adolescents is scarce. This paper examines the consequences from EU membership for student achievement and suggests a positive influence of EU membership on student skills through higher family wealth and increased school efficiency.

Expectations on the consequences for adolescents from the EU accession of Eastern Europe divide into an economic and a political dimension.² Economically, EU membership liberates the trade of goods and labor. Classic economic theory predicts rising welfare on the macro- and on the micro-level because a greater variety of goods and services are available at lower prices and employment increases. As a result, national economies and individual households become wealthier, because the higher developed Western EU countries attract lower skilled labor from Eastern Europe. Hence, returns to (further) education increase. Richer families associate with higher performing children (Carneiro & Heckman 2002; Dahl & Lochner 2012; Bulman et al. 2017). Yet, more parental employment comes at cost of family time in which children and adults interact. At its extreme, parents may leave the family (temporarily) to migrate for work. This may decrease student achievement (Banerji, Berry & Shotland 2013; Bergman 2014). In sum, it is unclear how increased parental employment due to EU membership may affect student achievement.

¹ For example, the 2004 accessions augmented GDP per capita by 12 percent across all member states and cost-benefit analysis suggest that benefits outweigh the costs of accession (Campos, Coricelli & Moretti 2014).

² There is also a psychological dimension, such as an increase in life satisfaction due to EU accession (for Romania and Bulgaria, see Nikolova und Nikolaev (2017) and Zapryanova & Esipova (2016)). Yet, my data provides only scarce information on attitudes and aspirations and I therefore do not regard psychological consequences from EU accession. Still, I capture a social dimension of EU membership when analyzing family structure.

Politically, EU membership changes processes in the accessing countries because European standards aim at raising efficiency and fairness in policy making incentivized by a report system (European Council 2017).

To investigate the effect of EU membership on student achievement, I build a country panel from six waves over 15 years of the Programme for International Student Assessment (PISA). My sample contains 1,073,652 students in 32 countries.³ The successive entry of eleven Eastern European countries between 2004 and 2013 offers an ideal setting for a difference-in-differences approach.⁴ Hence, I regress student achievement on a dummy of EU membership. In the search of mechanisms of transmitting EU membership to student achievement, I consider several inputs to the human capital production function.⁵ First, I use the inputs as alternative outcomes to the treatment of EU membership to verify whether they are well-identified.⁶ Second, I use the inputs as covariates to the main specification (of regressing student achievement on EU membership) which provides explorative, non-causal evidence.⁷

The main specification yields a positive and significant estimate of EU membership on student achievement by a decile of a standard deviation (SD). In explorative evidence, I detect well-identified mechanisms transmitting EU membership to student achievement. Verifying results using mediation analysis yields the following three key mediators of the treatment effect. First, the largest shift in the estimate EU membership on student achievement comes from conditioning on school efficiency measured by student tests for

³ Cyprus and Malta participated only two times in PISA which fails my criterium of having participated at least three times to make meaningful comparisons over time.

⁴ In 2004, Poland, the Czech Republic, Hungary, the Slovak Republic, Slovenia, Estonia, Lithuania, and Latvia entered the EU. In 2007, Bulgaria and Romania followed and Croatia entered in 2013.

⁵ The human capital production function was formalized by Hanushek (1970) and (1979) and more recently by Hanushek and Woessmann (2011) as $Y_i = f(I_i, R_i, F_i, A_i)$. The education outcome Y_i captures skills measured by test scores from (large-scale) assessments at individual level i . The input factors are intuitions I_i , school resources R_i , family background F_i , and student ability A_i .

⁶ If the alternative outcomes react to the treatment of EU membership, they are well-identified.

⁷ Bad controls are potential outcome variables to the treatment themselves and should not be included as control variables where estimates may have a causal interpretation. Bad controls are potential outcome variables because they determine after the treatment. To employ those controls determined after the treatment, one needs explicit assumptions on the timing of control, treatment, and outcome variables. In contrast, relevant variables measured before the treatment is determined are good controls and cannot become an outcome variable of the treatment (Angrist & Pischke 2009).

external comparisons, teacher absence and shortage, and school location in a city. Second, family wealth influences the effect of EU membership on student achievement measured by lower-status parental occupation. Lastly, single parenting seems to shift the effect of EU membership on student achievement. Hence, mechanisms comprise family, school, and institutional factors.

Difference-in-differences necessitates three key assumptions on the consistency of the treatment and control populations. First, the parallel-trends assumption requires that treated and untreated countries would follow the same trend in the absence of the treatment. This is violated if untreated countries experience a deterioration in student achievement. This may be caused by the comparison group of non-EU Eastern European countries investing less in skills because they expect to replace low-skilled labor in the new Eastern EU members states. For example, the Ukrainian plumber replaces the Polish plumber instead of becoming a financial accountant because the Polish plumber emigrated to work in Germany.

Figure 1 depicts the parallel trends in students' reading achievement.⁸ Additionally, a placebo test where the outcome variable leads the treatment variable by one period yields an insignificant estimate close to zero of EU membership on student achievement.⁹ Testing for lagged outcomes yields a small, positive, and significant estimate of EU membership on lagging student achievement. This indicates that EU membership continued to have an effect one period after accession. In summary, the graphical evidence and the placebo test suggest that the parallel trends assumption holds.

The second assumption on constant populations refers to the stable unit treatment variable. This necessitates the absence of spillovers from the treatment to the control group, i.e. if untreated countries react to the EU accession of Eastern Europe. This means

⁸ Note, that the volatility of the control group of never members (grey markers) originates from its heterogenous composition of Albania, Iceland, Montenegro, Norway, and Serbia, which are observed in PISA in different points in time. The upward kink in 2003 stems from low-performer Albania (378 points on average) missing in 2003 and 2006, while Montenegro (410 points on average) and Serbia (431 points on average) participated in PISA for the first time in 2006. To mitigate concerns on results being driven by this heterogenous comparison group, I subsequently exclude each country in my robustness analysis in Section 6.3.

⁹ As PISA is surveyed every three years, one period equals three years.

that permanent Western EU members decrease in academic performance because they invest less in skills in expectation of hiring highly qualified labor from Eastern EU-Europe. For example, Hungarian medical doctors are hired in Germany, while Germans pass on becoming medical doctors. This may be a reality for some doctors, but it seems unlikely on the large scale and across several professions. One reason is that Western EU-Europe's competitive advantage relies on highly qualified human capital.

The third key assumption on steady populations refers to a change in a country's population composition due to selective emigration. Usually, migration is selective towards higher ability and higher status. Yet, the Western European labor markets demand lower skilled labor. If low ability families emigrate from Eastern European entrant countries and leave behind higher performing students, the effect from EU membership on student achievement is upward biased. I compute the migration ratio as number of emigrants relative to their home population and regress student achievement on it. The coefficient is zero, which is potentially due to the small ratio of 0.001. Hence, even though there is explorative evidence of negative selection into emigration¹⁰ and with it those low-ability students disappear from their home country achievement, the treatment of EU membership would be overestimated by the remaining higher achievers. Yet, the number of violators is too small to affect my results.

Additionally, I test for sample composition at the country level and ensure the findings are not driven by one single country or wave.

My results relate two strands of the literature. First, indirect evidence of the EU altering incentives to education comes from the literature on the returns to skills.¹¹ A few well-identified studies investigate returns to skills when countries transit from communism to EU membership. Increasing returns seem to incentivize raising educational attainment and achievement (Fleisher, Sabirianova & Wang 2005; Farchy 2009; Anniste et al. 2012; Botezat & Pfeiffer 2014; Staneva & Abdel-Latif 2016). While the PISA data has no

¹⁰ See *Selective Emigration* in Section 6.1.

¹¹ There is no empirical evidence on the effect of EU membership on student outcomes.

information on returns to schooling in earnings, my results suggest an increase in family asset wealth and an increase in parental employment due to EU membership, which co-move with higher earnings. Explorative evidence suggests family asset wealth and parental employment are mechanisms that increase student achievement.

A second strand of literature regards the link of family structure and student achievement. Disrupted families, where less than two parents are present, associate with lower student achievement (Wuertz Rasmussen 2009; Francesconi, Jenkins & Siedler 2010; Tartari 2015). Yet, selection complicates causal analysis of family structure and student outcomes, as disrupted families tend to be of disadvantaged socio-economics status. For example, single-parent families seem to have lower employment rates, lower earnings, and more instable relationships (Ermisch & Francesconi 2001; Gruber 2004). Addressing the endogeneity issue using family-fixed effects or instrumental variable approaches, yields small or zero estimates of student outcomes due to family disruption (Björklund & Sundström 2006; Björklund, Ginther & Sundström 2007; Sanz-de-Galdeano & Vuri 2007; Francesconi, Jenkins & Siedler 2010). Using a difference-in-differences approach with repeated observations at the country level, suggests an increase in disrupted families due to EU membership. Disrupted families appear to be a mechanism of EU membership decreasing student achievement.

This paper continues as follows: In Section 2, I present background information on the influence of EU membership on education in Eastern Europe. Section 3 introduces the empirical strategy, followed by the description of the data in Section 4. The results are presented in Section 5 – divided into main results and mechanisms as outcomes and as covariates. Section 6 reports robustness checks and Section 7 concludes.

2. Impact of EU Membership on Education

EU membership affects educational outcomes of adolescents in Eastern Europe through economic and political mechanisms, which are intertwined: the political decision to access the EU demanded institutional prerequisites which in turn produced economic

consequences. Before accessing the EU by the *Treaty of Membership, a Process of Stabilization and Association* installs the *Copenhagen Criteria*; comprising democracy, rule of law, and human rights (European Council 2017). To implement these criteria, Eastern European institutions have modernized by reducing corruption and realizing more just processes applying human rights, such as freedom of choice realized in travel, work, study, investment, and retirement (Nikolova & Nikolaev 2017). After accessing the EU, a single market integrated formerly planned economies in free trade under competitive pressure.¹² Some countries even introduced the Euro currency (Halász 2015).¹³ Capital and labor were legalized to flow freely and employment increased domestically and abroad.¹⁴ For example, employment in Eastern Europe increased from 68 to 73 percent, between 2000 and 2017 (Eurostat 2018b). Overall, economic development has been built on local business, foreign direct investment and trade, employment regulations, policy facilitation, and structural funds (Nikolova & Nikolaev 2017).¹⁵ Hence, EU membership advanced political institutions and economic development in general, which probably augmented family wealth. As a result, one would expect from wealthier families to have academically higher achieving children.

Education policy is also influenced by EU membership, most likely through *soft coordination*.¹⁶ Central instrument are the *Education and Training* frameworks, most recently *ET 2020* that allow member states to cooperate (OECD 2015; 2016b; 2016a). For example, one of the *ET 2020* goals aims at a minimum of 40 percent of people aged 30–

¹² The Soviet Union ended in 1991 – nine years before my period of analysis starts and thirteen years before the first wave of Eastern European countries access the EU. Therefore, I do not expect aftermaths of the fading socialism to disrupt my analysis.

¹³ Slovenia, the Slovak Republic, Estonia, Latvia, and Lithuania introduced the Euro currency.

¹⁴ Free movement of labor was regulated by a 2+3+2-transformation model, where the United Kingdom, Ireland, and Sweden allowed labor migration immediately with EU membership. Two years later, Spain, Portugal, Finland, and Greece opened their market. Only seven years after the first round of accessions, in May 2011, Germany and Austria granted free labor migration to the 2004 entrants. For the 2007 entrants, Romania and Bulgaria, Germany allows migration since 2014. One year later, Croatia received the legal right to free labor movement to Germany (bpb 2016).

¹⁵ In contrast, economic analysis of earlier rounds attributed benefits of EU accessions to investment in physical capital (Baldwin & Sheghezza 1996) and in technological innovation (Rivera-Batiz & Romer 1991).

¹⁶ Soft coordination or the open method of coordination (OMC) is the EU's instrument which does not produce legislative binding rules but recommendations evaluated by one another (European Union 1998-2019).

34 having completed higher education in each member state. To achieve this higher education goal, preceding education levels need to provide quality education. As a result, higher quality at all levels of education may increase with EU membership. Another EU education policy is the provision of extensive funding, e.g. the *European Social Fund* (ESF) for investments into human capital, such as teacher training or new school curricula (European Commission 2013).¹⁷ As a result, more school resources (efficiently used) may increase academic performance of EU entrants

Overall, EU membership has affected education in Eastern Europe politically through more efficient institutions and economically through increasing funding and family wealth. Hence, one would expect an increase in student achievement from EU membership.

3. Empirical Strategy

I use a difference-in-differences approach on a country panel over time to identify the effect of EU membership on student achievement. The estimation equation is as follows:

$$A_{i,c,t} = \beta EU\ member_{c,t} + \lambda X_{i,t} + \mu_c + \mu_t + \varepsilon_{i,c,t} \quad (1)$$

The dependent variable $A_{i,c,t}$ is student achievement of student i in country c at time t . The variable of interest is $EU\ member_{c,t}$, and takes the value zero for a country c in time t which is not a member of the EU, and the value one for member states. The matrix $X_{i,t}$ captures student level covariates i in time t . Country-fixed effects μ_c account for unobserved time-invariant country characteristics, such as higher education funding in one country compared to another country. Time-fixed effects μ_t account for period-specific factors, such as a global trend towards more education. $\varepsilon_{i,c,t}$ is an individual-level error term clustered at the country level which is the treatment level. To shows that results

¹⁷ The ESF 2007-2013 supported human capital with € 25.5 billion (European Commission 2013).

are robust despite the small number of clusters (32), I bootstrap standard errors for the main results following Cameron, Gelbach & Miller (2008).¹⁸

Equation (1) identifies estimates of β from country-level variation over time. The coefficients are unaffected by systematic, time-invariant differences across countries. Hence, countries that do not change their EU membership status in the observation period do not contribute to the estimation of the coefficient β . This difference-in-differences approach builds on four assumptions.

First, the common trends assumption necessitates countries to develop parallelly in student achievement in the absence of the treatment. One advantage of the difference-in-differences approach is that EU membership does not need to be random, only the assumption of parallel trends needs to hold. I show parallel trends in Figure 1 with decomposed control groups according to permanent EU (black markers) and permanent non-EU members (grey markers), and decomposed treatment groups according to the three accession waves (red, green, and blue markers). The figure suggests parallel trends.¹⁹

Second, the stable unit treatment variable assumption denies spillovers from treated to untreated countries, i.e. student achievement changes without the change of a country's EU membership status. For example, the comparison group of non-EU Eastern European countries invests less in skills because they expect to succeed low-skilled labor in the new Eastern EU members states. For example, the Ukrainian plumber replaces the Polish plumber instead of the Ukrainian becoming a financial accountant because the Polish plumber emigrated to work in Germany. Another case of untreated countries reacting to the EU accession of Eastern Europe occurs if original Western EU members decrease in academic performance due to expecting to hire highly qualified labor from Eastern EU-Europe. This may be the case for Hungarian medical doctors working in Germany, but is

¹⁸ Bootstrapping the complete analysis would lead to very long computation times.

¹⁹ Note, that the volatility of the control group of never members (grey markers) originates from its heterogenous composition of Albania, Iceland, Montenegro, Norway, and Serbia, which are observed in PISA in different points in time. The upward kink in 2003 stems from low-performer Albania (378 points on average) missing in 2003 and 2006, while Montenegro (410 points on average) and Serbia (431 points on average) participated in PISA for the first time in 2006. To mitigate concerns on results being driven by this heterogenous comparison group, I subsequently exclude each country in my robustness analysis in Section 5.5.3.

seems unlikely to occur on a large scale because Western EU-Europe's competitive advantage relies on highly qualified human capital.

Third, the population composition remains constant. If individuals migrate between countries and select into or out of treatment, the assignment is not random. For example, if families of low socio-economic background with low student achievement emigrate from their Eastern European countries and the remaining population is of high socio-economic background with high student achievement, my analysis will be upward biased. I will eliminate this concern in Section 6.1.

Fourth, there are no country-specific changes over time in unobservables between treatment and control, such as economic shocks or improving school quality to one group. For example, if the Czech Republic introduced a policy to support school children of low-socio economic status, estimates would be biased. Hence, I condition the analysis on various school and institutional measures; such as school resources, teacher background, school autonomy and accountability, and government funding. Results are reported in Section 5.3. Further robustness checks on this assumption are shown in Section 6.4.

4. Data

I use six waves of the Programme for International Student Assessment (PISA), conducted every three years between 2000 and 2015. The survey tests 15-year-old students independently of the educational institution or grade they attend. Students' competencies in the subjects reading, math, and science are elicited by a two-hour test of tasks varying in difficulty. Using item response theory, achievement in each domain is plotted on a scale with student achievement to a mean of 500 points and a standard deviation of 100 points. Countries employ a two-stage sampling design. First, they draw a random sample of schools in which 15-year-old students are enrolled (with sampling probabilities proportional to a school's number of 15-year-old students). Second, they randomly sample 35 students of the 15-year-old students in each school. The aim is to ensure random sampling of schools and students and to monitor testing conditions in

participating countries. I exclude countries that do not meet the standards.²⁰ PISA does not follow individual students over time, but the repeated testing of representative samples of students creates a panel structure for countries observed every three years. I consider all European countries with and without EU membership.²¹ I require countries to participate at least three out of six waves, to deduct meaningful comparisons over time. My final sample contains 1,073,652 students in 32 countries. Summary statistics are displayed in Appendix Table 1 and the frequency with which a country participated in PISA is displayed in Appendix Table 1: **Summary Statistics**

Variable	Treatment group		Control Group	
	Mean	<i>Std. dev.</i>	Mean	<i>Std. dev.</i>
<i>Student characteristics</i>				
Reading score	476.9	98.65	490.2	101.0
Math score	483.7	95.02	490.8	96.17
Science score	490.8	96.53	493.4	100.0
Age	15.75	0.319	15.75	0.290
Female	0.494	0.500	0.499	0.500
Migrant student	0.020	0.138	0.062	0.241
Consumer goods	-0.397	0.993	0.178	0.987
Cultural goods	0.129	0.971	-0.044	1.016
<i>Number of books</i>				
0-10	0.123	0.329	0.126	0.332
11-100	0.473	0.499	0.461	0.498
101 – 500	0.183	0.387	0.183	0.387
> 500	0.135	0.342	0.142	0.350
Home educational resources	-0.025	0.759	-0.003	0.971
<i>Parental characteristics</i>				
Migrant parent	0.094	0.292	0.135	0.342
<i>Parental education</i>				
No education	0.001	0.0374	0.012	0.107
Primary	0.004	0.065	0.03	0.170
Lower secondary	0.034	0.182	0.1	0.297
Upper secondary I	0.138	0.345	0.105	0.306
Upper secondary II	0.395	0.489	0.252	0.434
University	0.427	0.495	0.504	0.500

²⁰ The Netherlands in 2000 and the United Kingdom in 2003. I exclude any country-by-wave observation for which the entire data of a background questionnaire is missing; as in France from 2003-2009 (missing school questionnaire) and Albania in 2015 (missing student questionnaire). Liechtenstein was dropped due to its small size.

²¹ Non-members are Albania, Montenegro, Serbia, Switzerland, Iceland, and Norway. Permanent EU members are Austria, Belgium, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Sweden (for a list of EU membership status by country over time, see Appendix Table 4).

Parental work status

Mother works full time	0.660	0.361	0.509	0.407
Mother works part time	0.0891	0.214	0.202	0.326
Mother looks for work	0.0916	0.215	0.0598	0.188
Mother has other work status	0.158	0.362	0.232	0.472
Father works full time	0.761	0.323	0.815	0.310
Father works part time	0.083	0.204	0.0739	0.209
Father looks for work	0.068	0.188	0.0414	0.155
Father has other work status	0.097	0.231	0.0939	0.248
Share imputed	0.423	0.494	0.353	0.478

(Continued next page.)

Variable	Treatment group		Control Group	
	Mean	Std. dev.	Mean	Std. dev.
<i>Parental occupation</i>				
Manager	0.147	0.354	0.163	0.369
Professionals	0.169	0.375	0.217	0.413
Technicians	0.146	0.353	0.137	0.344
Clerical	0.065	0.246	0.0822	0.275
Services and sales	0.171	0.376	0.154	0.361
Skilled agriculture/ forestry/ fishing	0.029	0.167	0.022	0.147
Craft and trade	0.135	0.342	0.090	0.286
Plant and machine operators	0.0509	0.220	0.043	0.203
Elementary	0.0570	0.232	0.051	0.220
<i>Family structure</i>				
Without parents	0.0267	0.120	0.015	0.098
Single mother	0.143	0.265	0.124	0.262
Single father	0.0205	0.105	0.0194	0.113
Share imputed	0.423	0.494	0.353	0.478
<i>School characteristics</i>				
<i>Location</i>				
Village (less 3,000)	0.106	0.308	0.0845	0.278
Town (3,000-15,000)	0.207	0.405	0.250	0.433
Large town (15,000-100,000)	0.371	0.483	0.403	0.490
City (100,000-1,000,000)	0.248	0.432	0.189	0.392
Large city (>1,000,000)	0.068	0.251	0.0584	0.235
Share imputed	0.020	0.111	0.015	0.120
Private	0.0426	0.202	0.170	0.375
Share imputed	0.016	0.125	0.01	0.094
Number of students	565.7	336.3	693.7	459.7
Share imputed	0.024	0.157	0.036	0.186
Share of government budget	1.976	10.03	7.837	24.89
Share imputed	0.042	0.189	0.047	0.211
Shortage of math teachers	0.0821	0.275	0.183	0.386
Fully certificated teachers	0.919	0.196	0.899	0.213
Share imputed	0.073	0.260	0.040	0.197

(Continued next page.)

Variable	Treatment group		Control Group	
	Mean	Std. dev.	Mean	Std. dev.
<i>Teacher absence as problem</i>				
not at all	0.427	0.495	0.223	0.416
a little	0.442	0.497	0.583	0.493
Some	0.0706	0.256	0.129	0.335
a lot	0.0102	0.100	0.013	0.114
Share imputed	0.199	0.399	0.171	0.376
<i>Education system</i>				
School autonomy	0.505	0.500	0.607	0.363
School autonomy x initial GDP	2.321	3.531	18.46	14.37
<i>Tests</i>				
School-based external comparison	0.663	0.142	0.515	0.270
Student-based external comparison	0.499	0.410	0.585	0.375
Standardized monitoring	0.741	0.117	0.641	0.166
Internal testing	0.707	0.123	0.662	0.161
Internal teacher monitoring	0.649	0.0987	0.387	0.236
Government expenditure on secondary	21.88	4.554	25.71	4.524
Share imputed	0.101	0.301	0.072	0.259
N	1,073,652			

Note: The treatment group consists of the eleven Eastern European countries accessing the EU. The control group consists of countries which either are always or never members of the EU in the period 2000 to 2015.

Appendix Table 2.

In the following, I present the variables which are considered as outcome and control variables. Test score in reading, the main outcome, varies between 2000 and 2015 by Eastern European country, as depicted in Figure 2. Especially Bulgaria, Romania, and Hungary experienced large changes. Top-performing Eastern European countries are Estonia and Poland scoring at the level of the Netherlands, while weak-performing Eastern European countries are Bulgaria and Romania scoring between non-EU members Montenegro and Serbia.

Following the education production function, I aim at including control variables at the student, parent, family, school, and country level. At the student level, I examine student gender, age, and migrant background.

At the parent level, I consider parental background as reported in the student questionnaires. I observe whether at least one parent was born abroad and the highest education level of both parents categorized by the International Standard Classification of Education (ISCED) into no education, primary, lower secondary, upper secondary I, upper secondary II, or university.

Parental work status could be full time, part time, searching, or other. The item was not asked in 2006 and not in 2015, which I ipolate at the country level to maintain a maximum number of observables.²²

The type of parental occupation is documented in the International Standard Classification of Occupations (ISCO) in nine gradings (manager, professional, technician, clerical, services and sales, skilled agriculture/ forestry/ fishing, craft and trade, plant and machine operator, and elementary), which was asked in every wave.

At the family level, I use wealth and family composition. Family wealth is represented by four items. First, I exploit the student background questionnaire to capture family

²² Ipolation on student level is impossible, due to resampling of a nationally representative population each wave. Without ipolation, I would lose half the sample; for some variables, I would lose up to three quarters. I report and control for the ipolated share of all variables.

wealth by the survey's index of consumer goods constructed from an own room, access to internet, number of phones, TVs, computers, cars, bathrooms, and DVD players. The family wealth index is provided in every survey wave. Second, I use the survey index cultural goods consisting of literature books, poetry, and art work. The cultural goods index was asked every year except in 2009, which I ipolate at the country level. Third, I use the number of books at home in five categories: 0-10, 11-100, 101-200, 201-500, and more than 500 books. The books variable was gathered every year. Lastly, I employ the home educational resources index consisting of a study desk, a quiet study place, a computer for school work, educational software, books for school work, technical reference books, and a dictionary. The home educational resource index was constructed in every survey wave.

To capture family structure, I use the student item "Who lives in your home?" and create binary variables for single mother, single father, or no parents, but living with sisters, brothers, grandparents, or other individuals.²³ It was asked in 2000, 2003, 2009, and 2012. Hence, I ipolate the waves 2006 and 2015 at the country level.

At the school level, I use the following items from the principal questionnaire: city size in five categories in which the school is located (village of less than 3,000 inhabitants; town of 3,000-15,000; large town of 15,000-100,000; city of 100,000-1,000,000; and large city of more than 1 million), private or public operator, number of students, share of government funding, shortage of math teachers, share of fully certified teachers, and degree to which teacher absence is a problem in four categories (not at all, a little, some, a lot). In 2006, teacher absence was not asked and I impute it.²⁴

²³ To eliminate concerns that disrupted families significantly differ from nuclear families, I report socio-economic characteristics of each family composition before and after EU membership in Appendix Table 5.

²⁴ If a whole country lacks answers in a specific wave, I ipolate: in Sweden in 2015, the school characteristics number of students, private or public operator, share of school budget from the government, city size. The share of fully certified teachers is missing in Denmark in 2006, 2012, and 2015; in Bulgaria in 2012; in Spain in 2009; in Hungary in 2000, 2012, and 2015. The number of students is missing in Albania in 2012; and in Austria in 2012 and 2015. Private or public operator is not reported for Bulgaria in 2006. The share of government budget misses for Austria in 2003, 2006, 2009, and 2015. Iceland does not provide the city size in 2000. In contrast, individual missing variables are not replaced.

At the country level, I use the share of schools with academic-content autonomy and its interaction with initial GDP per capita (Hanushek, Link & Woessmann 2013) because one expects better information locally instead of centrally dependent on the level of development of a country.

To capture school accountability, I employ the share of schools in a country using different forms of student test, such as (i) school-based tests for external comparison, (ii) student-based tests for external comparison, (iii) standardized monitoring, (iv) internal testing, and (v) internal teacher monitoring. These measures were developed by Bergbauer, Hanushek & Woessmann 2018).

Lastly, I consider expenditure on education as share of GDP from the World Bank of which I interpolate missing values at the country level.

5. Results

This section first reports the main results on the impact of EU membership on student achievement, in Eastern Europe (Sub-Section 5.1). Testing mechanisms of transmitting the country-level decision to individual education outcomes, I examine the influence of EU membership on several inputs of the human capital production function at individual, parental, family, school, and country level (Sub-Section 5.2). In a second step, I investigate mechanisms using the well-identified variables from above as covariates to the main specification (Sub-Section 5.3).

5.1 Main Results on the Effect of EU Membership on Student Achievement

Table 1 shows the estimation results of the main specification in the country panel model. Regressions are weighted by students' sampling probabilities within countries, giving equal weight to each country-by-wave cell across countries and waves. Standard errors are clustered at the country level throughout. The dependent variable is the test score in one of the three subjects: reading, math, and science. Columns 1, 3, and 5 show the base model. Columns 2, 4, and 6 show the model with time- and country-fixed effects. The coefficient of *EU member* suggests that entering the EU is related to a statistically

significant increase in reading achievement at the five percent level. The effect magnitude is a quarter of a standard deviation for the base model and a tenth of a standard deviation when applying country- and time-fixed effects. The point estimate of EU membership on math achievement is of similar magnitude in the base and in the fixed-effects model compared to reading achievement, but it is not statistically significant. In contrast, the EU-membership coefficient on science achievement in the base model is of similar magnitude and significance compared to reading achievement, but the EU-membership coefficient is not statistically significant, small, and negative in the fixed-effects model. This difference across subjects may be due to universally applicable numeracy skills opposed to language- and country-specific literacy skills or due to measurement error. Overall, there is no significant difference between the subjects. In the following, I concentrate on reading achievement.

To cater concerns on the low number of clusters (32), I wild-bootstrap standard errors 1,000 times and report p-values in square brackets below the clustered standard errors. As expected, significance levels decline, but the pattern remains: estimates of EU membership on reading are significant in the fixed-effects model, but not on math or science. Overall, the main specification suggests a positive effect of EU membership on student achievement.

5.2 Results on the Effect of EU Membership on Alternative Outcomes

This sub-section documents the influence of EU membership on several inputs of the human capital production function. If the inputs did change with EU membership, they are well identified, but bad controls in the sense of Angrist & Pischke (2009).

The three key individual level characteristics – age, gender, and migrant background – are shown in Table 2. The point estimates of EU membership seem unrelated to student gender and age. This is plausible, as tested students were begotten sixteen years prior to the study and parental fertility preferences seem unlikely to be influenced in advance to EU membership.

In contrast, the EU-membership estimate suggests that entering the EU is related to a significant decrease in first generation migrants by 3.4 percentage points. This reflects

that migration from other countries to Eastern Europe has decreased due to EU membership. This finding appears counter-intuitive to the EU's aim of increasing the population's mobility. Yet, relocating the EU's external borders to the Balkan may have complicated settlement for foreigners because the new member states may have controlled their borders more sincerely and had more to lose. Furthermore, together with a significant estimate of EU membership on reading skills, this may hint at the importance of language skills for migration.

Table 3 reports the effect of EU membership on parental characteristics. The estimate suggests that entering the EU is related to a significant decrease in parental migration by the same magnitude as of students (3.5 percentage points). This suggests joint migration of children and parents. Columns 2 and 3 of Panel A show that lower levels of parental education were unaffected by EU membership. Parental education should be unaffected by EU membership as it was likely to be completed before their surveyed children experienced the policy shift. In contrast, EU membership seems to significantly decrease higher levels of education by three to seven percentage points. It is plausible to observe a decrease in parents' higher education, as EU membership increased returns to schooling. In reality, average annual net earnings of a single person in the eleven Eastern European EU entrants increased from 3,022€ to 7,482€, between 2000 and 2015 (Eurostat 2018a). This is in line with research from Norway, where the unexpected discovery of oil resources increased returns to lower education and decreased educational attainment (Bütikofer, Dalla-Zuanna & Salvanes 2017).

Panel B of Table 3 reports estimation results for parental work status. The coefficient of EU membership is never significant for mothers. In contrast, the point estimate of EU membership for fathers working full time is significant at the ten percent level, suggesting an increase by 3.7 percentage points. The point estimate of EU membership for fathers looking for work is significant at the five percent level, suggesting a decrease by 2.1 percentage points.

Panel C of Table 3 reports estimation results for parental occupation. The coefficient of EU membership suggests that parents were significantly less employed as professionals

by 2.7 percentage points and more as clericals by 1.5 percentage points, in services and sales by 1.8 percentage points, and in elementary jobs by 1.8 percentage points.

Overall, Table 3 suggests a decrease in parental migration and a decrease in parental higher education, while fathers seem to work more and parents work rather in low-status occupation. These results are in line with expectations where Western EU Europe demands low-qualified labor

Table 4 reports outcomes of the impact of EU membership at the family level. In panel A, family wealth is expected to rise with EU membership due to an expansion of parental labor. The estimate suggests that entering the EU is related to a significant increase in consumer goods by 18 percentage points, while cultural goods decline by a similar magnitude. Additionally, the EU membership coefficient suggests a highly significant decrease in having more than 100 books at home by seven to two percentage points. In contrast, the EU membership coefficient is insignificant for educational resources. This surprising result suggests a shift in consumer preferences towards an expansion of status goods at the cost of intellectual goods.

Panel B shows estimates on the family structure. The estimate suggests that entering the EU is related to a significant increase in single parents by 3.1 percentage points for mothers and 1.4 percentage points for fathers. At its most lonely form, EU membership seems to significantly increase the share of children living without any parent by 1.5 percentage points. Hence, EU membership created *Euro orphans*.

Overall, EU membership seems to have increased status goods at the cost of intellectual goods and seems to have disrupted families.

Table 5 shows results at the school level. In panel A, the point estimate suggests that entering the EU is related to an increase in schools located in villages by 3.8 percentage points and a decrease in towns by 3.9 percentage points and in large towns by 6.6 percentage points. This shift to the countryside is consistent with international goals of increasing access to schools in remote rural areas (see the Millennium Development Goal No. 2).

Panel B reports results on school resources, which were likely increased by EU funding. The point estimate of EU membership suggests a reduction in the number of students per school by 11.5 percent and a decline in math teacher shortages by 5.4 percentage points. This suggests an improvement in school resources. Whether the resources were transformed effectively into student learning is examined in Section 5.3, where school resources are employed as covariates to the effect of EU membership on reading achievement. Other school characteristics, such as private or public operation, the share of government budget, the share of certified teachers, and problems with absent teachers show no significant link to EU membership.

At the country level, the EU's soft coordination may have triggered policy reforms. Estimation results are documented in Table 6. The point estimate of EU membership does not significantly link to school autonomy. This may be due to decentralization of the socialist school systems right after the dissolution of the Soviet states and not due to EU accession.

School accountability seems to be significantly affected by EU accession in some dimensions. The EU membership coefficient suggests a decrease in school-based tests with external comparisons by 9.4 percentage points and a decrease in internal teacher monitoring by 7 percentage points, while student-based external tests with external comparisons increased by 28.6 percentage points. Standardized monitoring and internal testing seem unaffected by EU membership. These estimates support that accountability regimes gained strength in the 2000s by shifting from internal testing to standardized tests with external comparability.

Another country-level education determinant is government expenditure on secondary education. The point estimate suggests a small negative, though insignificant, link of EU membership to government expenditure on secondary education. This may be due to a reduction in domestic education funding in response to increased EU funding.

In conclusion, estimates of EU membership suggest ambiguous effects for educational input factors. On the one hand, the share of adolescent and adult migrants decreased, fathers work more, families own more status goods, schools are more rural and have more

resources, and accountability shifted from internal to external testing. On the other hand, parental higher education decreased, parents work in lower-status jobs, intellectual goods diminished, and parents left their children. Hence, while material wellbeing seems to have improved, while social wellbeing deteriorated.

5.3 Mechanisms to the Effect of EU Membership on Student Achievement

In this sub-section, I employ reading score as outcome to EU membership conditional on the inputs to the human capital production function used as outcomes in the previous sub-section. In the preceding section, some of these variables were affected by the treatment. Hence, they are well-identified though bad controls of the main specification and serve as explorative, non-causal evidence. As a robustness check, I show results from mediation analysis at the end of this section.

The following tables expand its predecessors by a new first column to report the main specification in a reduced sample. The reduced sample results from missing observations in variables, which should not be imputed. Hence, samples vary, but most samples count more than 1 million observations, except for the samples including school- and country-level mechanisms. The succeeding columns report results conditional on mechanisms.

Table 7 suggests that the point estimate of EU membership on reading scores decreases slightly in magnitude and significance by 2 points conditional on student characteristics. Gender and age show positive and significant estimates on student achievement. Yet, they manifest pre-treatment. Thus, gender and age are good controls and no mechanisms. Migrant status shows a negative and significant estimate on student achievement and was well-identified in Section 5.2. Still, the coefficient of EU membership remains almost unchanged. Hence, student migrant status is a minor mechanism of EU membership influencing student achievement.

Parental characteristics as mechanisms are displayed in Table 8. In panel A, the estimate of EU membership shrinks marginally (1 point) when conditioning on parental migrant

status. Hence, migrant status is a minor mechanism of transmitting EU membership to student achievement.

Conditioning on parental education yields positive and significant estimates increasing in size when moving from primary to university level. The coefficient of EU membership increases by 4 points. This may be due to more educated parents tend to have information or skills to derive advantages in student achievement from EU membership. As a result, parental education is a relevant and well-identified (as of Section 5.2) mechanism.

Panel B presents the estimates of EU membership on student achievement conditional on parental labor. The point estimate of EU membership remains similar to the main specification when adding mechanisms for maternal and paternal work status. The estimates of parental work status are significant and positive – except for mothers looking for work – and significant and negative for fathers – except for fathers with other work status. These findings suggest that working mothers increase student achievement, while working fathers decrease it. This may be linked to the different kinds of work, hours away from home, income, and time spend with the child by mothers and fathers which I do not observe in my data.

In contrast, the coefficient of EU membership increases by 3 points conditional on parental occupation. Higher status occupations, such as professionals or technicians, expose a positive estimate on student achievement. Among the negative estimates, elementary occupations expose the largest coefficient because low-status occupations tend to link to other dimensions of low socio-economic and low ability background resulting in low student achievement. Yet, the interplay of socio-economic background and student achievement seems unrelated to parental involvement, as correlation analysis shows.²⁵

Table 9 reports estimates for family characteristics. The estimate of EU membership increases markedly in magnitude and significance by 6 points conditional on family wealth. The estimates of consumer and cultural goods, the number of books, and home

²⁵ See pairwise correlations of Appendix Table 6. Correlation coefficients are small and indicate little connection. I fall back to pairwise correlations, because PISA background questionnaires provide items on parent-child interactions in single waves. I do not run regressions drawing on only one wave, but report pairwise correlations.

educational resources are large, positive, and significant. Especially possessing more than 500 books seems to link to an advantage in reading scores. This may be due to high socio-economic status, , i.e. many of books or highly educated parents which may incentivize children to read. Similar to the previous section, consumer goods have a larger coefficient than cultural goods.

Conditional on family structure, the estimate of EU membership shows not very responsive (1 point), while the coefficients of single mother and single father are significant, large, and negative.

Potential mechanisms at the school level are documented in Table 10. The EU-membership estimate is unaffected qualitatively by potential school mechanisms, even for the well-identified characteristics, such as number of students and shortage of math teachers. As previous studies have shown, school resources are no strong predictors of student achievement (Hanushek & Rivkin).

Table 11 shows mechanisms at the country level.²⁶ The EU membership coefficient is slightly affected by a decrease of 2 points. The estimate of school autonomy is of expected size but insignificant. In the setting of EU accession, this is not surprising, as former socialist countries may have decentralized their education system already in the 1990s. Tests for external comparison (school-based and student-based) and internal testing yield positive point estimates, while internal teacher monitoring and standardized monitoring yield negative point estimates. This is consistent with Bergbauer, Hanushek & Woessmann (2018). The positive estimate of internal testing, which informs or monitors progress without external comparability and internal teacher monitoring including inspectorates, was originally found for poorly performing countries when entering the PISA study. The findings suggest that more targeted information creates stronger incentives, i.e. that incentives to students with consequences for their school career and with external comparability are more tangible and contribute more to student achievement. In contrast, testing seems to set adverse incentives to teachers. Importantly,

²⁶ The sample shrinks due to fewer observations of national tests used for student career decision from Eurydice (2009).

the results on EU membership effects are not confounded by the potentially coincidental introduction of policies that alter autonomy and accountability.

Surprisingly, expenditure on secondary education yields a negative but small significant estimate on student achievement given the other country-level mechanisms, which hints at an inefficient use of school resources.

In summary of the country-level mechanisms, the institutional frame, i.e. accountability, seems to be more decisive for student achievement than the economic conditions of a country.

In a final exercise of conditioning on mechanisms, I include the entire set of mechanisms as reported in Appendix Table 3. The coefficient of EU membership shows unaffected (from 14.298 points without mechanisms in the available sample to 15.736 points with all mechanisms). The fact that results are insensitive to the included set of relevant mechanisms reduces concerns that estimates are strongly affected by omitted variable bias from unobserved characteristics (in the sense of Altonji, Elder, and Taber (2005)).

As bad controls suffer from endogeneity and selection bias, mediation analysis seems to deliver more causal evidence under the assumption on the exogeneity of the mediator. Mediation analysis was pioneered by IMAI et al. (2011).²⁷ Two additional assumptions are necessary. Beyond the standard assumption of random treatment assignment across pre-treatment confounders (e.g. EU accession is exogenous to student gender), mediation analysis demands that the observed mediator is independent of potential outcomes and confounders given the actual treatment (e.g. parental occupation given EU accession and pre-treatment confounders). Thus, conditional on other confounders, the mediator is exogenous to the outcomes, i.e. student achievement. As a result, mediation analysis

²⁷ The “*mediation*” package implements a command in Stata following Hicks & TINGLEY (2011).

yields the quantity of how much of the treatment is transmitted by the mediator.²⁸ I report this share in a row for each mediator in Table 12.²⁹

Similar to the traditional approach of including controls, mediation analysis suggests that the largest share of mediated effects on the student level comes from migrant status (6.8 percent). At the parental level, mediation analysis assigns a small share of mediated effects of the treatment to parental education and medium shares to parental work status and large shares to parental occupation. Yet, the largest shares expose craft and trade (13.6 percent) and plant and machine operators (11.4 percent). Mediation analysis assigns a large share of the treatment effect to single mothers (12.4 percent) and single fathers (10.6 percent). At the school level, mediation analysis suggests large mediating effects on the treatment from school location in a city with 100,000 to 1 million inhabitants (16.6 percent), a shortage of math teachers (10.8 percent), and a little and a lot of teacher absence (18.6 percent and 25.1 percent). Concerning country-level mediators, student-based tests for external comparison expose the largest share of mediated effects (39.1 percent).

Overall, mediation analysis suggests similar effects to mediate the effect of EU membership on student achievement as traditional controls do: school efficiency, family wealth, and family structure.

6. Robustness Tests

My findings prove robust to several potential caveats. I consider selective migration, anticipation or delay of the effect from EU membership, sample composition, and alternative fixed effects.

²⁸ The package allows to include each mediator separately, but not several at the same time.

²⁹ Note, that I executed mediation analysis in a panel on country-wave level, as computations are not possible in a panel at the individual level due to limited memory capacity. I compare estimates of the main specification in the country-wave level data to the individual level data in Appendix Table 7. Further, the mediation command does not support country- and wave-fixed effects in this setting. Therefore, I residualized the two fixed effects in the main specification following Frisch & Waugh (1933).

6.1 Selective Emigration

This subsection aims at providing evidence on fulfilling the difference-in-differences assumption of an unchanged population. This intention is complicated by PISA's resampling of a representative set of students in every wave instead of an actual panel following the same students over time. Changes in the population pose a problem if estimates are overvalued. Usually, migration is selective towards higher ability and higher status groups of a country. Yet, the Western European labor markets demand for lower skilled labor and Eastern European emigrants seem to be of lower status. The left-behind home population may be more able and their children achieve higher student test scores. As a result, the home population would reach higher test scores due to emigration of the low performers. Then, my findings would be overestimated due to selected emigration. To address this problem, I provide descriptive evidence.

Emigration is typically directed from Eastern Europe to other Eastern European and Western European countries, especially to the direct neighbors of EU entrants, Austria and Germany (as documented in Appendix Table A 8). To better understand emigration patterns, family background characteristics are explored in Appendix Table 8, before and after EU membership. There is no common pattern across Eastern European countries for parental education. In Estonia and Lithuania, the home population is better educated than the emigrant population. In contrast, for Hungarian and Polish emigrants, parental education of emigrants has been higher relative to the home population. For nationals of the Czech Republic, Estonia, Romania, Slovenia, and the Slovak Republic, parental home and emigrant population was educated about the same. For Czechs, this equality vanishes with EU membership - emigrants became more educated. In contrast, the Croatian emigrants did not increase educational attainment with EU membership, but their home population did. Highly educated Hungarians and Polish people emigrated to their direct neighbors, Austria and Germany, while the economically vibrant Baltic states, Estonia and Lithuania, could retain their highly educated population.

Regarding parental occupation, Eastern Europeans seem to work in lower-status occupations abroad relative to their home population and their status decreased further with EU membership, at home and abroad.

Student achievement of first-generation migrants hints at how well children fare in their new environment. For most Eastern European countries, student achievement of the emigrant population is lower than of the home population. It seems that emigrant children cannot profit from host countries and that home countries have decently developed school systems. In Romania and in the Slovak Republic, the home population performs at the level of their emigrant population, which may be due to weaker education systems at home. Comparing student achievement before and after EU membership shows that Eastern European home populations increased their achievement while emigrants decreased achievement.

To evaluate the magnitude of emigration, I report the emigrant ratio as the number of emigrants relative to their home population, which averages to 0.001 percent (column 5).³⁰ As evident from Appendix Table 9, I only observe very few migrant students from each single Eastern European country. Figure A 1 confirms that the migration ratio in each country did not react to EU accession. Employing the emigration ratio as an outcome variable in equation (1) yields a point estimate of EU membership of zero, see Table 13 column 1. Hence, the emigrant ratio is unrelated to EU membership. In a second step, I test the emigration ratio as a potential mechanism of transmitting EU membership to student achievement. Column 3 shows that the estimate is unresponsive to conditioning on the emigration ratio, compared to the coefficient of the main specification in the reduced sample in Column 2. Yet, the point estimate suggests that increasing the number of emigrants from Eastern Europe relative to their home population by one percent decreases reading scores by forty percent of a standard deviation. This sizeable effect advocates that a larger emigration ratio of potential low performers decreases student achievement, while the effect is not well-identified.

In conclusion, parental decisions on emigration given their educational attainment does not seem to follow a common pattern across Eastern Europe. Parental occupational status and student achievement is generally lower in the host country relative to the home

³⁰ I disregard migrants from other countries than the Eastern EU entrants, such as Spain or France, and only regard migrants from Eastern Europe to other EU states (East and West).

country, which hints at a negative selection of emigrants leaving behind the high ability population. However, the low emigration ratio and explorative regression analysis provides evidence against an overestimation of my findings which suggest that EU membership increased student achievement.

6.2 Dynamics of the EU Accession

A remaining confounder in the difference-in-differences model with country- and time-fixed effects is the endogeneity of EU membership. The *Process of Stabilization and Association* preceding EU accession reforms political and economic institutions in the sense that entrant countries may already be on a higher trend than non-candidates. The common-trends assumption would be violated. The data's panel structure lends itself for a placebo test. If there is no anticipation of the EU membership, there should be no effect on the achievement of students in the wave before EU membership. However, if EU membership was endogenous, I would yield significant estimates prior to achievement. Therefore, to conduct the placebo test, I create leads of the reading outcome variable relative to the EU accession by one period.³¹

Table 14 reports the results of this placebo test. In column 1, the point estimate of EU membership is small, negative, and not significantly related to the leading student achievement. This result advocates that EU membership is not endogenous.

Another dynamic of the EU membership effect could be enduring or delayed effects where not all institutional reforms and economic possibilities were realized at EU accession and needed time to be taken up. If there is a delay in student achievement to EU membership then the estimate of EU membership may be significant one wave after EU membership. I create lags of the reading outcome variable relative to the EU accession by one period. Column 2 reports the results of the lagged placebo test. The small point estimate of EU membership relates significantly to the lagged student achievement and suggests a continuation of positive effects of EU membership on student achievement one wave after accession. Hence, benefits from EU membership endure.

³¹ PISA is surveyed every three years. Thus, one period corresponds to three years.

6.3 Sample Composition

To ensure that my results are not driven by a specific country, I rerun the main specification excluding one country at a time. The qualitative results are insensitive to this sample alteration, with coefficients remaining significant and of similar magnitude, compare panel A of Table 15.

To ensure that results are not driven by one wave, I exclude one wave at a time. In panel B, the estimates of EU membership are unresponsive to excluding waves, except for wave 2006; where the coefficient decreases in significance and in magnitude by one third. This is not surprising, as eight out of eleven countries are become EU members in that wave. This change of the coefficient suggests heterogenous treatment effects, which are stronger for the first wave of entrants as opposed to the two later waves.³² This more intense first treatment effect is likely caused by entrants being direct neighbors to original EU members with high demand for low-skilled labor, such as Germany and Austria.

6.4 Specification Test on Fixed Effects

Another robustness check validates the assumption of the absence of country-specific shocks over time in unobservables between treatment and control. I compensated for observable school quality by including various school and institutional measures, such as school resources, teacher background, school autonomy and accountability, and government funding. Results were reported in Section 5.3. A second computational check is provided by allowing for country-specific time trends. Table 16 shows the estimation results. The coefficient of EU membership decreases by one third but remains statistically significant in all three subjects. Hence, the model holds against country-specific time trends.

³² Therefore, I forego robustness checks by means of an event study, as this assumes that the three accession waves had the same effect.

7. Conclusion

This paper examined the consequences of EU membership of Eastern European countries on student achievement. I used six waves of PISA data in a country panel over fifteen years with more than one million individual observations in 32 countries. Employing a difference-in-differences approach, I find that, entering the EU links to an improvement in student achievement in reading by a tenth of a standard deviation.

In search of mechanisms transmitting EU membership to student achievement, I test alternative outcomes from different levels of the human capital production function and find EU membership had two key effects. First, families' material wellbeing and school resources and institutions seem to have improved. For example, fathers work more, families own more status goods, schools are more rural and have more re-sources, and accountability shifted from internal to external testing. Second, families' social wellbeing seems to have deteriorated. For example, parental higher education decreased, parents work in lower-status jobs, intellectual goods diminished, and children live without their parents.

In a further step, I use the alternative outcomes as mechanisms to the main specification and in mediation analysis. The following mechanisms are key mediators of the treatment: tests for external comparisons, teacher absence, school location in a city, parents in lower-status occupations, single parenting, and shortage of math teachers.

Verifying the assumptions of the difference-in-differences approach, I confirm the parallel trends assumption. Robustness tests mitigate concerns on negatively selected emigration being too small in magnitude to bias estimates, absence of anticipation and an afterglow of EU accession. Results are not driven by one country but they rely on including the wave 2006. Furthermore, estimates are robust to country-specific time trends. Overall, EU membership fulfilled its promise of economic and educational prosperity by increasing parental occupation and with it family wealth, and by improving school efficiency. On the downside, EU membership disrupted families with an increase of children living with one or with neither of their parents. In summary, EU membership increased student achievement.

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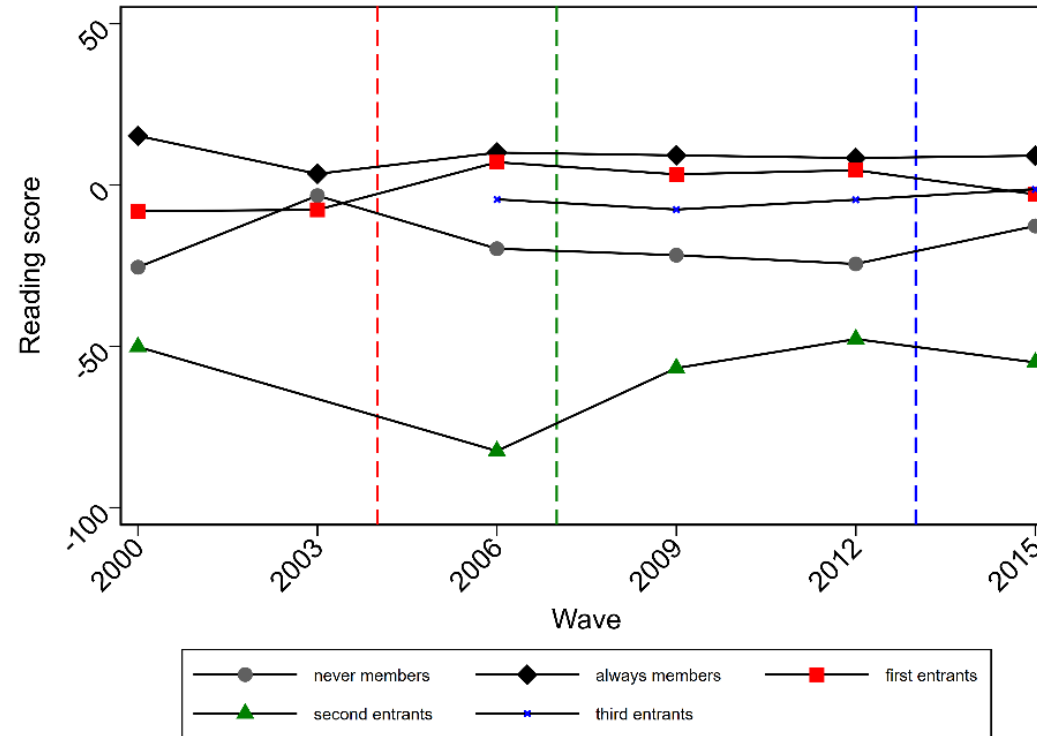
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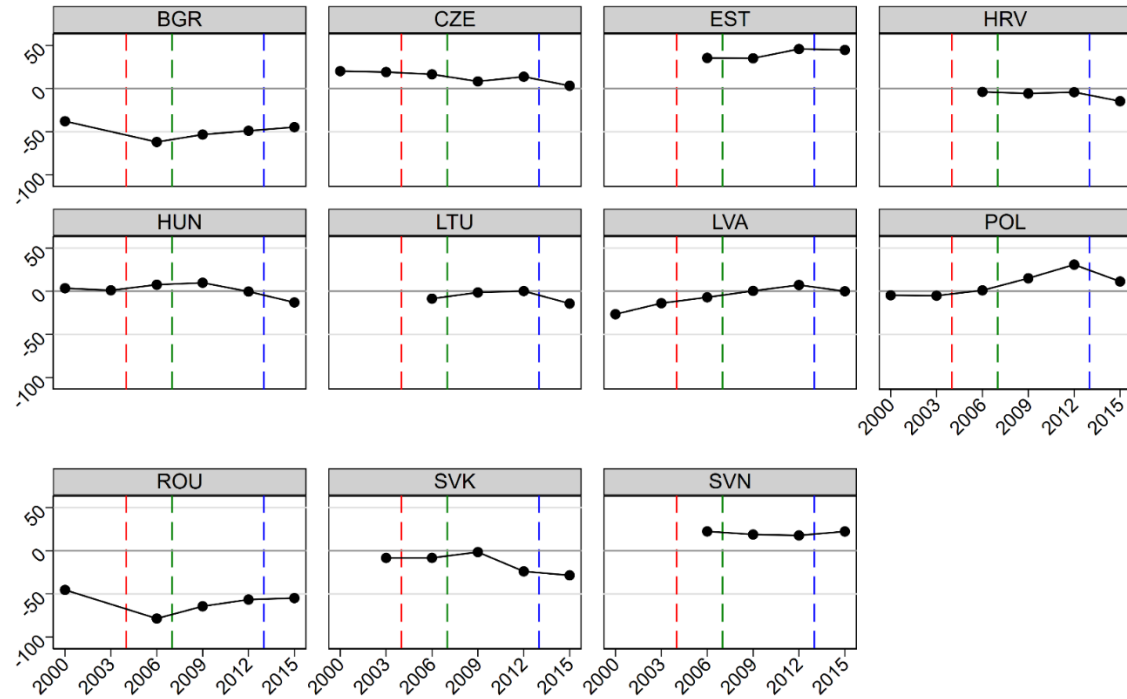
Tables and Figures

Figure 1: Parallel Trends of Reading Score by Treatment and Control Group



Note: The graphs depict the evolution of the demeaned reading score over time in the different treatment and control groups. The reading score was demeaned by the sample average to absorb time trends. The treatment group composes of the red markers indicating the first round of EU entrants, the green markers for the second round, and the blue markers for the third round. The control group consists of the black markers standing for permanent EU members, and the grey markers for permanent non-EU members. The figure shows the reading score in each survey wave between 2000 and 2015. The red, dashed, vertical line signals the 2004 entries. The green, dashed, vertical line indicates the 2007 entries. The blue, dashed, vertical line designates the 2013 entry. The first group of EU entrants contains the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, the Slovak Republic, and Slovenia; the second group includes Bulgaria and Romania; and the third entrants group is formed by Croatia. Permanent EU members are Austria, Belgium, Denmark, Finland, France, the United Kingdom, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Sweden. Permanent non-EU members are Albania, Iceland, Montenegro, Norway, and Serbia.

Figure 2: Evolution of Reading Achievement in Eastern Europe



Note: The figure shows the demeaned reading score for each Eastern European entrant in each survey wave between 2000 and 2015. The score was demeaned by the average of all 32 countries in the sample. The red, dashed, vertical line signals the 2004 entries. The green, dashed, vertical line indicates the 2007 entries. The blue, dashed, vertical line designates the 2013 entry. Country abbreviations stand for: Bulgaria (BGR), the Czech Republic (CZE), Estonia (EST), Croatia (HRV), Hungary (HUN), Lithuania (LTU), Latvia (LVA), Poland (POL), Romania (ROU), the Slovak Republic (SVK), and Slovenia (SVN).

Table 1: Main Result - The Effect of EU Membership on Student Achievement

<u>Dep. var.</u>	<u>Reading score</u>		<u>Math score</u>		<u>Science score</u>	
EU member	26.086** (12.165) [0.104]	9.667** (3.814) [0.032]	21.619 (14.045) [0.218]	7.648 (4.692) [0.184]	25.825** (12.034) [0.094]	-1.314 (4.359) [0.770]
Constant	464.663*** (12.029) [0.000]	376.124*** (2.785) [0.000]	471.549*** (13.805) [0.000]	383.010*** (3.332) [0.000]	471.372*** (11.611) [0.000]	382.940*** (3.182) [0.000]
Observations	1,073,652	1,073,652	1,021,595	1,021,595	1,021,522	1,021,522
R-squared	0.013	0.088	0.009	0.100	0.013	0.090
Fixed Effects	-	x	-	x	-	x

Note: Sample mean of reading score is 487 points, of math score is 491 points, and of science score is 494 points. When indicated by x, the model controls for time- and country-fixed effects. Standard errors are clustered at the country level reported in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). 1,000 times wild bootstrapped p-values are in square brackets. Least squares regression weighted by students' sampling probability.

Table 2: The Effect of EU Membership on Student Characteristics

<u>Dep. var.</u>	<u>Female</u>	<u>Age</u>	<u>Migrant</u>
EU member	0.002 (0.007)	0.035 (0.057)	-0.034* (0.020)
Constant	0.002 (0.007)	0.035 (0.057)	-0.034* (0.020)
Observations	1,072,650	1,072,448	1,032,304
R-squared	0.000	0.057	0.035

Note: The model controls for time- and country-fixed effects. Standard errors are clustered at the country level reported in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Least squares regression weighted by students' sampling probability.

Table 3: The Effect of EU Membership on Parental Characteristics

Panel A: Migration and Education

<u>Dep. var.</u>	<u>Migrant</u>	<u>No education</u>	<u>Primary</u>	<u>Education</u>			<u>University</u>
				<u>Lower secondary</u>	<u>Upper secondary I</u>	<u>Upper secondary I</u>	
EU member	-0.035*** (0.007)	0.004 (0.002)	-0.004 (0.002)	-0.030** (0.011)	-0.050*** (0.016)	-0.067** (0.030)	-0.040** (0.019)
Constant	-0.021*** (0.005)	0.027*** (0.002)	0.973*** (0.002)	0.899*** (0.009)	0.707*** (0.011)	0.609*** (0.015)	0.236*** (0.015)
Observations	1,032,304	1,038,580	1,038,580	1,038,580	1,038,580	1,038,580	1,038,580
R-squared	0.070	0.034	0.034	0.114	0.125	0.101	0.076

Note: The education categories refer to at least having obtained this level of schooling compared to all levels below. No education and university education compare to all other categories. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Panel B: Work Status

<u>Dep. var.</u>	<u>Mother</u>				<u>Father</u>			
	<u>Works full time</u>	<u>Works part time</u>	<u>Looks for work</u>	<u>Other</u>	<u>Works full time</u>	<u>Works part time</u>	<u>Looks for work</u>	<u>Other</u>
EU member	-0.021 (0.016)	0.005 (0.013)	-0.013 (0.010)	0.028 (0.018)	0.037* (0.022)	-0.002 (0.007)	-0.021** (0.009)	0.030* (0.017)
Constant	0.282*** (0.005)	0.071*** (0.005)	0.159*** (0.004)	0.500*** (0.022)	0.601*** (0.007)	0.191*** (0.003)	0.105*** (0.003)	0.324*** (0.016)
Observations	1,049,909	1,049,909	1,049,909	1,043,542	1,032,847	1,032,847	1,032,847	1,035,379
R-squared	0.130	0.137	0.032	0.034	0.051	0.024	0.028	0.085

Note: All variables are dummies taking the value 0 or 1 at individual level and therefore represent the share of a country. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Panel C: Occupation

<u>Dep. var.</u>	<u>Manager</u>	<u>Professionals</u>	<u>Technicians</u>	<u>Clerical</u>	<u>Services and sales</u>	<u>Skilled agriculture/ forestry/ fishing</u>	<u>Craft and trade</u>	<u>Plant and machine operators</u>	<u>Elementary</u>
EU member	0.007 (0.018)	-0.027** (0.011)	-0.017 (0.013)	0.015*** (0.005)	0.018** (0.007)	0.006 (0.004)	0.003 (0.008)	-0.000 (0.007)	0.013** (0.005)
Constant	0.125*** (0.008)	0.160*** (0.007)	0.048*** (0.004)	0.036*** (0.003)	0.118*** (0.005)	0.070*** (0.002)	0.169*** (0.004)	0.070*** (0.002)	0.120*** (0.003)
Observations	1,073,652	1,073,652	1,073,652	1,073,652	1,073,652	1,073,652	1,073,652	1,073,652	1,073,652
R-squared	0.017	0.023	0.012	0.008	0.008	0.014	0.023	0.007	0.013

Note: All variables are dummies taking the value 0 or 1 at individual level and therefore represent the share of a country. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 4: The Effect of EU Membership on Family Characteristics

Panel A: Family wealth

<u>Dep. var.</u>	<u>Consumer goods</u>	<u>Cultural goods</u>	<u>Books at home</u>					<u>Home educational resources</u>
			<u>0 – 10</u>	<u>11 – 100</u>	<u>101 – 200</u>	<u>201 – 500</u>	<u>>500</u>	
EU member	0.180*** (0.063)	-0.191*** (0.049)	0.017 (0.012)	-0.017 (0.012)	-0.078*** (0.022)	-0.056*** (0.016)	-0.022*** (0.008)	-0.044 (0.034)
Constant	-1.727*** (0.041)	0.033 (0.024)	0.360*** (0.005)	0.640*** (0.005)	0.165*** (0.008)	0.080*** (0.007)	0.047*** (0.004)	0.248*** (0.037)
Observations	1,062,602	1,055,592	1,050,897	1,050,897	1,050,897	1,050,897	1,050,897	1,063,940
R-squared	0.227	0.065	0.033	0.033	0.043	0.027	0.014	0.023

Note: The index consumer goods includes an own room, access to internet, number of phones, TVs, computers, cars, bathrooms, and DVD players. The index cultural goods includes literature books, poetry, and art work. Reference category for the number of books are 0 to 10 books. The index home educational resources contains a study desk, quiet study place, computer for school work, educational software, books for school work, technical reference books, and dictionary.

Panel B: Family structure

<u>Dep. var.</u>	<u>Both parents</u>	<u>Single mother</u>	<u>Single father</u>	<u>Without parents</u>
EU member	-0.058*** (0.018)	0.031** (0.014)	0.014*** (0.003)	0.015** (0.006)
Constant	0.806*** (0.008)	0.068*** (0.005)	0.019*** (0.001)	0.040*** (0.002)
Observations	1,064,038	1,025,676	1,043,859	1,058,528
R-squared	0.026	0.030	0.005	0.013

Note: All variables are dummies taking the value 0 or 1 at individual level and therefore represent the share of a country. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, (**) $p < 0.05$, (*) $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 5: The Effect of EU Membership on School Characteristics

Panel A: Location

<u>Dep. var.</u>	<u>Village (less 3,000)</u>	<u>Town (3,000-15,000)</u>	<u>Large town (15,000-100,000)</u>	<u>City (100,000-1,000,000)</u>	<u>Large city (>1,000,000)</u>
EU member	0.038* (0.019)	-0.039* (0.019)	-0.066** (0.024)	-0.007 (0.012)	0.000 (0.000)
Constant	0.216*** (0.011)	0.783*** (0.011)	0.538*** (0.010)	0.017* (0.008)	1.000 (0.000)
Observations	1,038,771	1,029,941	1,029,941	1,029,941	59,150
R-squared	0.090	0.089	0.077	0.064	-

Note: All variables are dummies taking the value 0 or 1 at individual level and therefore represent the share of a country. The model controls for the share of ipolated school location observations and for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Panel B: Resources

<u>Dep. var.</u>	<u>Private</u>	<u>Number of students</u>	<u>Government budget</u>	<u>Shortage of math teachers</u>	<u>Certified teachers</u>	<u>Not at all</u>	<u>Problem with absent teachers</u>		
							<u>A little</u>	<u>Some</u>	<u>A lot</u>
EU member	0.010 (0.013)	-74.828** (31.154)	-5.285 (3.667)	-0.054** (0.024)	0.028 (0.059)	-0.002 (0.074)	0.010 (0.025)	0.012 (0.014)	0.010 (0.013)
Constant	0.071*** (0.007)	584.156*** (14.479)	-6.119** (2.999)	0.098*** (0.020)	0.390*** (0.024)	0.460*** (0.020)	0.102*** (0.016)	0.063*** (0.009)	0.071*** (0.007)
Observations	1,033,531	1,014,384	1,017,502	1,026,860	1,029,536	1,029,536	1,029,536	1,029,536	1,033,531
R-squared	0.306	0.315	0.448	0.124	0.201	0.136	0.065	0.041	0.306

Note: All variables are dummies taking the value 0 or 1 at individual level and therefore represent the share of a country. The model controls for the share of ipolated observations of private, number of students, and share of government budget. It also conditions on time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 6: The Effect of EU Membership on Country Characteristics

<u>Dep. var.</u>	<u>Autonomy</u>	<u>School-based external comparison</u>	<u>Student-based external comparison</u>	<u>Tests Standardized monitoring</u>	<u>Internal testing</u>	<u>Internal teacher monitoring</u>	<u>Gov. expenditure on sec. education</u>
EU member	-0.059 (0.050)	-0.094* (0.050)	0.286* (0.157)	-0.041 (0.027)	-0.053 (0.031)	-0.070** (0.029)	-0.235 (1.178)
Constant	0.515*** (0.034)	0.562*** (0.043)	-0.349** (0.148)	0.772*** (0.035)	0.666*** (0.016)	0.755*** (0.027)	0.278 (1.000)
Observations	1,073,652	1,059,186	994,129	1,059,186	1,059,186	1,059,186	782,274
R-squared	0.865	0.824	0.790	0.825	0.833	0.925	0.799

Note: Autonomy is the share of schools with academic-content autonomy. Tests also report the share of school in a country which employ standardized student tests for the different purposes. Autonomy and tests are both derived from the PISA principal questionnaire. The model controls for time- and country-fixed effects and additionally in the last column for the ipolated share of secondary government expenditure. Standard errors are clustered at the country level.

Table 7: The Effect of EU Membership on Student Achievement Conditional on Student Characteristics

Dep. var.	Reading score	
EU member	9.222** (4.323)	7.104* (3.960)
Female		37.455*** (1.496)
Age		14.689*** (1.805)
Migrant student		-44.945*** (4.734)
Constant	378.015*** (2.653)	128.835*** (28.529)
Observations	1,031,557	1,031,557
R-squared	0.090	0.137

Note: The mean of the dependent variable is 487 points. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (*** p<0.01, ** p<0.05, * p<0.1). Least squares regression weighted by students' sampling probability.

Table 8: The Effect of EU Membership on Student Achievement Conditional on Parental Characteristics

Panel A: Migration and Education

<u>Dep. Var.</u>	<u>Reading score</u>			
EU member	9.098** (4.315)	8.713* (4.325)	9.334** (3.727)	13.009*** (4.172)
Migrant parent		-11.073*** (3.427)		
<i>Education</i>				
Primary				25.364*** (6.310)
Lower secondary				38.258*** (5.472)
Upper secondary I				63.167*** (7.005)
Upper secondary II				79.339*** (6.518)
University				100.844*** (6.897)
Constant	377.796*** (2.638)	377.565*** (2.664)	380.185*** (2.629)	311.391*** (4.840)
Observations	1,032,304	1,032,304	1,038,580	1,038,580
R-squared	0.090	0.091	0.093	0.140

Note: The mean of the dependent variable is 487 points. Reference category for parental education is no education. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Panel B: Parental Labor Situation

Dep. Var.	Reading score			
EU member	9.138** (3.744)	8.368** (3.506)	9.667** (3.814)	12.553*** (3.752)
<i>Work status</i>				
Mother works full time		18.312*** (2.298)		
Mother works part time		16.654*** (2.182)		
Mother looks for work		-18.204*** (2.582)		
Mother has other work status		16.519*** (1.805)		
Father works full time		-10.071*** (2.311)		
Father works part time		-13.654*** (2.517)		
Father looks for work		-3.868 (4.034)		
Father has other work status		18.312*** (2.298)		
<i>Occupation</i>				
Professionals				31.789*** (2.476)
Technicians				5.824*** (2.075)
Clerical				-2.350 (1.884)
Services and sales				-30.261*** (1.315)
Skilled agriculture/ forestry/ fishing				-41.964*** (3.728)
Craft and trade				-46.583*** (2.024)
Plant and machine operators				-47.516*** (1.801)
Elementary				-71.616*** (3.117)
Constant	380.690*** (2.582)	370.622*** (3.236)	376.124*** (2.785)	397.156*** (3.269)
Observations	1,021,615	1,021,615	1,073,652	1,073,652
R-squared	0.090	0.104	0.088	0.172

Note: Reference category for work status is other and for occupation is manager. Elementary includes cleaner, agriculture, manufacturing, food, street. The model controls for student age and gender and its imputed shares. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 9: The Effect of EU Membership on Student Achievement Conditional on Family Characteristics

Dep. var.	Reading score			
EU member	9.404** (3.683)	15.860*** (3.280)	11.223** (4.232)	12.062*** (4.391)
<i>Family wealth</i>				
Consumer goods		15.860*** (3.280)		
Cultural goods		1.648* (0.838)		
<i>Number of books</i>				
11-100		12.529*** (0.614)		
101 - 200		49.104*** (2.347)		
201 - 500		80.797*** (3.041)		
> 500		100.331*** (3.435)		
Home educational resources		96.850*** (1.479)		
<i>Family structure</i>				
Single mother				-8.498*** (1.510)
Single father				-24.845*** (1.679)
Without parents				-60.736 (79.144)
Constant	382.590*** (2.515)	346.398*** (2.569)	376.697*** (2.689)	377.805*** (2.725)
Observations	1,041,450	1,041,450	1,022,428	1,022,428
R-squared	0.087	0.225	0.089	0.091

Note: The mean of the dependent variable is 487 points. The index consumer goods includes an own room, access to internet, number of phones, TVs, computers, cars, bathrooms, and DVD players. The index cultural goods includes literature books, poetry, and art work. Reference category for the number of books are 0 to 10 books. The index home educational resources contains a study desk, quiet study place, computer for school work, educational software, books for school work, technical reference books, and dictionary. Reference group for family structure is living with both parents. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 10: The Effect of EU Membership on Student Achievement Conditional on School Characteristics

<u>Dep. var.</u>		<u>Reading score</u>
EU member	9.634** (4.049)	9.193* (4.799)
<i>Location</i>		
Town (3,000-15,000)		11.030** (5.167)
Large town (15,000-100,000)		9.433*** (2.956)
City (100,000-1,000,000)		16.815*** (4.409)
Large city (>1,000,000)		23.572*** (5.345)
Private		31.410*** (7.867)
Number of students		26.696*** (3.371)
Government budget		0.035*** (0.007)
Shortage of math teachers		0.007 (0.055)
Certificated teachers		-5.501 (3.363)
<i>Teacher absence</i>		
a little		25.775*** (5.712)
some		4.120** (1.659)
a lot		-3.706 (2.814)
Constant	377.250*** (3.184)	318.238*** (7.534)
Observations	842,420	842,420
R-squared	0.085	0.123

Note: The mean of the dependent variable is 487 points. Reference category for location is village with less than 3,000 inhabitants. Reference category for teacher absence is not at all. The model controls for the share of ipolated observations of private, number of students, and share of government budget. It also conditions on time- and country-fixed effects. Standard errors are clustered at country level (*** p<0.01, ** p<0.05, * p<0.1). Least squares regression weighted by students' sampling probability.

Table 11: The Effect of EU Membership on Student Achievement Conditional on Country Characteristics

Dep. var.	Reading score	
EU member	14.493*** (4.076)	12.332*** (3.516)
School autonomy		1.781 (6.971)
School autonomy x initial GDP		-0.679 (0.524)
<i>Tests</i>		
School-based external comparison		17.063* (9.898)
Student-based external comparison		11.772*** (3.437)
Standardized monitoring		-11.051 (14.542)
Internal testing		37.725* (18.913)
Internal teacher monitoring		-22.249 (15.217)
Expenditure on secondary education		-0.507* (0.281)
Constant	481.188*** (3.994)	495.542*** (16.416)
Observations	772,067	772,067
R-squared	0.054	0.055

Note: The mean of the dependent variable is 487 points. Autonomy is the share of schools with academic-content autonomy. Tests also report the share of school in a country which employ standardized student tests for the different purposes. Autonomy and tests are both derived from the PISA principal questionnaire. GDP per capita is measured in international US\$ in PPP, government expenditure per secondary student is a share of GDP per capita. The model controls for the isolated share of secondary government expenditure and for time- and country-fixed effects. Standard errors are clustered at country level (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 12: Estimation Results from Mediation Analysis

<u>Dep. var.</u>	<u>Reading score</u>
<i>Student characteristics</i>	
Female	-0.038
Age	-0.010**
Migrant student	0.068**
<i>Parental characteristics</i>	
Migrant parent	-0.080**
Primary	-0.008**
Lower secondary	-0.002**
Upper secondary I	0.009**
Upper secondary II	0.008**
University	-0.053**
Mother works full time	-0.005**
Mother works part time	0.060**
Mother looks for work	0.026**
Father works full time	0.057**
Father works part time	0.062**
Father looks for work	0.012**
Professionals	0.055**
Technicians	-0.073**
Clerical	-0.042**
Services and sales	-0.087**
Skilled agriculture/ forestry/ fishing	-0.012**
Craft and trade	-0.136**
Plant and machine operators	0.114**
Elementary	0.004**
<i>Family characteristics</i>	
Consumer goods	0.091**
Cultural goods	0.012**
11-100 books	0.054**
101-200 books	-0.115**
201-500 books	-0.051**
>500 books	0.015**
Home educ. resources	0.009**
Single mother	0.124**
Single father	0.106**
Without parents	0.033**

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<i>School characteristics</i>	
Town (3,000-15,000)	-0.011**
Large town (15,000-100,000)	0.044**
City (100,000-1,000,000)	0.166**
Large city (>1,000,000)	-0.007**
Private	-0.014**
Number of students	-0.004**
Government budget	0.004**
Shortage of math teachers	0.108**
Certificated teachers	0.066**
Teacher absence: a little	0.186**
Teacher absence: some	0.041**
Teacher absence: a lot	-0.251**
<i>Country characteristics</i>	
School autonomy	0.099**
School autonomy x initial GDP	-0.021**
School-based external comparison	0.008**
Student-based external comparison	0.391**
Standardized monitoring	0.046**
Internal testing	-0.024**
Internal teacher monitoring	0.016**
Expenditure on secondary education	-0.004**

Note: The table reports the share of the mediated effect as extracted from causal mechanism analysis. Each line represents one regression, as mediation analysis tests only one mediator per regression, but the model is residualized for time- and country-fixed effects. Due to computational limitations, I run the analysis in country-level data which produce the same main results as the individual-level data (compare Appendix Table 7). Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). The mean of the dependent variable is 487 points. Least squares regression weighted by students' sampling probability.

Table 13: Selection Test – Emigration

<u>Dep. var.</u>	<u>Migrant ratio</u>	<u>Reading score</u>	<u>Reading score</u>
EU entry	0.000 (0.001)	9.089** (4.283)	9.105** (4.263)
Migrant ratio			-41.620*** (9.721)
Constant	-0.000 (0.000)	378.400*** (2.441)	378.380*** (2.436)
Observations	976,887	976,887	976,887
R-squared	0.005	0.098	0.099

Note: The emigrant ratio represents the number of first-generation emigrants from an Eastern European country tested in another country relative to the number of students in the respective home country. The average emigrant ratio is 0.001. The mean of reading score is 487 points. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 14: Placebo Test with Leads and Lags

<u>Dep. var.</u>	<u>Leading reading score</u>	<u>Lagged reading score</u>
EU member	-0.059 (0.557)	1.270** (0.584)
Constant	377.678*** (0.260)	378.062*** (0.350)
Observations	1,073,620	1,073,620
R-squared	0.086	0.086

Note: The mean of the dependent variable is 487 points in reading scores. Each field represents a separate regression. The dependent variable leads or lags by one period relative to the independent variable. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 15: Robustness Test - Sample Composition

Panel A: Omitting one country at a time

<u>Dep. var.</u>	<u>Reading Score</u>										
<u>without:</u>	<u>BGR</u>	<u>CZE</u>	<u>EST</u>	<u>HRV</u>	<u>HUN</u>	<u>LTU</u>	<u>LVA</u>	<u>POL</u>	<u>ROU</u>	<u>SVK</u>	<u>SVN</u>
EU member	8.986** (4.198)	11.492*** (3.531)	9.728** (3.819)	10.074** (4.176)	10.213** (4.107)	9.632** (3.815)	9.183** (4.208)	7.499** (3.556)	8.221** (3.996)	10.540** (3.915)	9.646** (3.794)
Constant	375.781*** (2.830)	375.936*** (2.831)	376.063*** (2.794)	376.183*** (2.845)	376.232*** (2.836)	376.091*** (2.793)	376.579*** (2.796)	376.402*** (2.817)	375.725*** (2.824)	376.290*** (2.799)	375.879*** (2.780)
Observations	1,048,780	1,037,750	1,053,694	1,052,628	1,044,437	1,053,237	1,046,736	1,046,066	1,048,979	1,045,992	1,048,585
R-squared	0.081	0.091	0.088	0.089	0.090	0.089	0.090	0.089	0.079	0.089	0.089

Note: Each cell represents a new regression based on a different sample excluding the group named in line two. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability

Panel B: Omitting one wave at a time

<u>Dep. var.</u>	<u>Reading Score</u>					
<u>without:</u>	<u>2000</u>	<u>2003</u>	<u>2006</u>	<u>2009</u>	<u>2012</u>	<u>2015</u>
EU member	8.634* (4.323)	14.499*** (4.866)	5.765 (4.205)	9.837** (4.294)	8.820** (3.604)	11.289*** (4.076)
Constant	390.500*** (2.272)	376.808*** (2.870)	375.715*** (2.865)	370.493*** (2.206)	368.149*** (2.058)	376.255*** (2.838)
Observations	955,915	954,226	876,376	854,332	847,020	880,391
R-squared	0.081	0.094	0.082	0.086	0.090	0.094

Note: Each cell represents a new regression based on a different sample excluding the group named in line two. The model controls for time- and country-fixed effects. Standard errors are clustered at country level (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability.

Table 16: Specification Test on Country-specific Time Trends

<u>Dep. var.</u>	<u>Reading score</u>	<u>Math score</u>	<u>Science score</u>
EU member	5.205** (2.220)	10.114* (5.680)	5.742* (2.911)
Constant	-1,676.036*** (0.000)	-7,299.901*** (0.000)	-3,128.500*** (0.002)
Observations	1,021,595	1,073,652	1,021,522
R-squared	0.105	0.091	0.092

Note: Sample mean of reading score is 487 points, of math score is 491 points, and of science score is 494 points. The model controls for country-specific time trends. Standard errors are clustered at the country level reported in parenthesis (*** p<0.01, ** p<0.05, * p<0.1). Least squares regression weighted by students' sampling probability.

Appendix

Appendix Table 1: Summary Statistics

Variable	Treatment group		Control Group	
	Mean	<i>Std. dev.</i>	Mean	<i>Std. dev.</i>
<i>Student characteristics</i>				
Reading score	476.9	98.65	490.2	101.0
Math score	483.7	95.02	490.8	96.17
Science score	490.8	96.53	493.4	100.0
Age	15.75	0.319	15.75	0.290
Female	0.494	0.500	0.499	0.500
Migrant student	0.020	0.138	0.062	0.241
Consumer goods	-0.397	0.993	0.178	0.987
Cultural goods	0.129	0.971	-0.044	1.016
<i>Number of books</i>				
0-10	0.123	0.329	0.126	0.332
11-100	0.473	0.499	0.461	0.498
101 – 500	0.183	0.387	0.183	0.387
> 500	0.135	0.342	0.142	0.350
Home educational resources	-0.025	0.759	-0.003	0.971
<i>Parental characteristics</i>				
Migrant parent	0.094	0.292	0.135	0.342
<i>Parental education</i>				
No education	0.001	0.0374	0.012	0.107
Primary	0.004	0.065	0.03	0.170
Lower secondary	0.034	0.182	0.1	0.297
Upper secondary I	0.138	0.345	0.105	0.306
Upper secondary II	0.395	0.489	0.252	0.434
University	0.427	0.495	0.504	0.500
<i>Parental work status</i>				
Mother works full time	0.660	0.361	0.509	0.407
Mother works part time	0.0891	0.214	0.202	0.326
Mother looks for work	0.0916	0.215	0.0598	0.188
Mother has other work status	0.158	0.362	0.232	0.472
Father works full time	0.761	0.323	0.815	0.310
Father works part time	0.083	0.204	0.0739	0.209
Father looks for work	0.068	0.188	0.0414	0.155
Father has other work status	0.097	0.231	0.0939	0.248
Share imputed	0.423	0.494	0.353	0.478

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Variable	Treatment group		Control Group	
	Mean	Std. dev.	Mean	Std. dev.
<i>Parental occupation</i>				
Manager	0.147	0.354	0.163	0.369
Professionals	0.169	0.375	0.217	0.413
Technicians	0.146	0.353	0.137	0.344
Clerical	0.065	0.246	0.0822	0.275
Services and sales	0.171	0.376	0.154	0.361
Skilled agriculture/ forestry/ fishing	0.029	0.167	0.022	0.147
Craft and trade	0.135	0.342	0.090	0.286
Plant and machine operators	0.0509	0.220	0.043	0.203
Elementary	0.0570	0.232	0.051	0.220
<i>Family structure</i>				
Without parents	0.0267	0.120	0.015	0.098
Single mother	0.143	0.265	0.124	0.262
Single father	0.0205	0.105	0.0194	0.113
Share imputed	0.423	0.494	0.353	0.478
<i>School characteristics</i>				
<i>Location</i>				
Village (less 3,000)	0.106	0.308	0.0845	0.278
Town (3,000-15,000)	0.207	0.405	0.250	0.433
Large town (15,000-100,000)	0.371	0.483	0.403	0.490
City (100,000-1,000,000)	0.248	0.432	0.189	0.392
Large city (>1,000,000)	0.068	0.251	0.0584	0.235
Share imputed	0.020	0.111	0.015	0.120
Private	0.0426	0.202	0.170	0.375
Share imputed	0.016	0.125	0.01	0.094
Number of students	565.7	336.3	693.7	459.7
Share imputed	0.024	0.157	0.036	0.186
Share of government budget	1.976	10.03	7.837	24.89
Share imputed	0.042	0.189	0.047	0.211
Shortage of math teachers	0.0821	0.275	0.183	0.386
Fully certificated teachers	0.919	0.196	0.899	0.213
Share imputed	0.073	0.260	0.040	0.197

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Variable	Treatment group		Control Group	
	Mean	Std. dev.	Mean	Std. dev.
<i>Teacher absence as problem</i>				
not at all	0.427	0.495	0.223	0.416
a little	0.442	0.497	0.583	0.493
Some	0.0706	0.256	0.129	0.335
a lot	0.0102	0.100	0.013	0.114
Share imputed	0.199	0.399	0.171	0.376
<i>Education system</i>				
School autonomy	0.505	0.500	0.607	0.363
School autonomy x initial GDP	2.321	3.531	18.46	14.37
<i>Tests</i>				
School-based external comparison	0.663	0.142	0.515	0.270
Student-based external comparison	0.499	0.410	0.585	0.375
Standardized monitoring	0.741	0.117	0.641	0.166
Internal testing	0.707	0.123	0.662	0.161
Internal teacher monitoring	0.649	0.0987	0.387	0.236
Government expenditure on secondary	21.88	4.554	25.71	4.524
Share imputed	0.101	0.301	0.072	0.259
N	1,073,652			

Note: The treatment group consists of the eleven Eastern European countries accessing the EU. The control group consists of countries which either are always or never members of the EU in the period 2000 to 2015.

Appendix Table 2: Number of Student-level Observations by Country

Country	2000	2003	2006	2009	2012	2015	Total of country
Albania	4,980	-	-	4,596	4,743	-	14,319
Austria	4,745	4,597	4,927	6,590	4,755	7,007	32,621
Belgium	6,670	8,796	8,857	8,501	8,597	9,651	51,072
Bulgaria	4,657	-	4,498	4,507	5,282	5,928	24,872
Croatia	-	-	5,213	4,994	5,008	5,809	21,024
Czech Republic	5,365	6,320	5,932	6,064	5,327	6,894	35,902
Denmark	4,235	4,218	4,532	5,924	7,481	7,161	33,551
Estonia	-	-	4,865	4,727	4,779	5,587	19,958
Finland	4,864	5,796	4,714	5,810	8,829	5,882	35,895
France	4,673	-	-	-	4,613	6,108	15,394
Germany	5,073	4,660	4,891	4,979	5,001	6,504	31,108
Greece	4,672	4,627	4,873	4,969	5,125	5,532	29,798
Hungary	4,887	4,765	4,490	4,605	4,810	5,658	29,215
Iceland	3,372	3,350	3,789	3,646	3,508	3,371	21,036
Ireland	3,854	3,880	4,585	3,937	5,016	5,741	27,013
Italy	4,984	11,639	21,773	30,905	31,073	11,583	111,957
Latvia	3,893	4,627	4,719	4,502	4,306	4,869	26,916
Lithuania	-	-	4,744	4,528	4,618	6,525	20,415
Luxembourg	3,528	3,923	4,567	4,622	5,258	5,299	27,197
Montenegro	-	-	4,455	4,825	4,744	5,665	19,689
The Netherlands	-	3,992	4,871	4,760	4,460	5,385	23,468
Norway	4,147	4,064	4,692	4,660	4,686	5,456	27,705
Poland	3,654	4,383	5,547	4,917	4,607	4,478	27,586
Portugal	4,585	4,608	5,109	6,298	5,722	7,325	33,647
Romania	4,829	-	5,118	4,776	5,074	4,876	24,673
Serbia	-	-	4,798	5,523	4,684	-	15,005
Slovak Republic	-	7,346	4,731	4,555	4,678	6,350	27,660
Slovenia	-	-	6,595	6,155	5,911	6,406	25,067
Spain	6,214	10,791	19,604	25,887	25,313	6,736	94,545
Sweden	4,416	4,624	4,443	4,567	4,736	5,458	28,244
Switzerland	6,100	8,420	12,192	11,812	11,229	5,860	55,613
United Kingdom	9,340	-	13,152	12,179	12,659	14,157	61,487
Total of year	117,737	119,426	197,276	219,320	226,632	193,261	1,073,652

Note: Table shows the number of students per country and per year. “-“ signifies that the country did not participate in PISA the given year or that data was officially unusable.

Appendix Table 3: Mechanisms - Entire Set of Mechanisms

Dep. var.		Reading score
EU member	14.298** (5.532)	15.736*** (3.869)
Female student		33.903*** (1.377)
Age student		12.710*** (0.926)
Migrant student		-30.298*** (3.141)
Migrant parent		-12.506*** (2.207)
<i>Parental education</i>		
Primary		19.085*** (3.355)
Lower secondary		20.891*** (3.706)
Upper secondary I		31.108*** (5.170)
Upper secondary II		35.877*** (4.709)
University		37.174*** (5.113)
<i>Work status</i>		
Mother works full time		2.030* (1.157)
Mother works part time		2.569 (1.832)
Mother looks for work		-12.106*** (1.512)
Father works full time		3.567*** (1.179)
Father works part time		-14.253*** (1.864)
Father looks for work		-6.642*** (1.589)
<i>Occupation</i>		
Professionals		9.339*** (0.896)
Technicians		-3.684*** (1.024)
Clerical		-8.182*** (1.231)
Services and sales		-23.360*** (1.323)
Skilled agriculture/ forestry/ fishing		-22.089*** (2.920)
Craft and trade		-31.164*** (1.333)
Plant and machine operators		-30.065*** (1.975)
Elementary		-47.564*** (2.340)

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<i>Family wealth</i>	
Consumer goods	-2.337*** (0.745)
Cultural goods	8.264*** (0.460)
<i>Number of books</i>	
11-100	36.480*** (2.119)
101 - 200	58.921*** (2.818)
201 - 500	73.816*** (3.092)
> 500	74.463*** (3.423)
Home educational resources	-1.212 (2.289)
<i>Family structure</i>	
Single mother	-1.838* (1.044)
Single father	-8.151*** (1.408)
Without parents	-252.828 (169.092)
<i>Location</i>	
Town (3,000-15,000)	3.509* (1.818)
Large town (15,000-100,000)	7.386*** (2.326)
City (100,000-1,000,000)	9.961*** (2.796)
Large city (>1,000,000)	12.312*** (3.471)
Private	10.419*** (2.563)
Number of students	0.023*** (0.004)
Government budget	-0.009 (0.028)
Shortage of math teachers	-5.168** (2.312)
Certificated teachers	16.586*** (4.245)
<i>Teacher absence as problem</i>	
a little	2.410** (1.142)
some	-2.980 (1.907)
a lot	-0.975 (3.242)

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School autonomy		9.775 (7.176)
School autonomy x initial GDP		-0.672* (0.387)
<i>Tests</i>		
School-based external comparison		19.127 (11.314)
Student-based external comparison		12.237*** (3.035)
Standardized monitoring		-23.309 (13.917)
Internal testing		49.487*** (16.759)
Internal teacher monitoring		-19.557 (14.887)
Expenditure on secondary education		-0.541** (2.220)
Constant	487.863*** (5.478)	148.992*** (28.709)
Observations	527,198	527,198
R-squared	0.065	0.298

Note: The mean of the dependent variable is 487 points. Reference category for parental education is no education. Reference category for work status is other and for occupation is manager. Elementary includes cleaner, agriculture, manufacturing, food, street. The index consumer goods include an own room, access to internet, number of phones, TVs, computers, cars, bathrooms, and DVD players. The index cultural goods include literature books, poetry, and art work. Reference category for the number of books are 0 to 10 books. The index home educational resources contain study desk, quiet study place, computer for school work, educational software, books for school work, technical reference books, and dictionary. Reference group for family structure is living with both parents. Reference category for location is village with less than 3,000 inhabitants. Reference category for teacher absence is not at all. The model controls for the share of ipolated observations of private, number of students, and share of government budget. Autonomy is the share of schools with academic-content autonomy. Tests also report the share of school in a country which employ standardized student tests for the different purposes. Government expenditure per secondary student is a share of GDP per capita. The model controls for the ipolated share of secondary government expenditure. The model also conditions on time- and country-fixed effects. Standard errors are clustered at country level (** p<0.01, * p<0.05, * p<0.1). Least squares regression weighted by students' sampling probability.

Appendix Table 4: EU Membership Status by Country

Country	2000	2003	2006	2009	2012	2015	Total of years per country
Albania	0	0	0	0	0	0	0
Austria	1	1	1	1	1	1	6
Belgium	1	1	1	1	1	1	6
Bulgaria	0	0	0	1	1	1	3
Croatia	0	0	0	0	0	1	1
Czech Republic	0	0	1	1	1	1	4
Denmark	1	1	1	1	1	1	6
Estonia	0	0	1	1	1	1	4
Finland	1	1	1	1	1	1	6
France	1	1	1	1	1	1	6
Germany	1	1	1	1	1	1	6
Great Britain	1	1	1	1	1	1	6
Greece	1	1	1	1	1	1	6
Hungary	0	0	1	1	1	1	4
Iceland	0	0	0	0	0	0	0
Ireland	1	1	1	1	1	1	6
Italy	1	1	1	1	1	1	6
Latvia	0	0	1	1	1	1	4
Lithuania	0	0	1	1	1	1	4
Luxembourg	1	1	1	1	1	1	6
Montenegro	0	0	0	0	0	0	0
Netherlands	1	1	1	1	1	1	6
Norway	0	0	0	0	0	0	0
Poland	0	0	1	1	1	1	4
Portugal	1	1	1	1	1	1	6
Romania	0	0	0	1	1	1	3
Serbia	0	0	0	0	0	0	0
Slovak Republic	0	0	1	1	1	1	4
Slovenia	0	0	1	1	1	1	4
Spain	1	1	1	1	1	1	6
Sweden	1	1	1	1	1	1	6
Switzerland	0	0	0	0	0	0	0
Total of countries per year	15	15	23	25	25	26	-

Note: 1 signifies EU membership, 0 signifies no EU membership.

Appendix Table 5: Individual Characteristics by Family Structure

Variable	<u>Both parents</u>				<u>Single parent</u>				<u>Without parents</u>			
	<u>before EU entry</u>		<u>after EU entry</u>		<u>before EU entry</u>		<u>after EU entry</u>		<u>before EU entry</u>		<u>after EU entry</u>	
	Mean	<i>Std. Dev.</i>	Mean	<i>Std. Dev.</i>	Mean	<i>Std. Dev.</i>	Mean	<i>Std. Dev.</i>	Mean	<i>Std. Dev.</i>	Mean	<i>Std. Dev.</i>
Reading score	474.88	<i>100.67</i>	499.68	<i>93.75</i>	478.30	<i>97.40</i>	490.81	<i>95.63</i>	453.12	<i>107.33</i>	486.22	<i>100.79</i>
Age	15.73	<i>0.34</i>	15.77	<i>0.29</i>	15.75	<i>0.33</i>	15.76	<i>0.29</i>	15.77	<i>0.29</i>	15.78	<i>0.29</i>
Female	0.50	<i>0.50</i>	0.50	<i>0.50</i>	0.51	<i>0.50</i>	0.52	<i>0.50</i>	0.48	<i>0.50</i>	0.49	<i>0.50</i>
Consumer goods	-0.20	<i>1.07</i>	0.14	<i>0.85</i>	-0.34	<i>1.05</i>	-0.21	<i>0.88</i>	-0.14	<i>1.03</i>	-0.02	<i>0.89</i>
Cultural goods	0.18	<i>0.98</i>	0.07	<i>0.98</i>	0.09	<i>1.00</i>	-0.08	<i>1.00</i>	0.14	<i>0.99</i>	0.04	<i>0.97</i>
Home educational resources	-0.058	<i>0.002</i>	-0.027	<i>0.728</i>	-0.059	<i>0.002</i>	-0.026	<i>0.748</i>	-0.059	<i>0.002</i>	0.033	<i>1.256</i>
Books	3.63	<i>1.59</i>	3.54	<i>1.47</i>	3.71	<i>1.56</i>	3.34	<i>1.48</i>	3.25	<i>1.48</i>	3.32	<i>1.44</i>
Parental education	4.55	<i>1.28</i>	4.44	<i>1.46</i>	4.50	<i>1.28</i>	4.39	<i>1.47</i>	4.51	<i>1.38</i>	4.46	<i>1.46</i>
Parental occupation	6055.91	<i>2649.18</i>	6325.452	<i>2660.03</i>	5852.52	<i>2613.94</i>	6242.49	<i>2638.18</i>	6364.75	<i>2628.40</i>	6515.72	<i>2612.23</i>
Maternal work status	2.02	<i>1.23</i>	2.01	<i>1.53</i>	1.55	<i>1.02</i>	1.55	<i>1.01</i>	1.69	<i>1.09</i>	1.59	<i>1.02</i>
Paternal work status	1.42	<i>0.91</i>	1.32	<i>0.80</i>	1.85	<i>1.14</i>	1.84	<i>1.13</i>	2.28	<i>1.29</i>	2.18	<i>1.27</i>

Note: The table shows descriptives of key individual characteristics across the three family structures. Consumer and cultural goods and home educational resources are standardized to mean zero and standard deviation of one. Books is the number of books at home. Parental education is classified in ISCED coding ranging from zero to six with lower values representing lower education levels. Parental occupation is classified in ISCO codes between 1,000 and 9,996 with lower values representing higher occupational status. Maternal and paternal work status is coded in four categories with higher values representing less working time, i.e. lower work status.

Appendix Table 6: Pairwise Correlations of Parental Involvement

	Reading score	Consumer goods	Cultural goods	Edu. resources	Books
Academic interest (<i>N</i> = 115,335 in 2000)	0.154 (0.000)	0.020 (0.000)	0.310 (0.000)	0.121 (0.000)	0.230 (0.000)
Study time (<i>N</i> = 219,341 in 2012)	-0.131 (0.000)	-0.030 (0.000)	0.047 (0.000)	0.049 (0.000)	0.001 (0.685)
Talks about school (<i>N</i> = 171,468 in 2015)	0.089 (0.000)	0.041 (0.000)	0.049 (0.000)	0.094 (0.000)	0.036 (0.000)
Emotional support (<i>N</i> = 182,725 in 2015)	0.114 (0.000)	0.146 (0.000)	0.144 (0.000)	0.214 (0.000)	0.109 (0.000)
Learning support (<i>N</i> = 49,246 in 2015)	-0.022 (0.000)	0.023 (0.000)	0.132 (0.000)	0.125 (0.000)	0.077 (0.000)

Note: The table reports the correlation coefficients of student achievement and family wealth with measures of parental involvement with their children. P-values are reported in parenthesis below. Parents' academic interest in their children is a WLE index ranging between -2.2 and 2.72 with higher values representing higher interest. Time parents study with their children ranges from zero to 30. Talking about school takes values of 0 or 1 representing the answer option "no" and "yes". Emotional support is an index ranging between -3.1 and 1.1, and learning support is an index ranging between -5.8 and 3.7 with higher values representing higher support. The indices consumer goods, cultural good, educational resources and books were standardized to mean zero and standard deviation of one.

Appendix Table 7: Main Results on Country-Wave Level

<u>Dep. var.</u>	<u>Reading score</u>	
Aggregation level:	<u>Individual</u>	<u>Country</u>
EU member	9.667** (3.814)	9.667** (4.323)
Constant	376.124*** (2.785)	376.124*** (3.157)
Observations	1,073,652	168
R-squared	0.088	0.915

Note: This table shows regression results from the main specification in the individual-level data (column 1) and in the country-level data (column 2). The table belongs to Table 12. Sample mean of reading score is 487 points, the model controls for time- and country-fixed effects. Standard errors are clustered at the country level reported in parenthesis (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$). Least squares regression weighted by students' sampling probability in individual data.

Appendix Table 8: Difference between Emigrants and their Home Population

	<u>Parental Educational Attainment</u>				<u>Parental Occupation</u>				<u>Student Test Score in Reading</u>			
	<u>Home population</u>		<u>Emigrant population</u>		<u>Home population</u>		<u>Emigrant population</u>		<u>Home population</u>		<u>Emigrant population</u>	
	<u>before EU</u>	<u>after EU</u>	<u>before EU</u>	<u>after EU</u>	<u>before EU</u>	<u>after EU</u>	<u>before EU</u>	<u>after EU</u>	<u>before EU</u>	<u>after EU</u>	<u>before EU</u>	<u>after EU</u>
BGR	4.90	4.69	.	4.64	5976.02	6569.22	.	8145.73	415.88	435.44	.	455.22
CZE	4.61	4.47	4.62	5.44	5324.20	6289.83	5540.13	6419.23	501.78	503.77	470.83	433.89
EST	.	4.92	.	4.89		6014.62	.	6940.50	.	511.46	.	454.31
HRV	4.49	4.72	4.69	4.02	6794.18	6706.94	6511.27	7689.33	478.94	487.71	433.42	418.89
HUN	4.53	4.49	.	4.94	5988.24	6773.603	.	6350.80	481.03	489.58	.	428.46
LTU	.	5.01	.	3.50		6129.11	.	9132.00	.	469.91	.	371.33
LVA	5.10	4.88	.	.	5664.27	6711.00	.		478.61	489.56	.	.
POL	4.42	4.09	.	4.51	5831.83	6632.97	.	7100.21	482.93	511.55	.	462.36
ROU	4.66	4.62	.	4.62	6795.86	7508.51	.	6874.71	419.99	432.67	.	433.76
SVK	4.32	4.40	4.61	4.49	6529.96	6959.19	6250.23	6342.53	475.22	466.69	528.10	468.92
SVN	.	4.18	.	4.15	.	6683.72	.	7793.64	.	468.76	.	488.72

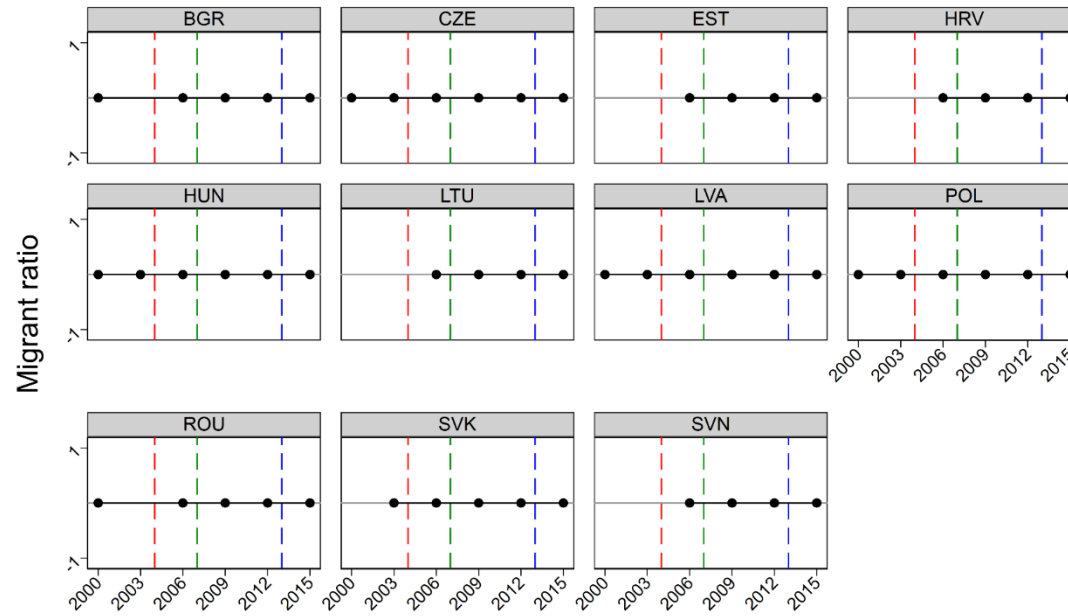
Note: This table shows descriptive statistics of the home population in the eleven Eastern European entrant countries compared to emigrants from those countries not living in their home country anymore. The country means are displayed. Parental education is classified in ISCED coding ranging from zero to six with lower values representing lower education levels. Parental occupation is classified in ISCO codes with lower values representing higher occupational status. Student test score has a mean of 500 points with a standard deviation of 100 points. Missing data is due to Eastern European countries joining PISA wave by wave. Country abbreviations stand for: Bulgaria (BGR), the Czech Republic (CZE), Estonia (EST), Croatia (HRV), Hungary (HUN), Lithuania (LTU), Latvia (LVA), Poland (POL), Romania (ROU), the Slovak Republic (SVK), and Slovenia (SVN).

Appendix Table 9: Summary Statistics on Emigrants and Natives by Home Country

Nationality	Country of Residence	N home country	N host country	Emigrant ratio	Std. Dev.
Bulgaria	Greece, the Netherlands	24,872	11	0.000	<i>0.021</i>
Croatia	Austria, Germany, Montenegro	21,024	150	0.007	<i>0.084</i>
Czech Rep.	Austria, Slovak Rep.	35,902	51	0.001	<i>0.038</i>
Estonia	Finland, Ireland	19,958	175	0.009	<i>0.093</i>
Hungary	Austria, Slovak Rep., Slovenia	29,215	54	0.002	<i>0.043</i>
Lithuania	Ireland	20,415	3	0.000	<i>0.012</i>
Latvia	-	26,916	0	0.000	<i>0.000</i>
Poland	Austria, Germany, United Kingdom, Ireland, the Netherlands	27,586	330	0.012	<i>0.108</i>
Romania	Austria, Ireland	24,673	96	0.004	<i>0.062</i>
Slovak Rep.	Austria, Czech Rep.	27,660	194	0.007	<i>0.083</i>
Slovenia	Austria, Germany	25,067	14	0.001	<i>0.024</i>

Note: The table shows origin, destination, and number of first generation migrants in the sample.

Figure A 1: Evolution of Migrant Ratio



Note: The migrant ratio relates the number of first generation emigrants from Eastern Europe living in another country to the number of students in each Eastern European country. The red, dashed, vertical line signals the 2004 entries. The green, dashed, vertical line indicates the 2007 entries. The blue, dashed, vertical line designates the 2013 entry. Country abbreviations stand for: Bulgaria (BGR), the Czech Republic (CZE), Estonia (EST), Croatia (HRV), Hungary (HUN), Lithuania (LTU), Latvia (LVA), Poland (POL), Romania (ROU), the Slovak Republic (SVK), and Slovenia (SVN).