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How to cite

BURGER, Kaspar. Intergenerational transmission of education in Europe: Do more comprehensive education systems reduce social gradients in student achievement? In: Research in social stratification and mobility, 2016, vol. 44, p. 54–67. doi: 10.1016/j.rssm.2016.02.002

This publication URL: https://archive-ouverte.unige.ch/unige:91228
Publication DOI: 10.1016/j.rssm.2016.02.002

Author's original manuscript

Published in final edited form as:

Burger, K. (2016). Intergenerational transmission of education in Europe: Do more comprehensive education systems reduce social gradients in student achievement? *Research in Social Stratification and Mobility*, *44*, 54-67.

To link to this article:
http://dx.doi.org/10.1016/j.rssm.2016.02.002

Intergenerational transmission of education in Europe: Do more comprehensive education systems reduce social gradients in student achievement?

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Abstract
Research has examined how education systems affect student achievement. Much of this research has compared comprehensive systems of schooling with tracked (selective) systems with regard to the degree to which they influence social class gradients in educational achievement. This study looks at comprehensive schooling in a broader way. Using standardised cross-national data for 31 European countries, it examines whether the comprehensiveness of education systems – in terms of pre-primary education, public/private sectors, educational tracking, and annual instruction time – contributes to explain the transmission of educational advantage from parents to children. Results suggest that the effect of parental education on a child's educational achievement is stronger in highly tracked education systems and in systems with a shorter annual instruction time. However, the social composition of a school's student population also affects the intergenerational transmission of education, and it interacts with the annual instruction time, such that the effect of school social composition on a child's achievement is stronger in education systems with a longer instruction time. This challenges the theory that by extending the school year policymakers could minimise social inequality in education (a theory that would be confirmed if we looked only at micro-level data). The findings inform debates about the influence of education policies on social stratification and mobility in Europe.

Keywords
Inequality; educational policy; composition effects; international comparative research; PISA

1. Introduction

Governments all over Europe have agreed that children have a right to education on the basis of equal opportunity (UN General Assembly, 1989). Education shall allow children to develop their personality, talents and abilities, and the principle of equal opportunity shall ensure the eradication of discrimination (e.g., related to gender, beliefs or social origins). Meritocratic education systems aim to guarantee equal educational opportunity. In these systems, children's educational attainments should be in direct proportion to their merit. However, formal equality of opportunity does not readily translate into substantive equality of opportunity. Research has demonstrated social disparities in educational attainment; children of less educated parents tend to end up being less educated themselves (Hertz et al., 2007). On average across OECD countries, for example, only one in five students, whose parents have low levels of education, attains a degree in tertiary education, compared to two thirds of students who have at least one parent with tertiary education (OECD, 2012a). Hence parental education tends to determine that of their children; moreover the degree of intergenerational transmission of educational attainment may be considered a measure of inequality of opportunity in a society.

In contrast to the inequality of opportunity interpretation, it could be argued that differences in educational attainment reflect differences in natural abilities (i.e., genetics), transmitted from parents to children. However, growing up poor significantly decreases the chances of escaping poverty, irrespective of individuals' actual intellectual ability (Fischer et al., 1996). Similarly, children's educational attainments frequently vary by social, cultural and economic characteristics of the household in which they are raised, even if their cognitive skills are assumed to be comparable (Jerrim, Vignoles, Lingam, & Friend, 2015; Pfeffer, 2008).

To date, there seems to be no country without a social gradient in educational attainment. However, significant differences exist between countries with respect to the magnitude of this gradient (Breen, Luijkx, Müller, & Pollak, 2009). This indicates that country-specific contexts influence how parents can transmit school-related knowledge and skills and shape their children's educational opportunities. A considerable body of comparative research has examined macro foundations of children's educational opportunities (e.g., Breen & Jonsson, 2005; Kerckhoff, 2001; Müller & Karle, 1993; Shavit & Blossfeld, 1993; Treiman & Ganzeboom, 2000),[1] and research has also specifically addressed the question of how education systems and policies influence educational inequalities (e.g., Kerckhoff, 1995; Van de Werfhorst, & Mijs, 2010; see also section 2). Arguably, one of the most intensely studied characteristics of education systems in this context has been tracking, or allocation of students to different types of schools or educational programmes, structured hierarchically by student performance and usually differing by the curriculum offered (Hanushek & Wössmann, 2006; Lucas, 2001; Robinson, 2008). Typically, this research has compared tracked (selective) systems with comprehensive systems (where low- and high-performing students are schooled together during most or all of secondary education) with regard to the degree to which these systems influence social gradients in educational outcomes. This is an important question as comprehensive school reform has been a popular approach to school improvement in several countries in Europe and beyond (Desimone, 2002; Hall, 2012; Iannelli & Paterson, 2007; Leschinsky & Mayer, 1999; Machin, Salvanes, & Pelkonen, 2012), and the question of whether comprehensive systems are more or less equitable than selective systems

[1] Research also exists on the question of how institutional structures of education systems determine labour market outcomes and occupational destinations (e.g., Andersen & Van de Werfhorst, 2010; Kerckhoff, 2001). However, this research is beyond the scope of this paper.

remains a subject of debate in many countries and among international organisations (OECD, 2013; and section 2.3)

One of the shortcomings of much research on tracked versus comprehensive education systems is that it tends to neglect other important dimensions relating to the selectivity or comprehensiveness of education systems – or to the extent to which individual students receive different (or the same) types and amounts of education. Drawing on a broader theoretical framework, the current study goes beyond previous work by assessing how four dimensions of education systems influence the intergenerational transmission of education in 31 European countries: (1) pre-primary education enrolment rates, (2) public/private school sectors, (3) tracking during compulsory education, and (4) the annual instruction time, or the amount of time that children spend at school annually. These four dimensions – hereafter also referred to as education policies – reflect different aspects of the comprehensiveness of education systems. Theory suggests that they can affect the transmission of education across generations (see section 2). Furthermore, in several countries, policymakers have implemented reforms relating to these policy dimensions with the objective of improving equity in education (OECD, 2015).

First, access to pre-primary education has been expanded in most European countries. For instance, a marked increase in enrolment rates has been observed between 1999 and 2009 in countries such as Lithuania (from 48.3% to 73.3%), Estonia (75.7% vs. 91.7%), Sweden (75.7% vs. 94.2%), and Norway (74.8% vs. 97.3%), to name but a few (ILO, 2012). It has been argued that an extensive system of preschool education is a *sine qua non* to minimise the 'social inheritance' of educational advantage and of social status, but only few studies have examined this claim empirically (Esping-Andersen, 2008; Field, Kuczera, & Pont, 2007).

Second, a number of countries have increased public funding for private schools – through school vouchers, tuition tax credits, or direct subsidies to private schools – to partially offset the impact of family background on educational attainment (OECD, 2012b; Toma, 1996). For example, public funding for private schools has been increased in the 1990s in Sweden (Björklund, Edin, Fredriksson, & Krueger, 2004), England (Whitty, 1997), Hungary, and the Czech Rebublic (Filer & Münich, 2000). It has been argued that combining private management of schools with public funding may be conducive to student performance and equity in education systems, but empirical evidence in this regard is still scarce (Schütz, Ursprung, & Wössmann, 2008; Wössmann, 2008).

A third policy strategy aimed at reducing social gradients in education has been to de-track schools (Rubin, 2006). Many European countries have delayed the start of tracking in their education systems, beginning with Sweden, Norway, the United Kingdom and Italy in the 1960s, and continuing with Finland in the 1970s, France in the 1980s, and Spain and Portugal in the 1990s (Brunello, Rocco, Ariga, & Iwahashi, 2012). However, significant differences still exist with regard to the onset of tracking in European education systems and it remains unclear to what extent these differences influence the intergenerational transmission of education, when examined in a comparative framework.

Finally, policymakers have focused attention on extending the length of the school day or year as a means to enhance student achievement (Pittman, Cox, & Burchfiel, 1986). Such policies have been implemented over the last years, for instance, in Germany (Freitag & Schlicht, 2009), the Netherlands (Meyer & van Klaveren, 2013), and Denmark (Jensen, 2013). While the evidence of effects of instruction time on overall student achievement is mixed, research suggests that the intergenerational reproduction of social classes can be minimised in education systems that

intensify exposure to formal schooling through an increase in the amount of schooling that children receive in a given school year (Patall, Cooper, & Allen, 2010; Schütz et al., 2008). A longer annual instruction time reduces the influence of family effects on children's education to some extent, which may primarily benefit children from lower classes who are at higher risk of school failure. What is missing in the literature, however, is a comparative analysis of the effects of the length of the school year on educational inequality (for an exception see Long, 2014).

Considering these open questions, the influences of education policies on educational inequality merit study. Besides, detailed knowledge of the transmission of education across generations is important for at least two further reasons. First, parental education is among the primary predictors of children's educational attainment (Ou & Reynolds, 2008). Second, since the first generation of mobility research (Ganzeboom, Treiman, & Ultee, 1991), education has been considered as the main factor in both social mobility and the reproduction of social status across generations (Hout & DiPrete, 2006). Against this background, this study extends research on social stratification and mobility by analysing whether cross-national differences in the comprehensiveness of education systems – in terms of pre-primary enrolment rates, public/private sectors, tracking, and annual instruction time – contribute to explain associations between parental education and children's educational achievement.[2]

2. Dimensions of comprehensive education and their influences on the intergenerational transmission of education

'Comprehensiveness' has been regarded as "the leading idea in implementing the basic values of equity in education" (Sahlberg, 2007, p. 154). Theory suggests that comprehensive education, in its ideal-typical form, aims to ensure and enrich educational provisions for all pupils and to equalise educational opportunities throughout individuals' educational careers, with as little differentiation between pupils as possible (Arnesen & Lundahl, 2006; Phillips, 2003; Pring & Walford, 1997). The comprehensiveness of education systems can be assessed on a continuum ranging from highly comprehensive education – which is socially inclusive, driven by egalitarian politics, and continuously concerned with the redistribution of opportunity – to highly selective and divisive education – which differentiates early between pupils and emphasises competition among students. Highly selective systems are committed to market values and elitism, they are driven by political liberalism, and characterised by comparatively large private school sectors (Wiborg, 2009). They consider education to a greater extent to be a private responsibility, which may also translate into a minor importance given to the preschool sector and a shorter annual instruction time. This section reviews research on the influences of four dimensions of comprehensive education on educational inequalities and presents the hypotheses of this study.

2.1 Pre-primary education

Children who grow up in socioeconomically disadvantaged families typically enter school with fewer skills than their more advantaged peers, and considerable gaps in educational achievement persist during subsequent school years (Heckman, 2006). Given that children acquire a wide

[2] The paper distinguishes between educational achievement (performance as measured by standardised tests) and attainment (typically measured by school graduation or highest level of education completed). As opposed to much prior research on educational inequalities, this study does not consider how a composite measure such as socioeconomic status affects children's education. Instead, it isolates and disentangles the role of parental education in the intergenerational transmission of educational advantage.

range of skills in early childhood during sensitive periods when the brain is particularly receptive to environmental influences, early childhood education has been proposed to partially offset the impacts of disadvantage and adverse learning environments on child development (Barnett, 2011). Different types of programmes – from the infancy period to early primary education, from intensive small-scale programmes to large-scale public programmes – have been examined in terms of their potential to reduce achievement gaps in education (Anderson et al., 2003; Burger, 2010; Currie, 2001; Sylva et al., 2014). There is now ample empirical evidence from various countries showing that the majority of programmes designed to support child development during the preschool period have substantial positive short-term effects and moderate or weak longer-term effects on children's academic skills (Barnett, 1998; Hasselhorn & Kuger, 2014; Melhuish et al., 2013; Spiess, Büchel, & Wagner, 2003).[3] Moreover, these programmes can supplement the learning environments of children at risk of unfavourable development by compensating for the lack of informal learning opportunities in families that do not ascribe great importance to education. Children from disadvantaged families tend to make more developmental progress in early childhood education than children from more advantaged families (Sylva, 2014). In other words, early childhood education can diminish social class differentials in children's skills and help establish equal educational opportunity. However, whether or not early childhood education has a compensatory effect (i.e., produces stronger positive paths for disadvantaged children) seems to depend on a variety of factors including the type of programme and the group composition (e.g., Biedinger, Becker, & Rohling, 2008; Vandell et al., 2010). A recent review of studies suggests, for instance, that there is empirical support both for the thesis that children across social classes benefit in equal measure from early childhood education and for the compensatory effects hypothesis whereby children from lower social classes benefit more in relative terms (Burger, 2010).[4]

It is important to note that in virtually all countries disadvantaged children have less access to pre-primary education, in particular where pre-primary education is not widespread (OECD, 2011a). Extending the pre-primary sector and thus making it more accessible for disadvantaged children should therefore reduce achievement gaps between children of diverse origins. A few cross-national comparative studies have assessed relationships between national pre-primary enrolment rates and social inequalities in education and suggest indeed that the association between family background and children's achievement is weaker in countries with higher pre-primary enrolment rates (Esping-Andersen, 2008; Schütz et al., 2008). Thus, given that educationally disadvantaged children are more likely to be enrolled in pre-primary education in countries with higher enrolment ratios, and given that pre-primary education can improve children's educational outcomes, I hypothesise that the degree of intergenerational transmission of education is lower in countries with higher pre-primary enrolment ratios (hypothesis 1).

2.2 Private schooling

[3] The only type of programme that consistently seems to produce negative effects is early, extensive and continuous centre-based childcare which notably tends to increase the risk of externalising problem behaviour and less harmonious parent-child relations (Belsky, 2001).

[4] Moreover, there is an ongoing debate on the conditions under which early education can best exert its positive influences and on why some positive effects fade out over the course of schooling whereas others are sustained into adolescence and adulthood (Barnett, 1998; Gorey, 2001). Factors to be considered include the pedagogical quality of institutions, the curricula, and the duration and intensity of programme attendance (Burger, 2010, 2014; Gray & McCormick, 2005; OECD, 2012c; Vandell et al., 2010).

There has been a debate about differences in the effectiveness of private and public schools (Cherchye, De Witte, Ooghe, & Nicaise, 2010). It has been presumed, for instance, that private schools may be better able to tailor their instruction to the needs of students and to provide more individualised attention (Braun, Jenkins, & Grigg, 2006). So far, however, research has yielded inconsistent findings with regard to the hypothesis that private schools are more effective in supporting student learning when individual characteristics are controlled for (Dronkers & Avram, 2010; Gamoran, 1996; Rangvid, 2008; Vandenberghe & Robin, 2004). It seems that where private schools 'produce' higher average achievement, this superiority can be attributed to the fact that private schools may constitute ‚functional communities' which are characterised by a high level of value consistency (consensus about the significance of education) and shared social capital among its members (Coleman & Hoffer, 1987), or to the fact that private schools exhibit a better school climate which favours learning (Dronkers & Robert, 2008). Furthermore, private schools frequently admit students based on academic achievement, and academic achievement is associated with social origin (Jenkins, Micklewright, & Schnepf, 2008; Tavan, 2004). In this regard, private schools contribute to social segregation by attracting children who perform well at school (Hsieh & Urquiola, 2006) and children who come from higher social strata (Jerrim, Chmielewski, & Parker, 2015; Lankford & Wyckoff, 2001). Cross-national comparative studies support the hypothesis that social segregation in education systems increases as the proportion of private schools at national levels increases (Alegre & Ferrer, 2010; Le Donné, 2014). This indicates that social disparities in educational achievement might be stronger in countries with a larger private school sector as a greater proportion of children from educationally and socially advantaged homes are likely to be schooled together in private schools (and thus separated from less advantaged children who tend to attend public schools). In sum, a higher proportion of private schools in a country seems to be related to greater social segregation and thus greater social-class related inequality in school learning environments. I therefore hypothesise that the size of the private school sector in a country – conceptualised as the share of schools that demand fees – is positively related to the degree to which parents can transmit educational advantages to their children (hypothesis 2).

2.3 Educational tracking

The central motive behind tracking is that homogeneous classrooms allow for more effective instruction, adapted to the needs and skills of the students who are grouped together. The effects of tracking have been examined repeatedly. On the one hand, studies suggest that tracked systems and comprehensive systems are comparable in terms of their impact on social gradients in education. For instance, evidence from Great Britain, France and Germany suggests that the shift from a selective to a comprehensive secondary school system did not (or only marginally) decrease social-class related gaps in educational outcomes or affect rates of social class mobility (Ambler & Neathery, 1999; Boliver & Swift, 2011; Glaesser & Cooper, 2012). Besides, tracking may also partly equalise educational opportunities among students from different social strata (Holm, Jaeger, Karlson, & Reimer, 2013) and promote educational mobility by attracting students into higher education who would not typically proceed to these educational tracks (Erikson & Hansen, 1987). On the other hand, a considerable body of research suggests that social class disparities in education are smaller in comprehensive education systems (Brunello & Checchi, 2007; Dupriez & Dumay, 2006; Marks, 2005). This research points out that selective systems which differentiate between educational tracks at an early age tend to be less egalitarian than

comprehensive systems where students with varying academic abilities are schooled together (Bauer & Riphahn, 2006; Brunello & Giannini, 2004; Gorard & Smith, 2004). Comprehensive education reforms in Sweden and Finland seem to have increased intergenerational social mobility (Meghir & Palme, 2005; Pekkarinen, Uusitalo, & Kerr, 2009); and research using cross-nationally standardised data mostly confirms that early tracking intensifies the impact of social origin on educational achievement and thus exacerbates educational inequalities (Horn, 2009; Le Donné, 2014; Schütz et al., 2008), although there are differences between countries with regard to the way in which tracking exerts its influence on educational inequality (Schlicht, Stadelmann-Steffen, & Freitag, 2010).

Theory suggests that tracking may induce social stratification because learning environments in tracks with low-performing students tend to be systematically less favourable. Selection into different tracks may be affected directly or indirectly by family background, with better educated parents being more likely to enrol their children in academic tracks (Brunello & Checchi, 2007). Even where students are assigned on the basis of formal tests or administrative decisions, children from better-educated families are more likely to be selected into more demanding educational tracks because less-educated parents tend to have lower expectations regarding their children's educational performance, less knowledge about the educational requirements of more demanding tracks and less confidence that their children will fulfil these requirements, and they are consequently less likely to encourage their children to aspire to such demanding tracks or to invest in the education of their children (e.g., in private lessons or preparatory courses for tests). Research indicates that track placement reinforces the intergenerational persistence of educational achievements in particular if it takes place early and persists over the course of schooling (Bauer & Riphahn, 2013), because in tracking systems peer effects and curricular differences between different tracks may increase differences in educational performance that had already existed prior to the selection (Horn, 2013). Hence I hypothesise that more extensive tracking during compulsory education increases the transmission of education across generations (hypothesis 3).

2.4 Annual instruction time

If there were no schools at all, the transmission of education across generations would depend entirely on families and neighbourhoods. Given that middle-class parents tend to engage more actively in the education of their children than working-class parents (Lareau, 2002), the question arises whether the amount of time that children spend at school moderates the intergenerational links in education. Research found that socioeconomic gaps in children's academic skills increase during summer vacations when the school is not in session (Downey, von Hippel, & Broh, 2004). While the skills of children from upper socioeconomic strata continue to advance, those of children from lower strata tend to stagnate (Alexander, Entwisle, & Olson, 2001). This indicates that schools can equalise skill levels among children from different backgrounds as children from all social classes are socialised in a similar manner at school. Against this background, I hypothesise that the degree of intergenerational transmission of education is weaker in education systems with a longer annual instruction time, that is, where children spend more time at school per year (hypothesis 4).

3. School composition and intergenerational transmission of education

In addition to parents' educational background, the composition of a school's student population also tends to influence a child's education (Coleman et al., 1966). Peers in school affect learning environments, serve as role models and influence how pupils engage in competition. They influence a child's aspirations and attitudes towards education which, in turn, may affect educational achievement. Schools with large proportions of students from socioeconomically privileged families 'generate' better academic performance among students than those with smaller shares of advantaged students (Perry & McConney, 2010), and students from higher socioeconomic composition schools are more likely to transition into educational institutions with higher academic requirements (Palardy, 2013).

School composition effects have been conceptualised as the effects of aggregated student characteristics (e.g., socio-economic status) at the school level on children's achievement when these characteristics have been taken into account at the individual level (Dumay & Dupriez, 2008). To the extent that the school composition can shape educational performance independently from a student's initial ability and social status (Opdenakker & van Damme, 2001), the school composition may moderate processes of intergenerational transmission of education. Hence I will analyse whether the school educational composition – as indexed by a school's average parental educational background – contributes to the transmission of education across generations. I hypothesise a positive relationship between school educational composition and students' educational achievement after accounting for parental education at the individual level. Moreover, if school composition affects a child's achievement, the amount of time that a child spends at a particular school might increase the effect of school composition on a child's achievement. Thus, I also test the hypothesis that the longer the annual instruction time is, the stronger the influence of the school composition on a child's achievement will be.

4. Data and measures

This study draws on individual- and school-level data from the 2012 wave of the Programme for International Student Assessment (PISA), which provides wide-ranging cross-national information on students' achievement, their family backgrounds, and school characteristics. Country-level data are derived from different data repositories and statistical institutes (see Table 2). The sample consists of 203,240 15-year-old students who attended 8,665 schools in 31 European countries.

The dependent variable – students' educational achievement – is estimated in the form of five plausible values measuring mathematical performance (see Appendix A). Mathematical performance has been used successfully as a proxy for educational achievement in previous studies on educational policies and inequalities and it is used here to ensure comparability with these studies (Bol, Witschge, Van de Werfhorst, & Dronkers, 2014; Levels, Dronkers, & Kraaykamp, 2008; Stadelmann-Steffen, 2012). Analyses using either science or reading achievement as dependent variables corroborate the results. To determine population statistics and their respective standard errors, I use the standard approach for PISA data analysis, where each plausible value is used separately for any analysis and, subsequently, the results of these analyses are aggregated to obtain the final estimates of the statistics. This procedure is performed using the final student weights and the replicate weights provided in the PISA datasets (OECD, 2009).

The central covariate at the individual level is the highest level of education of the parent with the higher educational background, hereafter referred to as parental education. Parental

education was measured both in ISCED categories and in years of full-time schooling. ISCED categories allow for comparisons of educational levels across countries (UNESCO, 2006). They represent the levels of education from pre-primary education to the second stage of tertiary education, as shown in Table 1. Given the cross-national nature of this research, and for the sake of comparability with previous studies (Schlicht et al., 2010; Stadelmann-Steffen, 2012), I use the categorised education variable. Analyses using years of education lead to the same conclusions. In addition, the analyses include the individual-level covariates sex, immigrant status, home language, school grade at assessment, and family wealth. At the school level, the central covariate is an aggregate index measuring parents' average educational level.

Table 1. Levels of parental education, measured in ISCED categories, as used in PISA

ISCED 0	Pre-primary education
ISCED 1	Primary education, first stage of basic education
ISCED 2	Lower secondary education, second stage of basic education
ISCED 3C, 3B	(Upper) secondary education, providing direct access to the labour market or to ISCED 5B programmes
ISCED 3A, 4	(Upper) secondary education, providing access to ISCED 5A programmes
ISCED 5B	Tertiary education, first stage, leading to a degree not equivalent to a first university degree
ISCED 5A, 6	Tertiary education, second stage, leading to a university degree or to an advanced research qualification

At the country level, four variables are used (see Table 2). *Pre-primary enrolment* refers to the percentage of pupils who had attended pre-primary education (ISCED 0) for at least one year or less, as opposed to pupils who had not attended this type of education at all. Analyses based on a more conservative indicator of pre-primary enrolment, which includes only children who had attended pre-primary education for more than one year, confirm the findings. *Private school sector* designates the proportion of students who had attended private schools in primary and secondary education, compared to the total number of students in these grades. In contrast to public schools, private schools demand fees for the services that they provide. Both government-independent and government-dependent private schools belong to the private school sector and are included in the indicator. Averaged data are used for the period 2003 to 2012 – these are the years when the children in the PISA sample attended primary and secondary schools. *Tracking in compulsory education* refers to the proportion of time that children spent in a tracked system during primary and secondary education. A tracked education system consists of at least two tracks with different academic requirements. *Annual instruction time* (or taught time) in primary and secondary education indicates the amount of time that children spent at school during a school year. In addition to these policy variables, the analyses contain the following control variables at the country level: *gross domestic product per capita, overall level of parental education*, and *inequality in parental education* (countries with less inequality in parental education might have smaller associations between parental education and children's educational achievement due to restricted ranges of the independent variable). Information about the covariates, their operationalisation, and descriptive statistics can be found in Appendix B.

Table 2. Education policy variables in 31 European countries and number of students and schools in the sample

Country	Pre-primary enrolment (%) [1]	Private school sector (%) [2]	Tracking in compulsory education (%) [4]	Annual instruction time [6]	Number of students [9]	Number of schools [9]
Austria	98.22	8.16	68.0	822.08	4251	191
Belgium	97.62	55.07	50.0	886.00	7452	287
Bulgaria	89.75	1.71	41.7	687.00	4952	187
Croatia	73.19	1.19	33.3[5]	555.00	4846	163
Czech Republic	96.80	5.76	61.5	765.56	5072	297
Denmark	98.92	12.98	25.0	810.00	6546	341
Estonia	92.68	2.66	25.0[5]	714.67	4562	206
Finland	97.53	7.03	25.0	703.00	8447	311
France	98.21	21.35	25.0	932.00	4178	226
Germany	96.68	6.88	69.2	759.83	3632	230
Great Britain	94.96	30.08	15.4	830.82	11524	507
Greece	95.40	6.25	25.0	723.77	4816	188
Hungary	99.50	11.98	66.7	682.66	4633	204
Iceland	97.93	5.49	28.6	810.60	3275	134
Ireland	86.37	0.72	18.2	923.00	4770	183
Italy	95.72	6.26	38.5	782.10	27404	1194
Latvia	88.69	1.21	25.0	674.44	4071	211
Lithuania	69.53	0.69	66.7[5]	754.50	4278	216
Luxembourg	95.37	12.81	46.2	1'010.40	4282	42
Netherlands	97.69	39.05	50.0	950.44	4089	179
Norway	92.08	4.47	16.7	774.20	4338	197
Poland	97.50	5.34	38.5	730.22	4372	184
Portugal	85.04	14.66	25.0	920.17	4933	195
Romania	95.47	0.85	23.0[5]	830.60	4983	178
Serbia	79.66	0.91[3]	50.0[5]	928.00[8]	4438	153
Slovakia	93.18	7.90	61.5	774.00	4452	231
Slovenia	85.34	1.58	33.3	715.33	5578	338
Spain	94.08	29.86	16.7	945.00	24037	902
Sweden	91.78	8.62	25.0	740.55	4155	209
Switzerland	98.15	6.13	27.3	805.67[7]	10197	411
Turkey	29.68	2.08	54.5	802.00	4677	170

Note: Own calculations: [1] enrolment rates, data from PISA 2012; [2] average enrolment rates in the private school sector, 2003-2012, data from Eurostat (2014); [3] data from UNESCO (2014); [4] proportion of tracking during

compulsory education; the data, derived from Brunello and Checchi (2007), refer to 2002 and are the most accurate data for the relevant time period (tracking regimes remained stable over time in most countries); the variable is defined as the ratio of $(t_3 - t_2)$, where t_3 is the age at the end of compulsory education (ISCED 3) and t_2 is the age of first selection into tracks, to $(t_3 - t_1)$, where t_1 is the age when primary education starts; [5] imputed figures, data from Classbase (2014); [6] measured in hours, data from Eurydice (2013), [7] data from OECD (2011), [8] data from UNESCO (2011), [9] PISA 2012 data.

5. Methodology

First, this study assesses the degree of intergenerational transmission of education in European countries by relating the educational achievement of 15-year-olds to the educational levels of their parents. I create two indices of educational transmission, one focusing on the individual level and a second one focusing on the school level. Specifically, I use multiple linear regression models to estimate (1) student achievement as a function of parental education and (2) schools' average achievement as a function of schools' average parental education (i.e., school educational composition), controlling for confounding variables in both cases. The coefficients of these models constitute a measure of the strength of the relationships between parental education and children's achievement at both individual and school levels.

Second, I apply multilevel modelling techniques to assess the interplay of characteristics of students, schools and country-specific education policies (which represent different degrees of the comprehensiveness of education systems). These techniques take into account the hierarchical nature of the data by allowing for simultaneous modelling of individual- and context-level variables (Snijders, & Bosker, 2012). I perform random intercept and slope models which imply that average student achievement can vary across schools and countries. The models include cross-level interactions to determine, first, whether the associations between parental education and children's achievement are moderated by the four education policies described above and, second, whether the associations between school educational composition and children's achievement are moderated by the annual instruction time. The equation hereafter specifies the model that predicts the educational achievement of a child as a function of individual-, school- and country-level variables and cross-level interactions.[5]

$$Y_{ijk} = \beta_{000} + \beta_1 X_{1ijk} + \ldots + \beta_d X_{dijk} + \ldots + \beta_n X_{nijk} + \delta_1 S_{1jk} + a_1 W_{1k} + \ldots + a_m W_{mk} + \ldots + \gamma_1 X_{nijk} \cdot W_{1k} + \ldots + \gamma_p X_{nijk} \cdot W_{mk} + \zeta_1 S_{1jk} \cdot W_{mk} + (\beta_{100} + \nu_{1k}) X_{nijk} + \nu_{0k} + \mu_{0jk} + \varepsilon_{0ijk}.$$

Y_{ijk} denotes the educational achievement of a child i in school j in country k. A child's educational achievement is accounted for by the overall mean (β_{000}), individual-level covariates (X_{1ijk} to X_{nijk} and their respective estimates β_1 to β_n), a school-level covariate (S_{1jk} and its estimate δ_1), and country-level covariates (W_{1k} to W_{mk} and their respective estimates a_1 to a_m). In addition, each country-level covariate is interacted randomly with the individual-level covariate X_{nijk}, that is, parental education ($X_{nijk} \cdot W_{1k}$ to $X_{nijk} \cdot W_{mk}$, the respective estimates being γ_1 to γ_p). The country-level covariate W_{mk}, that is, 'annual instruction time', is also interacted with the school-level covariate S_{1jk}, or 'school educational composition' ($S_{1jk} \cdot W_{mk}$, the respective estimate being ζ_1). The model includes a random slope $\nu_{1k} \sim (0, \sigma^2_{\nu 1k})$ on parental education at the country level, thereby taking into account that the effect of parental education on children's achievement varies across countries. Adding a random slope means adding a fixed effect for the country average on

[5] The equation of the final model is shown; previously, a series of increasingly complex models had been computed.

parental education as well as a random effect which specifies the between-country variance in the slope. The random slope is specified by the term $(\beta_{100} + \nu_{1k})\ X_{\mathrm{n}ijk}$, where β_{100} is the slope of parental education $X_{\mathrm{n}ijk}$ for the average country and $\sigma^2_{\nu 1k}$ shows how much variation there is in this slope between countries. The model includes three residuals: $\nu_{0k} \sim (0, \sigma^2_{\nu\ 0k})$ is the residual at the country level, $\mu_{0jk} \sim (0, \sigma^2_{\mu 0jk})$ is the residual at the school level, and $\varepsilon_{0ijk} \sim (0, \sigma^2_{\varepsilon\ 0ijk})$ is the residual at the individual level. The residuals are assumed to be mutually independent, to have zero means given the explanatory variables, and to be drawn from normally distributed populations. The population variances of the country-, school- and individual-level residuals are denoted by $\sigma^2_{\nu 0k}$, $\sigma^2_{\mu 0jk}$, and $\sigma^2_{\varepsilon\ 0ijk}$, respectively. Finally, the model allows a correlation between the country-level random intercept $\beta_{000} + \nu_{0k}$ and the random slope ν_{1k}.The tolerance and variance inflation factor values have been computed to test for multicollinearity among the predictors. These values indicate no multicollinearity issues, thus none of the individual-, school- or country-level predictors is redundant (grand mean-centred continuous variables and dichotomous variables were used). Although multilevel analysis is a standard technique to analyse data from the PISA surveys and from many other cross-sectional comparative studies (e.g., Marteleto & Andrade, 2014; Stadelmann-Steffen, 2012), a limitation needs to be acknowledged. Without taking into account prior student achievement, causal inferences concerning the way in which parental education and educational policies interactively lead to student achievement cannot be drawn unequivocally. Most cross-national research on educational achievement faces this limitation (e.g., Byun, Henck, & Post, 2014; Schlicht et al., 2010). In accordance with previous studies, I therefore include school grade as a proxy for prior educational achievement in the analyses. Grade repetitions lead to variation in the grade distribution of the 15-year-old students in the sample. Consequently, grade has been used as an indicator of prior educational achievement where attending higher grades at the age of 15 means having performed better during preceding school years (Chiu, 2010; Lee, Zuze, & Ross, 2005). Note that grade repetition is a result of both ability and family background characteristics. Thus, to some extent, grade repetition can be regarded as a mediating variable between family background and a child's current educational achievement (whether a child repeats a grade or not is affected by family background). Accordingly, it could be argued that including grade level in the analysis may lead to overcontrol and that, as a result, the analyses might underestimate the effect of parental education on a child's achievement. However, grade repetition can also be regarded as a mediating variable between a child's ability and achievement. Thus, if we removed grade level from the model we would overestimate the effect of parental education because there would be no proxy for ability (and prior achievement) left in the analysis at all. Including such a proxy is essential because in cross-sectional studies without any proxy for ability and prior achievement the effects of family background have been systematically overestimated and those of a child's ability and achievement have not been detected at all (Esser & Relikowski, 2015). Note, however, that as a result of controlling for grade level, this analysis provides a conservative estimate of the effect of parental education on a child's achievement.

6. Results

6.1 Intergenerational transmission of education in European countries

The degree of intergenerational transmission of education in European countries has been estimated in the form of coefficients from OLS regressions. Table 3 shows two indices of

educational transmission. (1) At the individual level, the degree of educational transmission is measured as the mean change in students' mathematical achievement when parental education increases by one ISCED level. (2) At the school level, the degree of transmission is measured as the mean change in a school's average mathematical achievement (i.e., school educational composition) associated with a one-level increase in a school's average parental educational level. On average, across the 31 countries, a one-level increase in parental education is associated with a 14.74 points higher child achievement, whereas a one-level increase in a school's educational composition is associated with a 42.93 points higher school achievement, which corresponds to improvements in average achievement of approximately a 0.15 and 0.43 standard deviation, respectively. The associations between school educational composition and average school achievement are bivariate associations without controls at the individual level. They may be mediated by differences in the curricula and academic requirements between schools, as children from families with higher educational backgrounds may be enrolled in schools with extended requirements more frequently than children from lower-educated families. However, regardless of the potential mediating channels, the figures show that on average students' educational achievement is better in schools with greater proportions of children from more highly educated families.

Table 3. Individual- and aggregate-level indices of intergenerational transmission of education

Country	Transmission at individual level		Transmission at school level		Country	Transmission at individual level		Transmission at school level	
	Coef.	(SE)	Coef.	(SE)		Coef.	(SE)	Coef.	(SE)
Spain	8.17	(0.07)	31.03	(0.07)	Great Brit.	13.88	(0.09)	20.57	(0.08)
Sweden	8.80	(0.24)	42.13	(0.22)	*Average*	14.74	(0.12)	42.93	(0.14)
Italy	8.85	(0.08)	42.70	(0.11)	Romania	15.26	(0.18)	38.84	(0.18)
Portugal	9.49	(0.18)	42.12	(0.22)	Denmark	15.32	(0.26)	45.13	(0.23)
Switzerland	10.18	(0.21)	43.41	(0.20)	Latvia	15.57	(0.55)	42.13	(0.51)
Luxembourg	10.60	(0.68)	34.82	(0.98)	Austria	16.34	(0.24)	39.85	(0.23)
Iceland	12.00	(1.12)	38.71	(1.15)	Greece	16.55	(0.20)	39.22	(0.24)
Netherlands	12.13	(0.17)	35.96	(0.16)	Slovenia	18.10	(0.48)	41.76	(0.45)
France	12.37	(0.07)	41.18	(0.08)	Croatia	18.10	(0.37)	42.85	(0.32)
Germany	12.54	(0.07)	44.42	(0.07)	Ireland	19.34	(0.28)	37.54	(0.30)
Finland	12.54	(0.29)	41.49	(0.20)	Bulgaria	20.83	(0.30)	39.25	(0.29)
Estonia	12.63	(0.69)	44.57	(0.63)	Hungary	21.03	(0.19)	45.77	(0.23)
Turkey	12.87	(0.05)	50.52	(0.08)	Lithuania	22.75	(0.47)	40.64	(0.38)
Serbia	13.01	(0.25)	41.16	(0.28)	Slovakia	23.70	(0.37)	42.66	(0.25)
Belgium	13.26	(0.20)	44.33	(0.17)	Czech R.	25.25	(0.29)	39.25	(0.21)
Norway	13.63	(0.38)	40.52	(0.27)	Poland	26.86	(0.12)	39.80	(0.11)

Note: Coefficients of OLS regressions. The regressions include the following control variables: sex, home language, immigrant background, school grade (in the individual-level analyses); aggregate variables for sex, home language, immigrant background and school grade at the school level (in the aggregate-level analyses). Own calculations based on data from the PISA 2012 wave; data are weighted, using the weights provided by the Programme for International Student Assessment, so that the estimates are representative for each country. Very similar coefficients result when the following covariates are entered additionally in the models: students' age, families' cultural possessions, home educational resources, home possessions, and wealth.

In every country, parental education and the schools' educational composition account for a portion of the variation in student achievement and in schools' overall achievement, respectively. However, the cross-national differences in the intergenerational associations of education indicate that country-specific factors play a role in shaping transmission processes. The coefficients range from 8.17 to 26.86 in the individual-level analyses and from 20.57 to 50.52 in the school-level analyses. This finding contributes to the debate about the extent to which student achievement is a product of genetic inheritance or of environmental influences or of their interplay (Lucchini, Della Bella, & Pisati, 2013). Given that nation differences in the degree of educational transmission cannot be attributed to genetics, the environment in which the intergenerational transmission occurs obviously plays a role. Figure 1 shows a scatterplot of the indices of the transmission of education at the individual level and school level, respectively. The relationship between the two indices is positive, however its strength is almost negligible albeit statistically significant, $r(29) = .14$, $p < .01$.

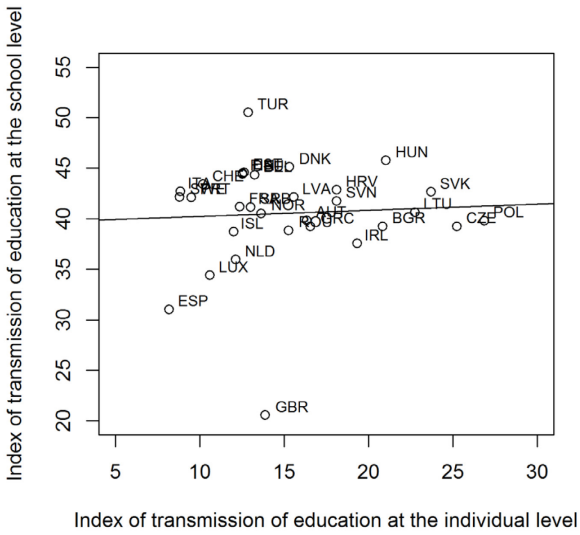

Fig. 1. Scatterplot of the two indices of transmission of education.

6.2 How education policies moderate the intergenerational transmission of education

The results of the multilevel analyses provide descriptive evidence on whether education policies (or the comprehensiveness of education systems) can explain cross-country variations in the degree of intergenerational transmission of education. Table 4 sets out the results of the full model. Less sophisticated models fit the data less well. The model shows that the individual-level covariates are associated with students' mathematical achievement. As expected, parental education is related positively to student performance. Furthermore, male students outperform female students. First-generation immigrants perform below average in mathematics, whereas those whose home language corresponds to the test language perform above average, as do those who are in higher school grades[6] and whose families possess higher levels of wealth.

The model also provides evidence that the schools' educational composition is positively related to student achievement even if parental education is held constant at the individual level.

[6] As a result of grade repetitions not all the 15-year-olds included in the sample attended the same school grade at the time of the assessment.

Since PISA does not assess student ability, it is not possible to determine the extent to which the relationship between school composition and student achievement is due to student ability or to the actual impact of school composition (i.e., peer effects) on student achievement. Thus, the school composition effect estimated here reflects either the effect of aggregated individual abilities (and their influence on student achievement) or the combined effect of aggregated individual abilities and peer effects.

Table 4 also indicates statistically significant cross-level effects of the pre-primary enrolment ratio and of the size of the private school sector on student achievement. As the country-level policy variables have been interacted with parental education, these main effects reflect the effects of the country-level variables when the variable 'parental education' takes the value zero (which represents average parental education given that parental education is centred at the grand mean). Between-country differences in the effect of parental education on children's educational achievement are modelled by including a random slope on parental education at the country level. Adding a random slope significantly improves the model fit, as indicated by a likelihood ratio test based on a comparison of the deviances of a model with a random slope and a model without a random slope on parental education, X^2 (2, N = 203,240) = 1124.8, $p < .001$.

Table 4. Multilevel linear regression model explaining students' mathematical achievement

	Coefficient (*b*)	(SE)
Fixed effects		
Intercept	498.16***	(6.28)
Individual-level covariates		
Parental education	13.58***	(0.87)
Sex (reference category female)	16.25***	(0.36)
First-generation immigrant	-8.80***	(1.10)
Home language is test language	15.83***	(0.75)
School grade	55.16***	(0.35)
Family wealth	5.37***	(0.22)
School-level covariate		
School educational composition	28.93***	(1.99)
Country-level covariates		
Pre-primary enrolment	0.83*	(0.37)
Private school sector	0.89**	(0.37)
Tracking in compulsory education	-0.06	(0.23)
Annual instruction time	-0.05	(0.05)
Interactions		
Parental education * Pre-primary enrolment	0.08	(0.06)
Parental education * Private school sector	-0.03	(0.08)
Parental education * Tracking in compulsory education	0.09*	(0.05)
Parental education * Annual instruction time	-0.01^{+}	(0.01)
School educational composition * Annual instruction time	0.01*	(0.01)
Random effects		
Random slope on parental education (SD)	17.4	(4.17)
Individual level variance (SD)	156817.3	(396.00)
School level variance (SD)	892.6	(29.88)
Country level variance (SD)	433.1	(20.81)
-2 log-likelihood	2446312	

Note: Coefficient estimates with standard errors in parentheses (fixed effects) and variance estimates with standard deviations in parentheses (random effects). Wald tests were used to determine the significance of the coefficients of the fixed effects, *** $p < .001$, ** $p < .01$, * $p < .05$, $^{+}$ $p < .10$. The random slope on parental education was calculated at the country level. Data were weighted using the weights provided by PISA such that each country contributes to the analyses proportionally to their student-population size. The analyses include the country-level controls 'overall level of parental education', 'inequality in parental education' and 'gross domestic product per capita'.

When analysing interaction effects, it is essential not to consider solely the significance or insignificance of the coefficients (Brambor, Clark, & Golder, 2006). To facilitate the interpretation of the interaction effects, I plot the marginal effects of parental education on children's educational achievement at different levels of the policy variables. Figures 2 to 5 illustrate how the marginal effect of parental education on children's achievement changes across the range of a given policy variable. The solid black line illustrates the marginal effect of a one-unit increase in parental education on children's educational achievement across the observed range of values of a policy variable when all the other variables are held at their means. The 95 percent confidence interval around this line, plotted in light grey, indicates the conditions under which parental education has a statistically significant marginal effect on children's educational achievement - notably whenever both the upper and lower bounds of this interval are above the zero line.

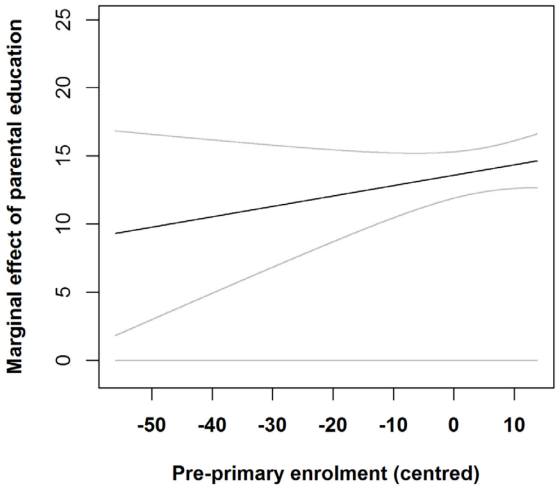

Fig. 2. Marginal effect of parental education on children's achievement as pre-primary enrolment ratios change.

Figure 2 suggests that the positive effect of parental education on children's achievement increases slightly, but not significantly (see Table 4), as the pre-primary enrolment ratio grows. The confidence interval visualises that the estimates are associated with increasing statistical uncertainty at lower levels of the policy variable. This may be explained by the fact that the pre-primary enrolment ratios were relatively high in most of the countries in the sample, the mean ratio being 90.69 percent. Only one country, Turkey, had an enrolment ratio of no more than 29.68 percent (which corresponds to the value -55.99 of the centred variable in the graph). In the other countries, the enrolment ratios ranged between 69.53 percent and 99.5 percent. The results

indicate that higher pre-primary enrolment ratios do not minimise the relationship between parental education and children's educational achievement. This is inconsistent with hypothesis 1. Two mechanisms might explain this counter-theoretical finding. On the one hand, the insignificant effect of pre-primary enrolment ratios on the intergenerational associations in education may be due to the fact that effects of pre-primary education on children's academic skills may disappear over the course of formal schooling (as shown in earlier research, the advantages bestowed by preschool education diminish during compulsory schooling as children who had experienced little or no preschool education gradually catch up – see Burger, 2010; Magnuson, Meyers, Ruhm, & Waldfogel, 2007). On the other hand, the insignificant effect might be explained by social gradients in the duration of pre-primary attendance. Pre-primary enrolment ratios were assessed using a dichotomous variable that distinguished between children who had not been enrolled in pre-primary education at all and those who had been enrolled for any given duration. A one-way analysis of variance showed that children of better educated parents attended pre-primary education for longer periods of time, $F(6, 202156) = 1239.38$, $p < .001$. Thus, a higher pre-primary enrolment rate in itself may not be sufficient to reduce social gradients in educational achievement if children from higher social strata are enrolled for a longer duration.

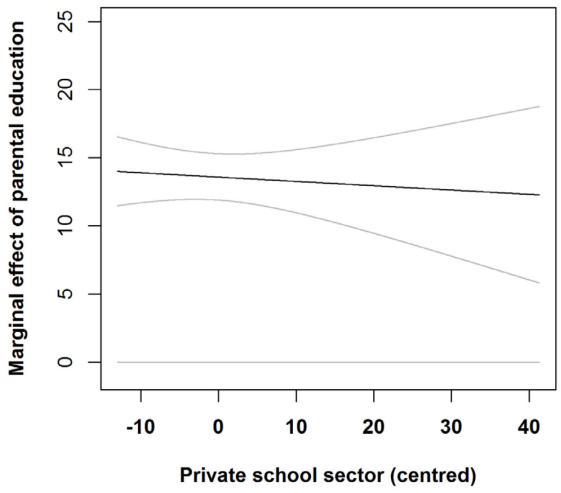

Fig. 3. Marginal effect of parental education on children's achievement as the size of the private school sector changes.

The size of the private school sector does not significantly change the effect of parental education on children's educational achievement (Figure 3 and Table 4). This might be the result of two opposite effects that private school sectors may have, depending on their size. On the one hand, they may generate social segregation and unequal school learning environments, divided along social class disparities. On the other hand, the larger a private school sector is, the less private schools can be used predominantly by higher-income and better-educated parents to transmit educational advantages to their children. Countries with a large private school sector tend to have a comparatively greater proportion of government-dependent (i.e., publicly subsidised) private schools within their private sector. The correlation between the overall proportion of private schools (government-independent and government-dependent) in a

country and the proportion of government-dependent private schools within the private sector is $r(29) = .68$, $p < .001$, according to PISA 2012 data. That is, systems with larger private sectors offer more families the possibility to send their child to private schools, which may reduce the effects on student achievement of favourable student compositions, functional communities and a beneficial school climate in private schools. As a result, the learning environments between private and public schools may no longer differ significantly, the larger a private school sector becomes.

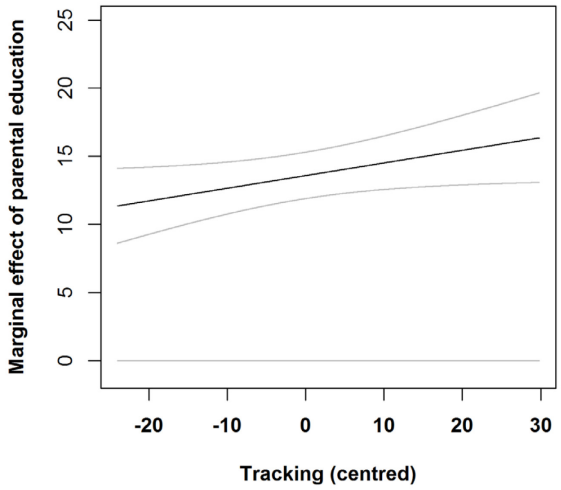

Fig. 4. Marginal effect of parental education on children's achievement as the proportion of tracking changes.

As predicted by hypothesis 3 regarding the impact of tracking, a significant positive interaction effect was found between the extent of tracking in an education system and parental education. Figure 4 illustrates that the positive marginal effect of parental education on children's educational achievement increases with the extent of tracking, which corroborates findings whereby tracking exacerbates educational inequalities associated with social origins (Hanushek & Wössmann, 2006; Horn, 2009).

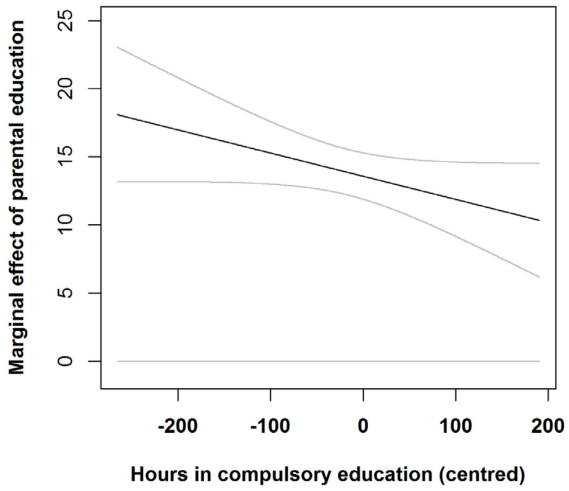

Fig. 5. Marginal effect of parental education on children's achievement as the annual instruction time changes.

As depicted in Figure 5, the longer the annual instruction time is, the smaller is the marginal effect of parental education on a child's achievement. A one-unit increase in parental education is estimated to increase children's achievement by approximately 18 points in education systems where children spend comparatively little time at school – e.g. in Croatia – and by around 10 points in systems where they spend comparatively more time at school – e.g. in Luxembourg and the Netherlands. This finding, although only marginally significant ($p < .10$), is in line with evidence whereby increasing the instruction time decreases social inequalities in education (Bellei, 2009; Schlicht et al., 2010). It seems to confirm the hypothesis of prior research that schools are more likely to serve as 'equalisers' (Downey et al., 2004) among children, the more intense the schooling that they provide. However, prior research did not look at how the annual instruction time interacts with the social composition of the schools that students attend. This study addresses the question and provides evidence of a significant interaction between school educational composition and annual instruction time – specifically, Figure 6 illustrates that the effect of school educational composition on a child's achievement increases as the annual instruction time increases.

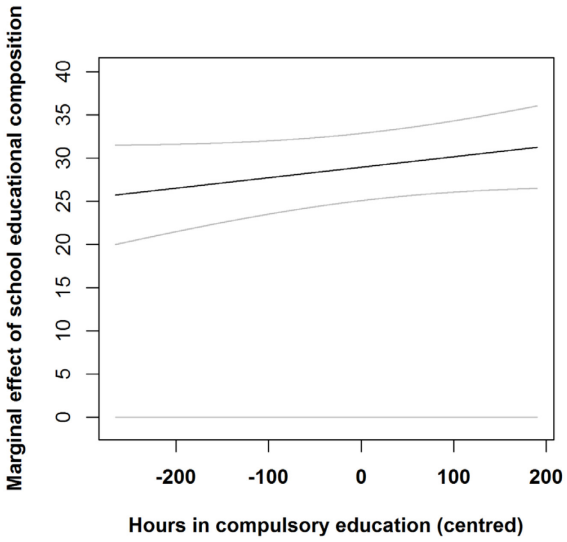

Fig. 6. Marginal effect of school educational composition on children's achievement as the annual instruction time changes.

Figures 2 to 5 indicate that parental education significantly impacts on children's educational achievement across the whole range of each of the observed education policy contexts, irrespective of the values of the respective policy variables (the confidence intervals do not overlap with the $y = 0$ line). This result is plausible as even in highly egalitarian education systems, parental education cannot be expected to completely lose its influence on children's educational achievement. However, the marginal effect of parental education on children's achievement is not constant across the range of each of the policy variables, which suggests that the intergenerational transmission of education is partly conditioned by the policies in question.

The random effects in Table 4 can be interpreted as the effects of any predictors that have not been controlled for (or even measured) at the respective levels. The unexplained variance at the individual level remains larger than the unexplained school- and country-level variances. This means that the differences in student achievement which remain unaccounted for should be attributed to a greater extent to (unmeasured) characteristics specific to students than to (unmeasured) school- or country-level variables (i.e., shared environmental factors). This result is consistent with sociological theory whereby relative to meso- or macro-characteristics, individual-level characteristics of students and families are more influential determinants of both student achievement and inequalities in educational outcomes (Dronkers, 2010).

Note, again, that many factors related to educational institutions, policies, and wider societal contexts can influence the intergenerational transmission of education. In the absence of longitudinal data, causal inferences cannot be drawn unambiguously and the results thus remain descriptive. To test the robustness of the results, another series of analyses has been performed. First, the analyses were replicated replacing the ISCED-based measures 'parental education' and 'school educational composition' through measures based on the number of years of schooling that parents had completed. Second, as mathematical achievement constitutes only one aspect of educational achievement, the analyses were replicated using students' reading and science achievements as dependent variables. Third, to check for omitted variable bias, a set of models was calculated with additional, potentially confounding covariates (at the individual level: cultural

possessions, home possessions, educational resources, family structure; at the country level: expenditure on compulsory education, measured as percentage of the gross domestic product). Finally, given that in some countries the provision of education differs by region, the analyses were replicated using different subsamples of countries (removing, for instance, countries with decentralised education policies such Austria, Belgium, Germany, Hungary, and Switzerland from the sample). These additional analyses confirm the findings and are available from the author (the coefficient estimate of the interaction between 'school educational composition' and 'annual instruction time' varied in size more than the estimates of the other interaction terms and it was not statistically significant across all robustness tests).

In conclusion, although spurious relationships between characteristics of education systems and the intergenerational transmission of education cannot be completely excluded (the study provides associational, not experimental, evidence), the results, in combination with the robustness tests, provide descriptive evidence that hypotheses 1 and 2 should be rejected, whereas hypotheses 3 and 4 can be confirmed. Moreover, the results indicate that the school composition and the annual instruction time interactively shape children's achievement – the effect of a favourable school composition is stronger where the annual instruction time is longer – which had not been shown in research previously.[7]

7. Conclusions

This study investigates how pre-primary sectors, private school sectors, tracking, and the annual instruction time influence the intergenerational transmission of educational advantage in Europe. The main conclusions are outlined hereafter.

(1) Unlike previous research (Esping-Andersen, 2008), this study finds that the size of the pre-primary sector does not significantly influence social gradients in educational achievement at age 15. This might be due to the fact that social-class disparities exist in the duration of pre-primary attendance in European countries, which make it difficult to assess the genuine effects of pre-primary enrolment rates at national levels unambiguously. It should also be noted that the effects of pre-primary education may vanish in the medium and long term, depending on the quality, type and effectiveness of the programme (Burger, 2010). Hence it will be a task for future research to further distinguish between the effects of pre-primary sectors of varying quality and type on the transmission of education from parents to their offspring.

(2) The size of the private school sector does not seem to affect the intergenerational transmission of education significantly. This is consistent with research that found insignificant relationships between the prevalence of private schools and social gradients in education (Le Donné, 2014; Pfeffer, 2007; Shavit, Arum, & Gamoran, 2007). Thus, private schools may lose a

[7] Further variables have been found to influence social inequalities in education, including centralisation, school autonomy (Kerckhoff, 1995; 2001), curriculum standardisation (Gamoran, 1996), central examinations (Bol, Witschge, Van de Werfhorst, & Dronkers, 2014), and competition between schools (Arum, 1996). Against this backdrop, I had performed numerous analyses using additional variables of theoretical interest, including: (1) an indicator of school autonomy; (2) a country's percentage of schools that use student assessments (*a*) to compare students to the national student performance, (*b*) to monitor progress from year to year, and (*c*) to compare the school with other schools; (3) an indicator of the extent to which schools compete with each other for students; (4) an indicator of the degree of exam standardisation; and (5) an indicator of centralisation in education systems (using data from PISA and from Bol and Van de Werfhorst (2013). At first sight, some of these models yielded interesting results. However, the coefficients of the cross-level interactions involving these variables sometimes changed considerably when I tested the robustness of the results, which cast doubts on whether these indicators can be used reliably in the analysis. Further research using different data and samples would be valuable to elucidate the role of these variables in generating educational inequalities.

part of their distinctive character in terms of student composition, the larger the private sector is. This is probably related to the financing and thus accessibility of the private school sector. Countries with a large private school sector have a greater proportion of government-dependent private schools. Learning environments in these more accessible, publicly subsidised, private schools may become comparatively less favourable, and privileged families may use private schools to a lesser extent as instruments to transmit educational advantages to their children.

(3) The earlier education systems select students into different tracks, the stronger is the degree of intergenerational transmission of education. This result is in line with the theory that tracked education systems primarily favour children from more highly educated families, who on average outperform children from less educated families, because peer effects in homogeneous learning groups and curricular differences between different tracks can reinforce differences in performance that had already existed prior to the selection into tracks (Brunello & Checchi, 2007; Horn, 2013). De-tracking education systems might reduce the degree of intergenerational transmission of education. However, research pointed out that different types of tracking – in terms of the rigidity of tracking (Pfeffer, 2008) and of the curricula offered in different tracks (Maaz, Trautwein, Lüdtke, & Baumert, 2008) – have different effects on educational inequality, or that one particular tracking system may lead to varying degrees of segregation among students (Felouzis & Charmillot, 2013). Research also indicates that the impact of tracking on educational inequality can be attenuated by central examinations during compulsory education (Bol et al., 2014), and a study from Japan illustrates that de-tracking reforms can have undesirable consequences as they may drive well-performing students out of public schools and increase the separation between students from different backgrounds (Kariya & Rosenbaum, 1999). Policymakers should take such evidence into account before they seek to implement educational reforms.

(4) This study also indicates that a longer annual instruction time minimises the effect of parental education on a child's education. This seems to imply that by extending the school year policymakers may be able to narrow gaps in performance between students of different social origins. However, the very same policy variable – annual instruction time – can have an opposite effect at the school level: The longer the annual instruction time is, the weaker is the association between parental education and children's educational achievement, but the stronger is the association between school educational composition and children's achievement. Consequently, I caution against the analysis and interpretation of effects of schooling time at only the individual level. Simply increasing the amount of schooling to reduce social gradients in education would constitute a simplistic approach to policy reform. Concrete reforms should draw on a systemic approach that views the education system as a whole in terms of interrelated subsystems, taking into account that changing a given policy variable may have paradoxical effects at different levels within a system. Given these findings, I tentatively conclude that education systems with a longer annual instruction time may be better prepared to ensure equality of educational opportunity only if there are low degrees of social and academic segregation within the system because greater segregation is likely to reinforce the effect of the annual instruction time on children's achievement (unequal school compositions increase the effects of the annual instruction time on educational inequalities).

Substantively the moderating effects of the country-specific educational policies on intergenerational associations in education are relatively small, comparable in size to those identified in other cross-national studies on the impact of policies on achievement inequalities

(Le Donné, 2014; Schlicht et al., 2010). In future studies, more sizable effects might potentially be identified if within-country variations in educational policies (i.e., in the comprehensiveness of school systems) are taken into account (Freitag & Schlicht, 2009). However, it should be noted that the evidence in this regard is mixed. For instance, in a study from Switzerland (Stadelmann-Steffen, 2012) the effects of sub-national policies on educational inequalities at sub-national levels were similar to those of the national policies on educational inequalities at national levels estimated here. This suggests that large-scale comparative policy analysis can be informative even if it does not necessarily take into account regional disparities as exhaustively as smaller-scale studies. A replication of the present study at sub-national levels may be expected to yield comparable findings as the ones presented here.

Albeit beyond the scope of this paper, the question arises of how the findings of this study relate to comparable research on longer-term outcomes of institutional arrangements and policies. To my knowledge, no evidence exists on the effects of pre-primary enrolment rates or of the annual schooling time on social gradients in attainment in education and in the labour market.[8] However, previous evidence (in line with this study) showed that the prevalence of private schools at the secondary and tertiary level does not significantly affect social inequality in educational attainment (Pfeffer, 2007; Shavit et al., 2007). Furthermore, it can be noted that educational tracking not only affects inequality in achievement at age 15, but also impacts on longer-term inequality in education and labour market outcomes. For instance, Pfeffer (2008), who focused on educational attainment, found that highly stratified, rigid education systems with an early onset of tracking and dead-end educational pathways hinder the equalisation of educational opportunities and limit intergenerational educational mobility – a finding that confirmed earlier studies (Gamoran & Mare, 1989; Kerckhoff, 1995). Looking at both educational attainment such as college completion and labour market outcomes such as earnings, Brunello and Checchi (2007) showed that school tracking intensifies the effect of family background and reduces intergenerational social mobility. However, findings in this regard are not unequivocal (Breen & Jonsson, 2005), and studies comparing selective (tracked) and comprehensive school systems in Great Britain indicate that neither of the two systems yields a social mobility advantage to children from any particular origins (Boliver & Swift, 2011; Iannelli, 2011). Hence although tracking can exacerbate educational inequality, a sweeping critique of tracking systems as the cause of low degrees of social mobility seems unwarranted.

Overall, this study corroborates findings whereby education systems in European countries struggle to grant every child the right to education on the basis of genuine equal opportunity, despite the commitment by all European states to protecting this right (UN General Assembly, 1989). Since education systems typically work as 'sorting machines' that lay the foundations for social hierarchies (Spring, 1976), establishing conditions that ensure equal educational opportunity is fundamental. This study documents that, to a minor degree, national education policies can influence the intergenerational transmission of educational advantage. It also shows that education policies can exercise opposite effects on educational inequality at the individual level and the school level, which has implications for theory and research on school improvement because it highlights the necessity to take into account inequalities at different levels of analysis (micro, meso and macro). Further research could compare the effects of

[8] But research indicates that expanding the (higher) education system may reduce the intergenerational transmission of educational attainment (e.g., Kwenda, Ntuli, & Gwatidzo, 2015).

education policies with those of other contextual factors such as family interactions, neighbourhood effects, class composition effects, and further institutional structures hypothesised to influence the intergenerational transmission of education (e.g., centralisation or exam standardisation). This research would be valuable to assess the role that policy reforms might play in comparison to other intervention strategies.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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Appendix A. Sampling and plausible values in PISA

The PISA surveys use two-stage stratified sampling. In the first stage, schools enrolling 15-year-old students are selected with probabilities proportional to the size of the schools. Second, students are sampled randomly within schools (the countries participating in the surveys differ to some extent in their definition of schools: in some countries they may be administrative units that may comprise several buildings, whereas in others individual buildings are considered as schools). PISA uses imputation methods, referred to as plausible values, for reporting student achievement. As in any item response scaling model, student achievement is not observed directly; it is inferred from the observed item responses and conceptualised as a latent construct. Plausible values are a selection of likely values for a student who attained a given score. They constitute a representation of a range of achievements that a student might reasonably display. A probability distribution for a student's achievement is estimated, consisting of possible values with an associated probability for each of these values. Based on the item parameters and

international calibration, the plausible values are drawn randomly from this distribution for each student (e.g., OECD 2012d).

Appendix B. Variables, operationalization, descriptive statistics

Variable	Operationalization	Descriptive statistics
Dependent variables		
Math achievement scores in PISA	Plausible value 1	Mean: 492.10, SD: 93.15 Min: 95.19, Max: 896.80
	Plausible value 2	Mean: 492.11, SD: 93.19 Min: 43.78, Max: 857.85
	Plausible value 3	Mean: 492.17, SD: 93.16 Min: 83.28, Max: 865.56
	Plausible value 4	Mean: 492.08, SD: 93.19 Min: 102.98,Max: 867.20
	Plausible value 5	Mean: 492.20, SD: 93.23 Min: 60.92, Max: 849.36

Individual-level covariates		
Parental education	ISCED, 7 levels, the higher level of either parent was used	Mean: 4.18, SD: 1.62 Min: 0, Max: 6
Sex	0: female, 1: male	Female: 49.85%
Immigrant status	0: native or second-generation immigrant 1: first-generation immigrant	First-generation immigrants: 3.83%
Home language	0: home language is not test language 1: home language equals test language	Same language: 91.94%
School grade	School grade compared to modal grade	Mean: -0.09, SD: 0.59 Min: -3, Max: 2
Family wealth	PISA index of family wealth	Mean: -0.01, SD: 0.91 Min: -5.34, Max: 3.25
School-level covariate		
School educational composition	Aggregate index based on parents' highest ISCED level: average parental education of a school	Mean: 4.18, SD: 0.38 Min: 2.00, Max:5.67
Country-level covariates		
Pre-primary enrolment	Percentage of children (1) who had been enrolled in ISCED 0 at least one year or less between 2001 and 2003, versus (0) children who had never been enrolled	Mean: 85.67, SD: 23.55 Min: 29.68, Max: 99.50
Private school sector	Average percentage of students in private schools (ISCED 1-3), 2003-2012	Mean: 13.75, SD: 12.74 Min: 0.69, Max: 55.07
Tracking in compulsory education	Percentage of primary and secondary school in tracking in 2002	Mean: 39.43, SD: 18.72 Min: 15.40, Max: 69.20
Annual instruction time	Recommended taught time (hours) per year in compulsory education in 2012	Mean: 820.22, SD: 79.56 Min: 555.0, Max: 1010.4
Overall level of parental education	Aggregate index based on parents' highest ISCED level: Average parental education of a country	Mean: 4.46, SD: 0.43 Min: 2.74, Max: 5.15
Inequality in parental education	Variance in parental education in the population of a country	Mean: 1.91, SD: 0.64 Min: 1.00, Max: 3.76
Gross domestic product per capita	Measure derived from Eurostat	Mean: 102.57, SD: 40.13 Min: 37.00, SD: 264.00