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Gingrich, Jane, Giudici, Anja and McArthur, Daniel John orcid.org/0000-0002-7310-9897 (2024) Multidimensionality matters:the implications of educational hierarchy and differentiation for intergenerational mobility in Europe. Comparative Education Review. ISSN 1545-701X

https://doi.org/10.1086/729572

Multidimensionality matters: the implications of educational hierarchy and differentiation for intergenerational mobility in Europe

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Version accepted for *Comparative Education Review* on December 10, 2023

ABSTRACT: The effects on social mobility of stratifying pupils into different educational pathways have been debated for decades. We intervene in this debate by showing that stratification in secondary schooling is multidimensional. The extent of *differentiation* into separate tracks is distinct from *hierarchy* between tracks. To address data limitations in existing research, we collect novel data on education policies from 1945 onwards for 16 European countries. Combined with mobility data from the European Social Survey we use difference-in-differences regression models to test the effects of hierarchy and differentiation on intergenerational mobility. Hierarchical stratification shapes the inheritance of educational attainment while differentiation does not. Differentiation only reduces mobility where educational pathways are hierarchically structured. These findings imply that studies using measures of differentiation (e.g. the tracking age), may instead be picking up aspects of hierarchy. They therefore highlight the importance for future research to measure multiple dimensions of stratification and assessing how combinations of policies can reinforce or undermine one another.

Research for this article is supported with funding from the European Research Council (ERC) with a Starting Grant for the project The Transformation of Post-War Education: Causes and Effects (SCHOOLPOL) (grant number 759188).

1 Introduction

What is the relationship between institutional stratification – or tracking – and educational mobility?[1] Politicians and academics have debated this question over the last half century. Despite intense scrutiny, the theoretical and empirical findings of existing studies are mixed. There is evidence, using both academic performance (Hanushek and Wößmann 2006; Bol and van Werfhorst 2013, Terrin and Triventi 2022) and intergenerational mobility rates (Meghir and Palme 2005; Bukodi et al. 2018) that early tracking correlates with larger class gaps. However, Bukodi et al. (2020) argue that educational structures vary more than mobility outcomes. Nor do institutions have straightforward effects: for instance, Breen (2010) finds greater intergenerational fluidity in the tracked German system than in the less tracked UK, with Brunello & Checchi (2007, 782) finding tracking to have "an ambiguous effect" on social outcomes.

These differing results follow, in part, from differences in the conceptualization and measurement of stratification. Much of the literature seeks to isolate the effects of specific institutions such as the age of tracking or the length of compulsory education on patterns of mobility. However, these policies are not always functional equivalents and rarely operate alone. For instance, the often-analyzed 1962 Swedish compulsory schooling reforms both postponed tracking and standardized

[1] We would like to thank Filip Bubenheimer (Austria), Julie Dereymaeker (Belgium), Henri Haapanala (Finland), Matthias Haslberger and Victoria Christmann (Germany), Ioanna Gkoutna (Greece), Leonardo Carella (Italy), Anna-Lina Müller (Switzerland) for their work on coding education policies. We also thank Nina Weber, David Rueda, and the anonymous reviewers for their helpful comments and advice.

the curriculum (Meghir and Palme 2005) whereas the 1975 French 'Haby reforms' reduced tracking without the same curricular standardization (Giudici et al. 2023).

In this paper, we make two analytic moves that add new theoretical and empirical perspectives to this longstanding debate. First, following Allmendinger (1989), Kerchhoff (2001), Bukodi et al. (2018), and Lucas (2001), we conceptualize the institutions producing educational stratification along two dimensions: *differentiation* and *hierarchy*. Differentiation refers to the extent to which education systems separate pupils of the same age into tracks providing distinct instruction. Hierarchy signifies the ranking of tracks based on pupils' alleged capabilities.

Second, we argue that *multiple institutional features* at both the lower and upper-secondary level produce differentiation and hierarchy. While the tracking age is the most visible form of differentiation, other features, such as the nature of the curriculum and teacher training also shape the distinctiveness of tracks. The same is true for hierarchy. A series of features – access to certificates, their uniformity in quality, and onward opportunities – shape perceived track ranking. Focusing on a single institutional feature can lead us to under or over-estimate the extent of stratification.

In the early post-war period, education systems were both differentiated and hierarchical. Reforms in the Scandinavian countries reduced both differentiation and hierarchy, while most Continental countries kept differentiation through early tracking but reduced hierarchy by improving the quality of non-academic certificates. Students across countries and time-periods were thus exposed to varying institutional configurations.

In this paper, we investigate the effects of this variation on intergenerational educational mobility. We argue that theoretically, hierarchy is more consequential for mobility than differentiation. While systems with greater differentiation do encourage track allocation in ways that align with social background, non-hierarchical tracking can provide pathways for attainment across social groups. By contrast, hierarchical differentiation weakens the quality of lower-ranked tracks, restricting upward mobility amongst disadvantaged children.

While many scholars have anticipated these arguments (Brunello and Checchi 2007; Bol and van de Werfhorst 2013; Braga, Checchi and Meschi 2013), to date they have been difficult to test due to a lack of systematic data on institutional variation. We develop the first comprehensive data on educational stratification by creating an original dataset. It measures differentiation and hierarchy using 24 indicators of lower and upper-secondary institutions from 1945-present for 16 European countries. We use a difference-in-differences style analysis to link our institutional measures to respondents' educational attainment and parental socio-economic status (SES) using the European Social Survey 2002-2018.

We find robust evidence that hierarchical stratification lowers absolute upward mobility for those from low SES backgrounds and suggestive evidence that it lowers relative mobility. By contrast, there is no evidence for an independent effect of changes in differentiation on either absolute upwards mobility or relative mobility. Differentiation only negatively affects attainment among lower SES individuals where educational pathways are hierarchical.

Our findings that hierarchy and differentiation have different long-run implications for mobility highlights the importance of conceptualizing and measuring the two-dimensional nature of educational stratification. They also suggest that previous studies focusing on specific measures

of differentiation, such as the tracking age, may be picking up aspects of hierarchy. Future research should attend to how combinations of policies can reinforce or undermine one another.

2 Education as a stratified and stratifying institution

2.1 Educational stratification as an institutional dilemma

As Domina et al. (2017, 311) argue, in defining categories and sorting mechanisms, schools are amongst the most consequential contemporary "stratification systems." The way in which educational institutions construct categories of learning and qualifications can shape subsequent social and economic stratification.

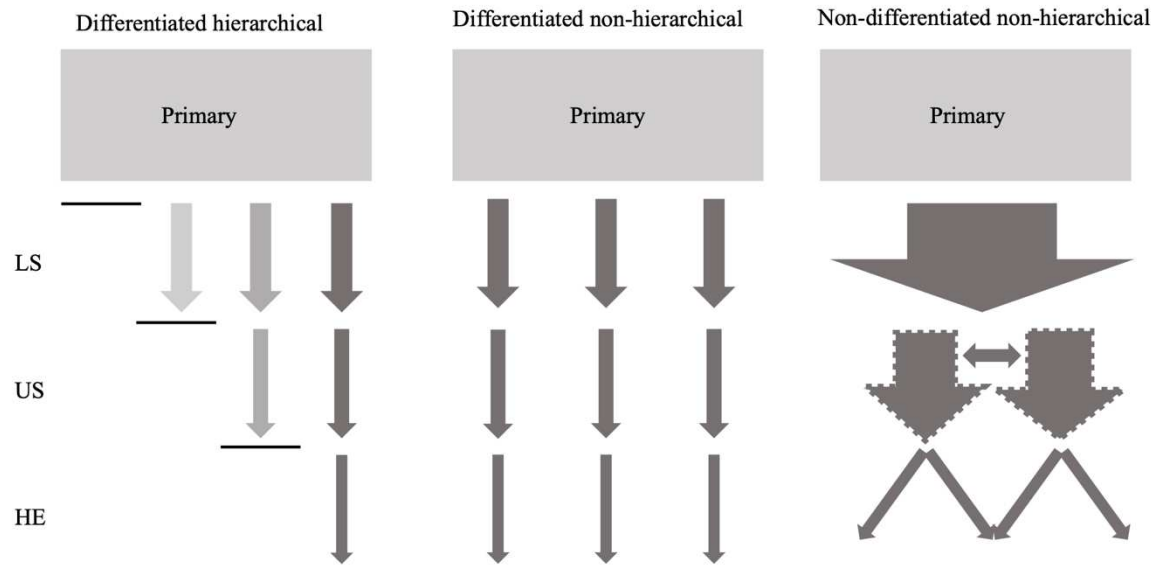
Classic work on institutional stratification conceptualizes it as process of both dividing pupils and ranking them. Kerckhoff defines stratification as "the degree to which systems have clearly differentiated kinds of schools whose curricula are defined as 'higher' and 'lower'" (2001, 4). Other authors distinguish "vertical" from "horizontal" stratification (Charles & Bradley 2002; Sørensen 1970) or curricular differentiation from selectiveness (Allmendinger 1989). This literature suggests that institutional stratification rests on two distinct sub-dimensions – what we label differentiation – the extent to which institutions provide pupils with specialized academic experiences – and hierarchy – the degree to which this specialization reflects pupils' alleged unequal capabilities.

First, education systems create more specialized educational experiences where they split pupils into *tracks*, which in turn, have distinct *content*. Students in systems with less tracking or cross-track curricula and teaching, have more common experiences than where they join narrow paths leading to specialized certificates taught by differently trained teachers.

Second, institutions that reduce differentiation generally reduce hierarchy. Where only one path exists, no hierarchical arrangement among paths is possible. But the reverse is not true. Where the *access to, quality of,* and *opportunities provided by* each track are uneven, a ranking emerges among tracks. Where access to specific tracks is limited (through selection or fees); where some tracks are longer and employ more qualified teachers; or where some tracks provide more access to onward education, a vertical arrangement meant to reflect students' varying alleged learning capabilities (or means) emerges. By contrast, institutions that limit selection, invest in equivalent levels of teacher training, or provide opportunities for students to deepen their knowledge in their field, limit stratification to horizontal specialization.

More differentiation is thus shaped by institutional a) tracking and b) curricular specialization, whereas greater hierarchy among tracks follows from institutions creating c) more selective access of some tracks relative to others, d) lower investment in quality of some tracks relative to others, and e) reduced onward opportunities from some tracks relative to others. Figure 1 schematizes the three possible combinations of hierarchy and differentiation. The model on the left is both hierarchical and differentiated: different tracks provide students with different experiences that in turn vary in ease of access, quality, and opportunities. The middle and right panels are less hierarchical but show varying degrees of differentiation. The model in the middle maintains distinct paths with varied content and certificates but provides equivalent access, quality, and opportunities, whereas the right model minimizes specialization altogether. The next section shows that these differences are not just of theoretical interest – politicians in the post-war period vociferously debated these models in extending secondary education.

Figure 1 Theoretical Pathways through Education Systems



2.2 Educational stratification as an historical dilemma

In the 1950s, Western European secondary education systems were both differentiated and hierarchical. Most countries tracked pupils at ages 10-12 into different specializations, ranging from purely academic to vocationally-oriented programs. These tracks also largely ranked access, quality, and opportunities according to alleged abilities. Aptitude for abstract knowledge was considered rare. Therefore, only the most selective (and expensive) tracks provided the curriculum, teaching, and certificates giving pupils a path to higher education and prestigious employment opportunities (Heidenheimer 1997). Non-selective tracks were often academic "dead-ends" that did not lead to further qualifications (Pöyliö, Erola and Kilpi-Jakonen 2018). These systems followed the logic of the left model in Figure 1, with differentiation starting at the lower-secondary level, and tracks of unequal quality leading to varying opportunities.

By the 1950s, this model became increasingly controversial. Pressures for expanding secondary access combined with a growing norm of equality of opportunity (Furuta 2020). Middle-class parents demanded more opportunities for their children, whose social status increasingly relied on formal certificates. Employers lamented the lack of general skills and questioned traditional hierarchies that favored humanist over technically oriented paths (Giudici et al. 2023).

In response, reforms examined models of *differentiation*. Across Europe, the political left and primary teachers called for reducing the number of tracks or delaying lower-secondary tracking – as ways of improving the chances for working-class pupils. Secondary teachers and right parties often preferred the status quo. Local power-dynamics led to institutional variation, resulting in diverging definitions of equality among secondary pupils (Gingrich et al. 2023). The Nordic countries moved towards comprehensive models, Southern Europe and France engaged in moderate de-tracking, while Continental countries maintained lower-secondary tracking (Busemeyer 2014; Giudici et al. 2023; Heidenheimer 1997; Wiborg 2009).

In all these countries, however, the increasing demand for skills (Busemeyer 2014) and more fluid conceptions of pupils' learning capabilities (Wiborg 2009) fundamentally challenged lower-secondary *hierarchy*. Across Europe, policy-makers – to differing extents – reduced fees and selective access to academic programs, extended the length of compulsory education (which de facto affected the non-academic tracks), equalized teacher training, and allowed bridging across tracks. These shifts reduced hierarchy in differentiated systems.

By the 1960s, debates over differentiation and hierarchy spread to the upper-secondary level (Heidenheimer 1997). The Nordic countries, and to a lesser extent Southern Europe and France, looked to expand access to traditional academic paths. In France, policymakers added new

technical specializations (i.e., math, economics) to the BAC – the certificate required to access university – increasing access. England and Ireland made steps to incorporating modular vocational programs into university eligibility, while Norway established a unitary curriculum structure for academic, commercial, and vocational schools. These reforms differed in their magnitude, but policymakers argued that the blurring of academic and vocational would increase social mobility. In reducing differentiation, these shifts also reduced hierarchy.

A second set of countries protected differentiation at the upper-secondary level, maintaining a strict separation of vocational and academic paths. However, policymakers did target hierarchy (Busemeyer 2014). New certificates, such as the German Fachhoschulreife (1967) and the Swiss Berufsmaturität (1993/2004), provided vocational students with their own pathways into higher education.

At the upper-secondary level then, reforms reducing differentiation looked to reduce specialization and access to academic paths by incorporating more vocational elements, while reforms to hierarchy looked to increase academic and financial access across tracks, reduce differences in track length, and increase onward opportunities from vocational tracks. Table 1 summarizes both dimensions for lower and upper-secondary education, with Appendix 1 providing more detailed information.

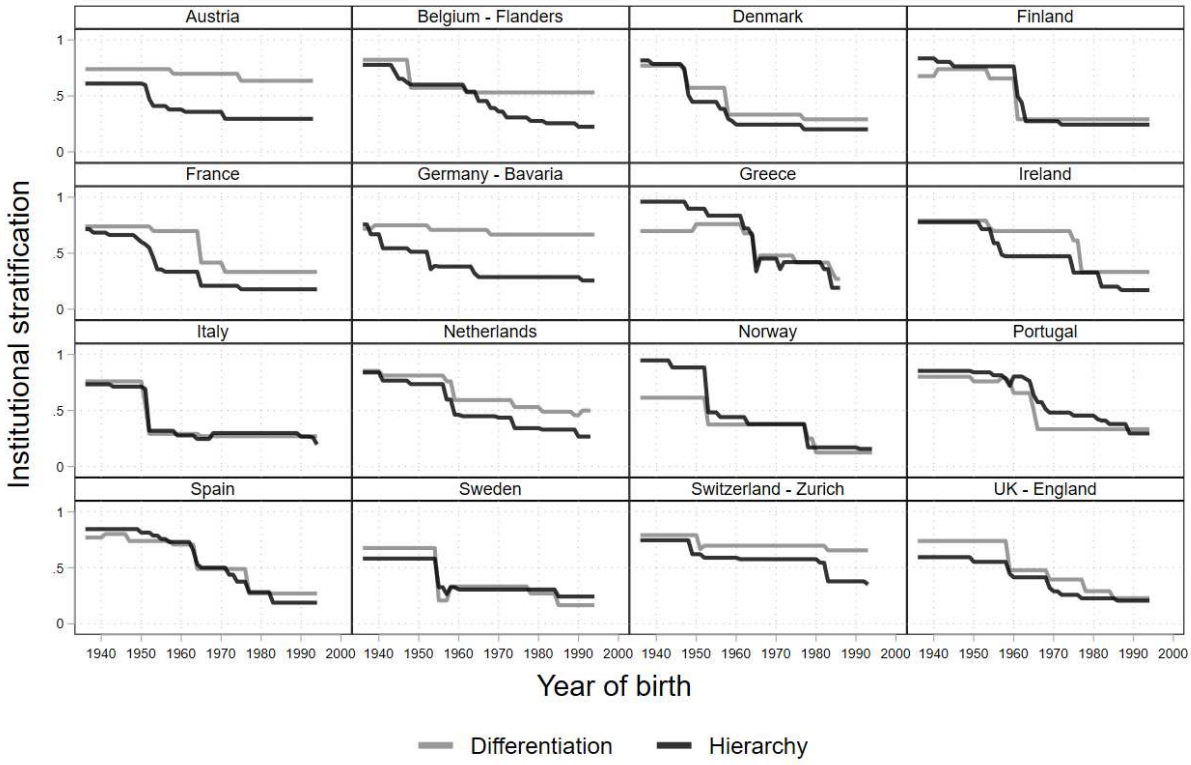
Table 1 Dimensions of Differentiation and Hierarchy

Level	Reforms Decreasing Differentiation	Reforms Decreasing Hierarchy
Lower Secondary	Common Tracks: • Increase tracking age • Decrease number of tracks Common Content: • Introduce common curriculum • Introduce common teacher training	Common Access: • Eliminate tuition fees • Introduce options for stream bridging Common Quality: • Increase length of compulsory full and part-time schooling • Reduce variation in level or length of teacher training across tracks Common opportunities: • Eliminate dead-ends • Increase onward opportunities
Upper Secondary	Common Tracks: • Reduce specialization of certificates issued in academic and/or vocational paths • Expand definition of academic paths Common Content: • Introduce common curriculum	Common Access: • Decrease selectivity of academic paths • Eliminate tuition fees • Decrease selectivity of alternative paths providing access to higher education Common quality: • Increase length of compulsory/optional schooling Common opportunities: • Increase range of vocational paths leading to higher education • Reduce selectivity in access to higher education from academic or vocational paths • Introduce certification-based paths into higher education

The above discussion suggests that the politics of stratification were historically two-dimensional. To increase social mobility, some countries decreased both hierarchy and differentiation while

others tackled only the former. As such, while most systems started out looking like the first panel on Figure 1, some moved towards the differentiated but less hierarchical middle panel, whereas others moved towards the low-differentiation model on the right. In both cases, these moves involved changes to multiple institutional features of secondary education – there was no singular "de-stratification." The result was substantial cross-place and cross-time variation in both dimensions of stratification. Figure 2 displays this over-time variation, the measurement of which we discuss in more depth below.

Figure 1 Trends in Differentiation and Hierarchy of Secondary Education by Country/Region and Birth Year – 1936-1994



3 Linking educational stratification to educational mobility

The above section argued that policy-makers often aimed to increase social mobility by de-stratifying education systems on multiple dimensions. Before examining whether these changes actually increased social mobility, we outline four key choices we make as to how to conceptualize mobility.

First, we focus specifically on educational mobility. Educational achievement is the core mechanism through which educational institutions are likely to matter for social mobility and education mobility is more independent from confounding institutions than income or class mobility. Moreover, given growing returns to education, it is an increasingly important feature of overall social mobility (Bukodi and Goldthorpe 2016; Bloome, Dyer and Zhou 2018).

Second, we focus on achievement in terms of years of education rather than qualification thresholds. In systems that offer extensive post-secondary non-university education, for instance, focusing on qualifications may underestimate educational attainment among some individuals. Indeed, the institutional mechanisms promoting mobility at one stage of education, or in one track, might operate differently at/in another (Mare 1980; Breen and Jonsson 2000).

Third, we examine two types of mobility: the changes in absolute levels of attainment among the children of low SES parents (absolute mobility) and the gap in attainment between the children of low SES parents and those from more advantaged backgrounds (relative mobility). The mass expansion of first secondary, and then higher, education has meant an increase in absolute educational attainment across the class spectrum. However, the children of the upper and middle classes have also upgraded over time, making relative gaps more persistent (Bukodi and

Goldthorpe 2016). Considering both relative and absolute mobility is thus important to understand mobility trajectories.

Fourth, because opportunities at the lower-secondary and upper-secondary levels are interrelated and sequential, we combine our measures of differentiation and hierarchy across the whole of secondary education. We thus link the educational mobility measures to our two-dimensional institutional measures with combined indicators from both levels of secondary education.

In examining the connection between stratification and mobility, much work focuses on how institutional stratification shapes both allocation into different tracks and the opportunities emerging out of them. Brunello and Checchi (2007), for instance, theorize that tracking increases the link between family background and attainment because it increases the risk of pupil misallocation into a low-performing stream and reduces positive peer effects in these streams. Other work focuses less on human capital accumulation than the signaling effect of elite education. Early tracking matters because parents with higher education are more able to prepare their children for selection processes, and this early access to elite tracks cements advantages for the next round of selection (Jackson and Jonsson 2013; Dumont, Klinge and Maaz 2019).

In other words, the link between tracking and mobility runs in part through differential track allocation across social groups and partly through an assumption of a hierarchical division among tracks that allocates lifelong opportunities in varying ways. However, if differentiation and hierarchy are distinct dimensions, then family-background disparities in allocation to tracks *may not necessarily* coincide with disparities in human capital acquisition or long-run attainment within a given track. To separate the effects of these processes, we compare the institutional mediation of

background and achievement in non-differentiated systems to both a) differentiated non-hierarchical systems and b) hierarchical systems.

Regarding the first comparison between the non-differentiated model and the differentiated non-hierarchical model, the literature offers ambiguous predictions.

Differentiation – even absent hierarchy – is likely to create background differences in track allocation. Where there is only one track, there is no role for family background in selection. As the number of tracks grows, uneven allocation into tracks becomes possible. If ability is not entirely correlated to background, and pupils are able to rationally plan ahead, then tracking should match pupils to pathways that suit their needs. However, where these conditions do not fully hold, family background plays a role in allocating pupils into tracks. In practice, children from higher SES backgrounds are more likely to attend academic tracks, whereas those from lower SES backgrounds are more likely to attend vocational streams (Dumont, Klinge and Maaz 2019).

This separation of class groups into different tracks affects peer composition, which could further compound differences. Peer effects could weaken/strengthen the performance of lower/higher SES children increasing the parent-child correlation in attainment (Brunello and Checchi 2007; Epple and Romano 2011). Tracking could also demotivate lower SES pupils, by drawing attention to early 'failure.' In these cases, the presence of more differentiation could, by itself, increase the SES gradient on achievement by affecting performance within tracks.

However, the link between family allocation into tracks and SES disparities in attainment does not just run through this initial selection mechanism and peer effects; there may be a countervailing quality effect. Where academic differentiation leads to programs more targeted to pupils' interests,

and produces vocational qualifications with high labor market value, it can reduce the incentives for lower SES children to exit school early. Much work on school-to-work transitions suggests that more vocationally oriented training can lead to smoother transitions (Bol and van de Werfhorst 2013; Bol et al. 2019), producing greater matching between training and labor market opportunities. Brunello and Checchi (2007) argue that a "specialization effect" can emerge – with specialized vocational training being more effective in equalizing adult training and competences across class groups.

Indeed, where differentiated institutions create specialized paths from non-academic streams to longer-term apprenticeships and vocationally-oriented higher education, they can increase the duration of lower SES children in education. Studies show that pupils staying within their specialization throughout their academic career are more successful in completing their studies (Biémar, Philippe and Romainville 2003; Wolter, Diem and Messer 2014; Verhoeven and De Vit 2000). These more targeted experiences can also create a `big-fish-little-pond-effect', reducing the negative effects on attitudes and achievement of comparing oneself with high-achieving peers (Loyalka, Zahkarov and Kuzmina 2018). In other words, non-hierarchical differentiation allows family allocation into tracks, but the existing literature suggests that it can also provide incentives for the completion of high-value vocational qualifications.

By contrast, when we compare hierarchical forms of differentiation to either non-differentiated or non-hierarchically differentiated systems, we have clearer predictions. As above, hierarchical systems allow family allocation into different tracks, but combine this allocation with variation in access, opportunities, and quality in ways which are likely to create disparities in attainment (Perry, Rowe and Lubienski 2022). Where fees exist and/or the leaving age is low, lower SES pupils are

less likely to enter longer tracks, either because they cannot stay (due to fees) or because the relative costs of staying in school (in terms of foregone wages) are less affordable (Jackson and Jonsson 2013). Where lower quality teaching and fewer onward opportunities compound these differences, educational institutions reinforce class differences in track allocation, enhancing background-related variation in achievement.

Hierarchy can also have an indirect effect. If low SES pupils largely train for less prestigious qualifications, they may be less incentivized to complete them; whereas those from higher SES background have strong incentives to complete more prestigious qualifications. From both a human capital and signaling perspective, hierarchically arranged tracking is likely to asymmetrically shape incentives for extended time in school across groups, increasing the correlation between parental background and child attainment through "diversion effects" (Brunello and Checchi 2007).

Reforms reducing hierarchy, even within differentiated systems, are therefore likely to increase mobility. Typical reforms that aim to reduce hierarchy – the aforementioned changes extending compulsory education or reducing dead-ends or upgrading opportunities for those in vocational and non-academic tracks – target lower SES pupils who are more likely to attend these tracks. These reforms, in creating more equal incentives, are likely to compress attainment differences and thus increase educational mobility. Relative to both non-differentiated and non-hierarchically differentiated systems, then, we expect these systems to reduce mobility.

These claims, on first glance, appears to be largely mechanical, i.e. removing institutional dead-ends or requiring attendance will necessarily increase schooling amongst those who previously did not attend. The presence of a dead-end imposes an upper limit on achievement for those in that

track. While lifting this barrier is likely to allow increases in absolute educational achievement, the effect on educational mobility is not mechanical. For instance, the 1964 Belgian Omnivalence reform virtually abolished selection into Belgian higher education, allowing holders of most upper-secondary certificates to access universities. However, in the subsequent decades, failure rates increased substantially. In the 1990s, 47% of students did not complete their undergraduate degree, with success rates showing a strong correlation to pupils' secondary specialization (Verhoeven and De Vit 2000). Appendix 5 shows that the removal of direct barriers to advancement (through dead-ends) did not lead to mechanical convergence in attainment across social groups. Nor does extending compulsory schooling necessarily reduce gaps among social groups – as all groups may stay in schooling longer. As such, we think of dead-ends as a limitation to mobility, and compulsory attendance as something permitting it, but see both as part of a larger package of institutions that shape mobility.

Thus, we propose the following hypotheses:

H1a: Greater hierarchy, net of differentiation, is associated with lower educational attainment among pupils from low SES backgrounds.

H1b: Greater hierarchy, net of differentiation, is associated with a larger gap in attainment between those from low SES and middle or high SES backgrounds.

H2a: Differentiation, net of hierarchy, will not be associated with worse performance among pupils from low SES backgrounds,

H2b: Differentiation, net of hierarchy, will not be associated with a larger gap in attainment between those from low SES and middle or high SES backgrounds.

We expect these hypotheses to hold both cross-sectionally and dynamically, although the data we use in our empirical test exploits only within-country dynamic variation.

4 Empirical Approach

4.1 Measuring differentiation and hierarchy in secondary schooling

Previous research on educational stratification and social mobility tends to examine single institutions in isolation. Studies addressing differentiation largely focus on tracking. This work finds that early tracking increases the correlation between family background and educational attainment in test scores and qualifications (Hanushek and Wößmann 2006; Marks 2006; van de Werfhorst and Mijs 2010; Bol and van de Werfhorst 2013); increases inequalities in performance (Hanushek and Wößmann 2006); but only decreases social mobility by *some* measures (Bukodi et al. 2018; van de Werfhorst 2019). Studies focusing on hierarchy largely examine extensions to the length of compulsory schooling, with more mixed results (Brunello, Fort and Weber 2009; Sturgis and Buscha 2015). However, as we argue above, political actors seeking to reduce hierarchy or differentiation typically reformed a wide range of institutional features of education systems. Data reflecting this institutional complexity is required for a rigorous test of our claim that hierarchy and differentiation have distinct consequences for patterns of educational mobility.

To address this need we developed a new index measuring *differentiation* and *hierarchy* in lower and upper-secondary education (Secondary Stratification Index). Differentiation is based on two subdimensions of *tracking* and *content*, while hierarchy is based on subdimensions of *quality, access,* and *opportunities* (see also Table 1). Note that our index measures between-school stratification at the secondary level, which existing research considers crucial in shaping future opportunities. This approach means that we neither account for additional stratification after

students reach tertiary education nor within-school differentiation such as grouping or electives. A detailed description of each variable and how it was coded can be found in Appendix 1.

4.1.1 Differentiation

We measure *tracking* by coding the age of streaming and number of lower-secondary streams. At upper-secondary level, where tracks are less clearly delimited, we use the breadth of academic paths and degree of certificate specialization as indicators. In less differentiated systems, academic tracks also include vocational and technical subjects, and upper-secondary certificates allow students to access different tertiary courses. Someone with a certificate in commerce might study education, something they could not do if differentiating institutions limit choices to their area of specialization.

To measure *content* differentiation, at both levels, we code the extent to which curricula are distinctive across tracks. At the lower-secondary level, we also code whether teachers receive the same type of training. In more differentiated systems, teachers' didactical and subject-specific preparation is tailored to specific tracks, whereas in less differentiated systems they receive the same type of training.

4.1.2 Hierarchy

We measure *access,* the first sub-dimension of hierarchy, in terms of policies shaping track-specific entry barriers (selectivity and fees). At the upper-secondary level, we measure mechanisms of allocating pupils into tracks providing paths to higher education (choice or selection). For lower secondary, tracking always implies selective allocation, and we therefore code whether institutionalized bridging mechanisms allow pupils to switch paths.

We measure *quality*, the second sub-dimension, through the extent to which the non-curricular content of the track reflects alleged variation in students' abilities. Here we include the length of the program and markers of teaching quality (length and level of teacher training – as opposed to specialization of teacher training, which we qualify as differentiation). These measures of teaching quality vary across levels.

Finally, the *opportunities* sub-dimension codes the extent to which tracks provide varying access to further education. At the lower-secondary level, we code whether some tracks are dead-ends or provide limited access to upper-secondary education. Since upper-secondary paths are less clearly delimited, at this level we code, first, the range of paths providing access to higher education, meaning whether some subject areas (e.g., nursing or construction) lack ladders into higher education, and second, whether paths provide direct access to tertiary-level education, or whether additional grade- or exam-based requirements apply. Finally, we also code the existence of mechanisms allowing individuals without the required upper-secondary certificates to access tertiary schools via exams or accreditation procedures.

4.2 Data collection and coding

We collect data on these variables for 16 West European countries from 1945 onwards. For federal countries with devolved responsibility for education we select one of the largest regions. Our sample includes: Austria, Belgium (Flanders), Denmark, Finland, France, Germany (Bavaria), Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland (Zurich), and UK (England).

This extensive program of data collection drew on three types of sources. Firstly, we systematically analyzed reports by international organizations such as Unesco, OECD, and the European authorities as well as encyclopedias depicting national education policies issued throughout the post-WWII period. Where the information provided in international sources was not specific or reliable enough, we turned to case literature in English or local languages. This category of sources includes descriptions of education systems or single reforms published in comparative and national education journals since 1945, as well as scholarly literature addressing the politics or impact of reforms. Finally, we referred to original legislation or policy-documents. For these steps, we worked with research assistants with knowledge of European languages. Appendix 1 outlines the sources and coding procedures.

We code each country-year on each indicator, and then rescale all indicators to run from 0 to 1. The overall differentiation and hierarchy scales are the means across all indicators for the lower and upper-secondary levels, with higher scores equating to greater educational stratification. Each specific indicator is equally weighted, as are the upper and lower-secondary levels, in the combined scale. Figure 2 plots stratification across countries and birth years, showing a consistent decline in hierarchy across countries, but more heterogenous trends in differentiation, with countries such as Austria, Germany (Bavaria), and Belgium (Flanders) retaining comparatively differentiated systems. Table 2 shows that differentiation and hierarchy are overall strongly correlated (r=0.74), as are levels of hierarchy in lower and upper secondary (r=0.61), though differentiation at upper and lower secondary are not (r=0.11).

These measures of differentiation and hierarchy are *formative constructs*, meaning that high scores on the individual indicators cause high levels of differentiation and hierarchy. This contrasts with

more commonly used *reflective constructs*, where high values on the underlying latent variable cause high levels of the observed indicator. The individual indicators underlying a formative construct do not need to be positively correlated with one another (and can be negatively correlated) if they are substitutes for achieving the same policy goal (Bollen and Lennox 1991). Thus, factor analytic techniques are not appropriate for validating our measures. However, Appendix 4 shows that the correlations among the subdimensions and individual indicators that comprise the overall scales are generally positively correlated.

Table 2 Correlation among hierarchy and differentiation scales, overall and at lower and upper-secondary levels

	Differentiation	Hierarchy	Diff. lower sec.	Hier. lower sec.	Diff. upper sec.	Hier. upper sec.
Differentiation	1.00					
Hierarchy	0.74	1.00				
Diff. lower sec.	0.93	0.58	1.00			
Hier. lower sec.	0.82	0.92	0.74	1.00		
Diff. upper sec.	0.47	0.59	0.11	0.43	1.00	
Hier. upper sec.	0.47	0.87	0.25	0.61	0.66	1.00

Estimated on N=817 country-years with valid mobility data and covariates.

4.3 Measuring educational mobility

We combine the measures of educational stratification with data on individual mobility outcomes for our 16 countries/regions of interest from the European Social Survey 2002-2018. Using an individual's year of birth and country of residence we link them to the educational institutions they would have been exposed to during their adolescence. We focus on individuals born between 1936 and 1994, who entered lower-secondary education between roughly 1946 and 2005. Our main outcome measure is the years of education an individual completed. Tables A7-8 report robustness checks using binary measures of completion of upper secondary and tertiary as outcome variables.

We measure individuals' family background using a composite measure of parental socio-economic status (SES) drawing on parental education and occupational class when the individual was aged 14. We combine them into a single variable distinguishing low, medium, and high parental SES using the mapping shown in Table 3. We use this combined measure of parental SES in part to reduce the complexity of our regression models, and to reduce the likelihood of measurement error in either parental education or occupation leading to spurious findings. Tables A13-14 replicate our main results using education and occupation as separate measures of SES.

Parental education is measured in three categories: Low (lower-secondary education and below - ISCED-2011 2 or less), Medium (upper-secondary and post-secondary non-tertiary education - ISCED-2011 3 to 4), and High (tertiary education - ISCED-2011 5 and above). Parental occupation is measured using a three-class version of the EGP class schema which distinguishes unskilled occupations, intermediate occupations, and service class occupations. In cases where we have

information on both the mothers' and the fathers' education and/or occupation we use information on the higher qualified parent. See figure A1 for trends in the association between parental SES and child educational attainment over countries and time.

Table 3 Mapping of SES

Parental occupation / **Parental education**	*Unskilled occupations*	*Intermediate occupations*	*Service class*
Lower secondary or lower	Low SES	Low SES	Medium SES
Upper secondary or vocational	Low SES	Medium SES	High SES
Tertiary	Medium SES	High SES	High SES

At an individual level we control for individuals' gender, age, and whether their parents were foreign born. At an aggregate level we control for variables which are likely to affect both educational policies and family background differences in educational attainment. We focus on measures of GDP growth (Maddison project – Bolt and Van Zanden 2020), unemployment rates (CPSD – Armingeon, Engler, and Leemann 2021; and IHS – Mitchell 2007), and the percentage of national or regional cabinet positions held by left parties (ParlGov – Döring and Manow 2021). All variables are measured when respondents were aged 11.

We exclude individuals aged under 25 to ensure our sample includes only those who have completed full-time education, and those who are first-generation immigrants, who may have been

exposed to the educational institutions of their country of birth. Our main model has 111,862 individuals nested in 817 country-birth-years. Descriptive statistics for all variables can be found in tables A1-A2.

4.4 Methods

Our analysis estimates the association between parental SES and child educational attainment conditional on the levels of hierarchy and differentiation to which children were exposed. We use a differences-in-differences style OLS regression model, building on van de Werfhorst (2019). Our main model specification is set out in equation (1) below, where *i* denotes individuals, *j* birth-years, and *c* countries/regions.

$$
\begin{aligned}
(1)\ YearsEdu_{ijc} &= \beta_1 ParentalSES_{ijc} + \beta_2 Differentiation_{jc} + \beta_3 Hierarchy_{jc} \\
&+ \beta_4 ParentalSES_{ijc} * Differentiation_{jc} \\
&+ \beta_5 ParentalSES_{ijc} * Hierarchy_{jc} + \delta_1 YearBorn_{jc} + \delta_2 ParentalSES_{ijc} \\
&* YearBorn_{jc} + \delta_3 Country + \delta_4 Country * YearBorn_{jc} + \delta_5 Country \\
&* ParentalSES_{ijc} + \delta_6 Country * ParentalSES_{ijc} * YearBorn_{jc} + \gamma X_{ijc} \\
&+ \theta_1 Z_{jc} + \theta_2 Z_{jc} * ParentalSES_{ijc} + \alpha + \varepsilon_{ijc}
\end{aligned}
$$

Our outcome variable is years of education completed $YearsEdu_{ijc}$. The parameters of interest are the β coefficients, which represent the association between parental SES and educational attainment and how this association varies based on levels of educational hierarchy and differentiation.

Our main strategy for dealing with potential confounders is to adjust for a rich set of fixed effects. We adjust for time-invariant differences in attainment between countries through country fixed effects $\delta_3 Country$, and country-specific associations between parental background and attainment by interacting country fixed effects with parental SES $\delta_5 Country * ParentalSES_{ijc}$. Over time variation in educational attainment is controlled using a linear year-of-birth trend $\delta_1 YearBorn_{jc}$. We use this rather than the time fixed-effects typically used in difference-in-difference models because mobility trends generally appear to evolve smoothly over time rather than responding rapidly to exogenous shocks. We interact the year of birth trend with parental SES $\delta_2 ParentalSES_{ijc} * YearBorn_{jc}$, to adjust for changes in the link between parental SES and attainment and with country to adjust for country-specific trends in attainment $\delta_4 Country * YearBorn_{jc}$. We interact year-of-birth with both parental SES and country to adjust for country-specific changes in educational mobility $\delta_6 Country * ParentalSES_{ijc} * YearBorn_{jc}$. We control for individual level demographic confounders through γX_{ijc}, which includes controls for gender, age, age^2, and parental country of birth. Finally, we adjust for exogenous macroeconomic and political shocks that could be associated with educational stratification and shape the association between parental SES and attainment by controlling for macro-level confounders (unemployment rate, GDP growth, and left-party share of cabinet posts) $\theta_1 Z_{jc}$, all of which are interacted with parental SES $\theta_2 Z_{jc} * ParentalSES_{ijc}$. This wide set of controls provides a conservative test of our hypotheses.

Standard errors are clustered by country-birth-year, ESS post-stratification weights are used, and all continuous variables are standardized to facilitate interpretation of interaction effects. Rather than directly interpreting coefficients from this model we instead calculate the average marginal

effect of a 1 standard deviation increase in each stratification index at different levels of parental education and occupational class.

5 Results

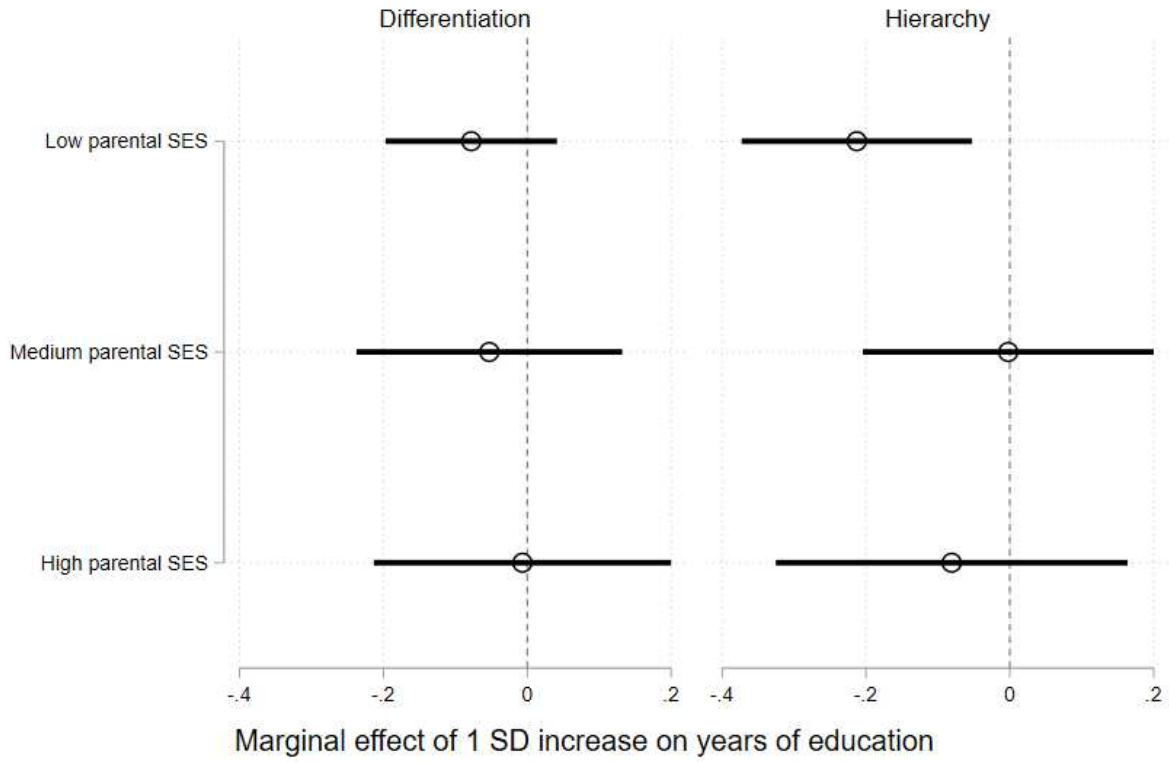
Figure 3 and Figure 4 present our estimates of the effects of tracking and hierarchy on the association between parental background and educational attainment. We find no evidence that greater differentiation is associated with either absolute or relative mobility. Estimated marginal effects of an increase in differentiation are close to 0, with 95% confidence intervals consistent with both positive and negative effects. A 1 standard deviation increase in differentiation is associated with a -0.08 years (95% CI: -0.2, 0.04) decrease in attainment among those from low SES backgrounds. Similarly, Figure 4 shows that moving from a country-year 1.5 standard deviations below the mean to a country-year 1.5 standard deviations above the mean is associated with a 0.21 years (95% CI: -0.46, 0.89) increase in the gap between those from low and high SES backgrounds and a 0.08 years (95% CI: -0.59, 0.74) increase in the gap between those from low and medium SES backgrounds.

The results suggest a more important role for hierarchy. A 1 standard deviation increase in hierarchy is associated with a -0.21 years (95% CI: -0.37, -0.05) decrease in years of education completed among those from low SES backgrounds. By contrast the associations between hierarchy and attainment among those from moderate or high SES backgrounds are close to 0 and imprecisely estimated. Moving from an area 1.5 standard deviations below the mean in hierarchy to an area 1.5 standard deviations above the mean is associated is associated with a 0.40 years (95% CI: -0.40, 1.19) increase in the gap between those from low and high SES backgrounds and

a 0.63 years (95% CI: -0.13, 1.39) increase in the gap between those from low and medium SES backgrounds. The confidence intervals around these estimates include 0, and are consistent with small decreases in SES attainment gaps. However, these results still provide suggestive evidence that hierarchy is associated with reduced relative mobility. The high correlation between differentiation and hierarchy (r=0.74) may be leading to very high standard errors on estimates of the interaction between hierarchy and family background, which has confidence intervals that do not overlap 0 in models where differentiation is not controlled for. By contrast estimates of the interaction between differentiation and family background overlap 0 even when hierarchy is not controlled for. See Appendix 6.04 for more details.

Thus, we find little evidence that differentiation shapes attainment for children of any social background, while finding evidence that increased hierarchy is associated with lower attainment among children from low SES backgrounds, and suggestive evidence that hierarchy is associated with larger family background differences.

Figure 2 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES



We now examine whether the effect of differentiation on attainment depends on concurrent levels of educational hierarchy. To do so, we extend our main model by recoding our measure of hierarchy into three equally sized groups representing low, middle, and high hierarchy. This measure is then interacted with both parental SES and differentiation, in a three-way interaction. We use this coarsened version of our measure of hierarchy partially to facilitate interpretation of the results, but also because differentiation and hierarchy are quite closely correlated (see figure A2).

Figure 4 Predicted levels of education by differentiation and hierarchy indices and parental SES. Rug plot displays distribution of underlying indices

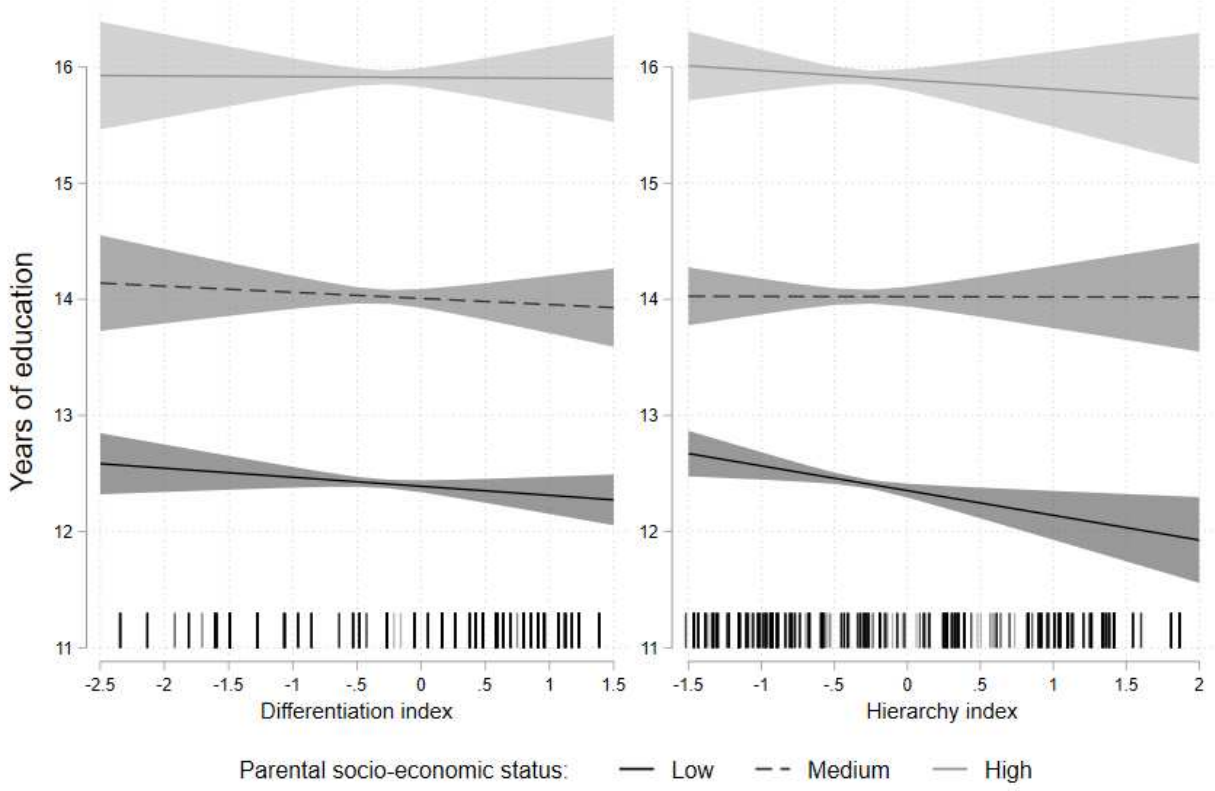
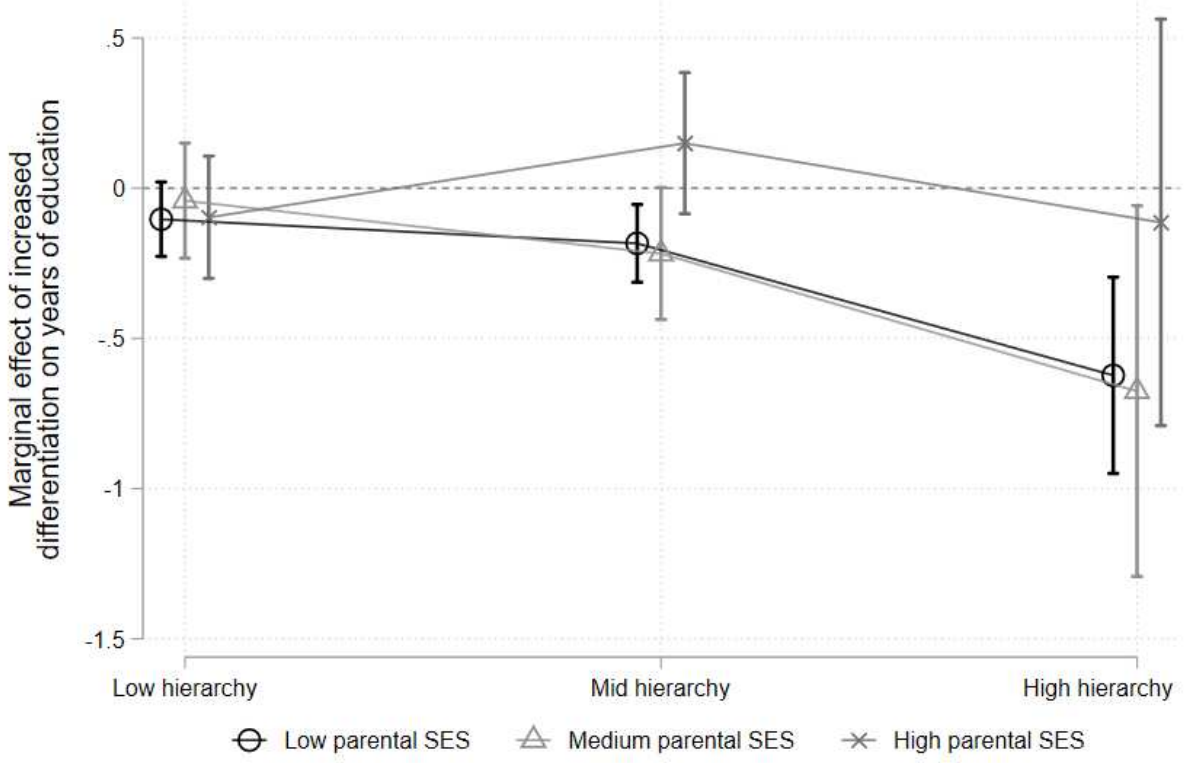


Figure 5 displays the estimated marginal effect of a 1 standard deviation increase in differentiation on educational attainment, conditional on both parental SES and hierarchy. Results support the idea that the effect of differentiation on educational attainment depends on the concurrent level of educational hierarchy. In country-years with low levels of hierarchy, the marginal effect of a one standard deviation increase in differentiation is small at all levels of parental SES (approximately 0.1 years) with 95% confidence intervals overlapping 0. By contrast, in cases in the top 1/3rd of the hierarchy distribution, a one standard deviation increase in differentiation is associated with substantially lower educational attainment among those from low (-0.62 years of education 95% CI: -0.95, -0.30) and moderate SES backgrounds (-0.68 years of education 95% CI: -1.30, -0.06).

This implies that the deleterious consequences of greater differentiation for attainment among those of low or medium SES are conditional on high levels of educational hierarchy.

Figure 5 Marginal effect of differentiation on educational attainment conditional on hierarchy and parental SES



5.1 Robustness checks

Tables A6-1 to A6-17 in Appendix 6 show that our main finding – that hierarchy but not differentiation is associated with lower absolute upward mobility for those from low SES backgrounds – is generally robust to a wide range of alternate modelling choices, while also providing some important nuances to our findings. We find some evidence that increased differentiation in *upper secondary* is associated with weaker performance among those from low SES backgrounds, but not *lower secondary* – the typical focus of previous analyses of educational

stratification (Table A6-5). Our results for hierarchy hold when we focus on the quality and access subdimension of hierarchy only, and are thus not solely driven by the presence of 'mechanical' barriers to progress like dead-ends (Table A6-16). Our main results seem to be driven by changes in the probability of completing upper secondary, rather than tertiary education (Table A6-6/7). Our results are generally robust to alternate sets of covariates, including a different set of aggregate covariates that allows more country birth-years to be included in the analysis (Table A6-8/11). Similarly, results are very similar when using only parental education or occupation as measures of SES (Table A6-12/13). Effect sizes for both differentiation and hierarchy are similar when estimated on subsamples born before and after 1960, though confidence intervals for hierarchy overlap 0 among the younger group (Table A6-14/15 – see Gingrich et al. 2023 for further discussion of this pattern). Finally, dropping each country/region sequentially from our model reveals that no specific country is driving our substantive conclusions (Table A6-16).

6 Discussion

The link between stratifying educational institutions and patterns of intergenerational mobility has been extensively debated by scholars and policymakers. In a seminal paper, Brunello & Checchi (2007) argue that tracking might have both diversion effects, preventing lower SES individuals from climbing the educational ladder, and specialization effects that increase these individuals' further training and adult competences. We make an important intervention in this debate by showing these two effects are linked to distinct institutional configurations. Educational stratification is multidimensional: the extent of differentiation into separate tracks is distinct from the extent to which the quality of those tracks is hierarchically organized. These dimensions are shaped by reforms targeting a wide variety of institutional rules at both upper and lower secondary

levels. To improve on the relatively limited measurements of hierarchy and differentiation in existing research, we collect detailed long-term comparative data on a wide range of education policies for 16 countries/regions. Our uniquely rich data facilitate a rigorous test of the joint effects of hierarchy and differentiation on patterns of intergenerational mobility.

We find clear evidence that greater educational hierarchy is associated with lower attainment among those from low SES backgrounds, and some suggestive evidence of larger disparities between those from lower and higher SES backgrounds. However, conditional on levels of hierarchy we find no evidence that levels of differentiation shape patterns of intergenerational mobility. Differentiated pathways are only associated with lower attainment for children from low SES backgrounds in institutional contexts where those pathways are hierarchically structured in terms of prestige and onward opportunities.

Politically, these findings suggest that both main post-WWII de-stratification strategies can increase intergenerational mobility in educational attainment, because they both target the hierarchical ranking of tracks. The implication is that policy-makers who are interested in increasing prospects for upward educational mobility should focus on reducing hierarchy by broadening onward opportunities. The findings also have implications for the large literature which argues that single institutional features, in particular the tracking age, shape social mobility. Our findings suggest that the results of some of these studies are potentially confounded by failing to simultaneously account for both hierarchy and differentiation. Other studies may be interpreting their results as reflecting changes in specific policies such as the tracking age when they are actually driven by other features of concurrent educational reforms. As a result, future research

should use multiple indicators of educational stratification to account for the multidimensional nature of educational reforms and the diverse policy levers used to de-stratify schools.

There is a large literature on how tracking increases inequalities in performance on standardized tests. Our results challenge the implications of these studies. Despite inequalities in test performance, non-hierarchical tracked systems may allow less able pupils from lower SES backgrounds to achieve high levels of education – especially if non-academic tracks provide clear pathways to higher vocational qualifications. Future research should investigate whether non-hierarchical differentiated systems, through their greater specialization, provide better school-to-work transitions and flatten the income distribution (Bol and van de Werfhorst, 2013; Bol et al. 2019). Alternatively, differentiation or "clustering", while not detrimental to educational mobility, might still reinforce labor market inequalities and mismatches, as discussed by Alam and Forhad (2019) in this journal.

In highlighting the *interactions* between differentiation and hierarchy our results are consistent with the plea to examine how "configurations of education policies and structures" (Perry, Rowe and Lubienski 2022: 7) reinforce or undermine one another in shaping patterns of segregation. However, it is important to note that our study only examines differences between pupils' experiences that are driven by formal institutional rules that stratify between schools. We do not examine the role of within-school differentiation, nor do we examine geographical variation in school funding or pupil composition, which can lead to substantial heterogeneity in students' experiences even within less stratified systems.

Nonetheless, our work offers an important insight for educational research. The institutions that shape school stratification are multidimensional. As a result, understanding the effects of education

policies on patterns of social mobility requires researchers to take institutional configurations seriously. Both conceptual and empirical research should assess the ways in which educational policies combine and interact in shaping opportunities.

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Online Appendix
"Multidimensionality Matters"

Jane Gingrich, Anja Giudici, and Daniel McArthur - June 2023

A1) Secondary Stratification Index: Conceptual Structure and Indicators

Appendix 1 outlines the structure, description, and coding logic applied to construct the Secondary Stratification Index. Building on Sørensen (1970), Allmendinger (1989), and Kerckhoff (2001), the SSI conceptualizes and measures stratification on two institutional dimensions.

First, we distinguish educational stratification in terms of the degree of *differentiation*, the extent to which institutions provide pupils with specialized academic experiences. Since our aim is to separate, theoretically and empirically, the concept of differentiation from that of hierarchy, we conceptualize differentiation strictly in terms of the extent to which pupils have different experiences through explicit divisions in qualifications and content (measured through both curriculum and teachers' curriculum). Conceptually, these distinctions follow from curricular standardization, which we measure with two core sub-components.

- Common Tracks: this sub-dimension refers to the extent to which pupils are educated in a single track that leads to a single qualification. Where there are fewer tracks or a later age of tracking, there is less explicit differentiation in learning.
- Comment Content: this sub-dimension refers to the extent to which pupils receive common curricular content. Where there are distinct tracks, but students have a common curriculum across tracks and teachers are trained similarly, there is less differentiation in their experiences.

Second, we distinguish education systems based on the degree of *hierarchy*, meaning the extent to which the above specialization is meant to reflect pupils' alleged unequal capabilities and arrange tracks in a ranked order. In our framework, where there is no differentiation, there is also no hierarchy among tracks. However, where multiple tracks do exist, they can be arranged in a more or less hierarchical way, in which some tracks are harder to access, have more investment in quality, and offer more onward opportunities. A less hierarchal ordering of experiences emerges where different tracks have more common entry paths, greater common quality during the education process, and have common exit opportunities.

- Common access: this sub-dimension refers to the barriers that students face to join or access a track. We measure this based on the extent of academic and financial barriers. Academic barriers refer to

track selectivity. Selectivity is nearly universal for systems that track at the lower secondary level;[2] but at the upper secondary level, countries vary as to whether access to academic tracks is rationed by performance. At both levels, fees constitute a potential financial barrier to access. Where barriers to access are higher, tracks that are more restricted to those from academic or class elites emerge, increasing the perceived link between tracks and pupil ability in a hierarchical way.

- Common quality: this sub-dimension refers to the standardization of the non-curricular components of the academic experience, namely the length of training for pupils and teachers. While quality is multi-dimensional, given our interest lies in institutional variation (rather than expenditures or resource based measures) we restrict ourselves to institutional quality features. Where pupils are required to spend more time in school, it reduces the gap between the typically longer-length academic tracks and other tracks. The same is true for teacher training. While teachers always have path and discipline specific training at the upper secondary level, the quality and type of teacher training varies at the lower secondary level. Where teachers are trained for less time or receive a lower qualification level for teaching in one track than the other, then the perceived quality and hierarchical prestige of that track is likely to be lower.
- Common opportunities: this sub-dimension refers to the extent that different tracks offer similar onward opportunities to further studies. Where there are formal "dead-ends", meaning that progression is not possible, some tracks will provide fewer opportunities than others to advance. However, even in the absence of formal dead-ends, onward opportunities vary. Where there are few opportunities to shift tracks, or where upper secondary tracks lead to a narrower range of certificates that do not allow access to university level higher education, progression is limited for one track relative to others. Where one track offers a greater range of onward opportunities than another, it is likely to have more hierarchical prestige.

We thus divide these two concepts – differentiation and hierarchy, into sub-concepts, measuring each at the lower and upper secondary level. The SSI measures these dimensions for the lower-secondary level (ISCED 2, i.e. formal education targeting the ages 10/12-15/16, in the middle school or early exam school period)

[2] We do not explicitly measure selectively at the lower-secondary level, as all countries that employ multiple tracks at the lower-secondary level use some selective mechanisms for determining access to different lower-secondary paths. The one partial exception is of Belgium where parents have free choice.

and upper-secondary level (ISCED 3, i.e., formal education targeting the ages 15/16-18/19 in both the general and vocational sectors). The following two tables outline the component parts of each based on the sub-concept.

A 1.01 Indicators

Table A1-1 Indicators for Lower-Secondary Stratification Index

	Indicators	Description	Coding
Differentiation	**Common Tracks**		
	1) Streaming Age *Higher score = ↓ stratification*	Age at which pupils are first sorted into distinct tracks. Tracks involve either (a) the existence of different curricula leading to different qualifications or (b) selective entry that sort pupils into different (even if they offer the same type of qualification). We do not consider within school streaming, where schools are comprehensive and do not award different qualifications.	Age of streaming (years)
	2) Number of Streams *Higher score = ↑ stratification*	Number of lower-secondary tracks based on the qualification they lead to (according to definition above).	Number of streams (number)
	Common Content		
	3) Common Curriculum *Higher score = ↓ stratification*	Age at which a common curriculum extends up to. In most cases, this will be the same as the streaming age, but in some countries, a common curriculum is introduced across different streams in order to facilitate movement and common skills, while in others different curricular paths exist within a comprehensive system. As a result, the age at which children stop experiencing a common curriculum may be higher/lower than the streaming age variable. We only consider curricula with separate paths (internal tracks, such as vocational, academic, or artistic) as separate curricula.	Age of curriculum streaming (years)
	4) Common Teacher-training Type *Higher score = ↓ stratification*	Differentiation in the type of training required to be a teacher in different lower-secondary tracks. Do all teachers receive the same type of training or do tracks employ specialized teachers who receive different types of education – for instance involving different degrees of subject specialization or didactic knowledge.	(0) Different types of teacher training (courses/institutions) required across tracks (0.5) Mixed system, with different types of training partly linked to tracking (1) Teachers across tracks receive the same type of training

Hierarchy	**Common Access**		
	5) Tuition Fees *Higher score = ↑ stratification*	Fees charged for the core academic program (i.e., not books or transportation) of academic track (if it exists). We only consider regulations for private schools when these are core providers of secondary education (i.e., some pupils have no alternative).	(0) No fees allowed (0.5) Fees are charged but almost entirely reimbursed by the public sector and/or non-paying tracks offer path to academic upper secondary (1) Fees allowed
	6) Stream Bridging *Higher score = ↓ stratification*	Existence of institutionalized mechanisms (e.g., based on grades, recommendation, or exams) allowing pupils to move from non-academic to academic tracks. Code 1 for countries with no streaming.	(0) No bridge across tracks (0.5) Transitions are theoretically possible, but require private investments (e.g., an exam outside of the curriculum of study) (1) Transitions are formally possible, even if they require extra tuition (e.g., repeating a year of schooling)
	Common Quality		
	7) Length of Full-time Compulsory Schooling *Higher score = ↓ stratification*	Length of full-time compulsory schooling measured by the difference between the age at which pupils must enter formal education and the age at which they are allowed to exit, or the prescribed minimum years of compulsory full-time formal education.	Age of entry Minimum leaving age Compulsory full-time school years (years)
	8) Length of Compulsory Education *Higher score = ↓ stratification*	Length of compulsory education (full- and part-time) measured by the difference between the age at which pupils must enter formal education and the age at which they are allowed to exit, or the prescribed minimum years of compulsory education.	Age of entry Minimum leaving age Compulsory education years (years)
	9) Variation in Level of Teacher-training *Higher score = ↓ stratification*	Variation in the level of training required to be a teacher in different lower-secondary tracks. Are all teachers trained at the same level (e.g., university graduates), or do some tracks employ teachers with lower levels of training. We code cases in which some teachers are university graduates and others are education by tertiary non-university institutions as same level.	(0) Teachers across tracks have different levels of training (0.5) Mixed system, with different levels of training partly linked to tracking (1) Teachers across tracks are trained at the same level
	10) Variation in Length of Teacher-training *Higher score = ↓ stratification*	Variation in the length of training required to be a teacher in different lower-secondary tracks. Does the year of formal education (fastest paths from start of compulsory schooling to acquisition of	(0) Teachers across tracks receive different lengths of training (0.5) Mixed system, with different lengths of training

		teaching certificate) required to teach at the lower-secondary level vary across tracks.	partly linked to tracking or one semester or less of difference (1) Teachers across tracks receive same length of training
	Common Opportunities		
	11) Academic Dead-Ends *Higher score = ↑ stratification*	Existence of lower-secondary tracks that either do not lead to a qualification, result in a qualification that does not allow further study at the upper-secondary level, or systems where students can stay in primary school to the end of compulsory education with no onward progression.[i]	(0) All lower-secondary qualifications allow progression into upper secondary (1) One or more lower-secondary tracks are academic dead-ends
	12) Onward Opportunities *Higher score = ↓ stratification*	Variation in the onward opportunities provided by lower-secondary tracks: do all lower-secondary credentials provide generalized access to different upper-secondary paths or do some certificates limit pupils' choice.	(0) Students without necessary credentials can drop out (e.g., because exams or certificates generally required to access upper-secondary paths) (0.5) Different qualifications or grades give access to different types of upper-secondary education, but options catering for different categories exist (1) Completion of lower-secondary schooling gives access to upper-secondary level education, with student choosing which path they want to pursue

Table A1 2 Indicators for Upper-Secondary Stratification Index

	Indicators	Description	Coding
Differentiation	**Common Tracks**		
	13) Specialization of Academic Paths *Higher score = ↓ stratification)*	This variable codes whether the specialization of a student completing an upper-secondary academic path (subjects, electives, or type of academic path) affects what disciplines they can access at the tertiary level, or whether they can access all courses regardless of their specialization. Our coding does not consider the special case of Latin, which was and sometimes still is a requirement to access specific university departments.	(0) Specialization in academic path affects which disciplines students can access at the tertiary level (0.5) Specialization does not formally limit disciplinary choice at tertiary level, but exam or admission structure means choice of subjects affects likelihood of being admitted into different programs (1) Specialization does not limit students' options at tertiary level
	14) Specialization of Alternative Paths *Higher score = ↓ stratification*	This variable codes whether the specialization of a student completing an alternative upper secondary path into higher education (subjects, electives, or type of path) affects what disciplines they can access at the tertiary level, or whether they can access any discipline at this level, or whether they can access all courses regardless of their specialization. Our coding does not consider the special case of Latin, which was and sometimes still is a requirement to access specific university departments.	(0) There are no alternative paths into higher education (1) Specialization affects which disciplines students can access at the tertiary level (e.g., a bookkeeping certificates provides access to economics courses but not to pedagogy) (2) Specialization does not formally limit disciplinary choice at tertiary level, but exam or admission structure means choice of subjects affects likelihood of being admitted into different programs (3) Specialization does not limit students' options at tertiary level
	15) Scope of Academic Paths *Higher score = ↓ stratification*	This variable codes the range of subjects and subject-combinations that can be studied within the academic upper secondary path. Definitions: Classics include Latin and other classical languages (e.g., Greek or Hebrew). Modern academic subjects include "realist" subjects that have come to be included at university level more recently, such as the sciences, social sciences, economics, foreign languages. Vocational include subjects that have a clear practical orientation and are not considered regular academic subjects (e.g., husbandry, home-economics, agriculture).	(0) Academic-path curriculum includes core subjects and classical languages (0.5) Academic-path curriculum also includes modern academic subjects (1) Academic-path curriculum also includes vocational subjects

	Common Content		
	16) Common Curriculum *Higher score = ↓ stratification*	This variable codes whether there are regulations setting common standards, outcomes, or content regulations (e.g., common core) for upper-secondary paths.	(0) No common curriculum regulations or aims (0.5) General aims or goals exist, but focus on general skills and values (e.g., citizenship) rather than content (1) Common curriculum regulations spanning across tracks exist
Hierarchy	**Common Access**		
	17) Selectivity of Academic Paths *Higher score = ↓ stratification*	System used to allocate pupils into academic upper-secondary paths. If allocation happens at the lower-secondary level (i.e., pupils are streamed at the end of primary schooling and then remain in their track), code the system used at this transition. If multiple transitions exist, we code the most frequently used.	(0) Selective admission based on entrance or exit exams (1) Selective admission based on teacher recommendation, past grades or certificates (2) Pupil choice, with previous grades/teacher recommendation if oversubscribed (3) Pupil choice
	18) Selectivity of Alternative Paths *Higher score = ↓ stratification*	System used to allocate pupils into other upper-secondary paths providing access to higher education. Even if apprenticeships are per se "selective", in that students need to find an employer, we do not code this as selection if there are not formal rules on the kind of certificates or grades students need to access a profession.	(0) There are no alternative paths into higher education (0.5) Alternative paths to higher education are selective (students need certificates that go beyond minimal lower-secondary qualification) (1) Non-selective paths lead to higher education
	19) Tuition Fees *Higher score = ↓ stratification*	Fees charged for the core academic program (i.e., not books or transportation) of academic upper-secondary path (main stream leading to university in state or publicly funded schools, if they are accessible for everyone). We only consider regulations for private schools when these are core providers of secondary education (i.e., some pupils have no alternative).	(0) Fees allowed (0.5) Split system, with only some types of academic paths schools charging fees (1) No fees allowed
	Common Quality		
	20) Extension of Compulsory Schooling *Higher score = ↓ stratification*	Extension of compulsory attendance (part- or full-time) into upper-secondary education.	(0) Compulsory schooling period ends with completion of lower-secondary schooling (0.5) Compulsory education period extends to the first 1 or 2 years of upper secondary but does not cover entire level. (1) Compulsory education period ends 2 or more years after the completion of lower secondary education

	Common Opportunities		
	21) Range of Alternative Paths *Higher score = ↓ stratification*	Range of paths providing opportunities to access higher education. This variable codes whether only selected profiles (i.e., traditional professions with high autonomy and higher-level training) provide access to tertiary education, or whether a broader range of curricula providers such opportunities.	(0) There are no alternative paths into higher education (1) Only courses for traditional professions provide ladders into higher education, i.e. commerce, engineering, architecture, technical fields (2) A broader range of professions, including non-traditional ones, provide ladders into higher education, but not all (3) All professional fields provide ladders into higher education
	22) Selectivity in Access to Higher Education from Academic Paths *Higher score = ↓ stratification*	This variable codes whether the main academic upper-secondary path provides direct access to university, or whether further selection takes place after completion of the course. Systems where additional requirements apply only for specific departments (e.g., medicine) but are not the rule are coded 1.	(0) Students are required to pass an exam or attend a selective preparation course to attend university (0.5) Universities (or other agencies) can set grade requirements or limit enrolment through other means if courses are oversubscribed (1) Direct access to university
	23) Selectivity in Access to Higher Education from Alternative Paths *Higher score = ↓ stratification*	This variable codes whether alternative upper-secondary paths provide direct access to higher education (or specific courses), or whether further selection takes place after completion of the course.	(0) There are no alternative paths into higher education (1) Access provided but comes with additional requirements in terms of exams or grades in relation to academic path (2) Access provided with additional requirements in terms of exams or grades that are the same as for students coming from academic path (3) Direct access to higher education including universities
	24) Certificate-based Paths into Higher Education *Higher score = ↓ stratification*	Existence of institutionalized mechanisms providing access to higher education for individuals without the generally required regular upper secondary or vocational certificate – e.g., via interviews, exams, or recognition of non-school related work.	(0) No substitutes for qualifications earned in school (0.5) Ad-hoc admission without certificates possible in principle, but no institutionalized exam or recognition system that guarantees access to higher education (1) Institutionalized exam- or recognition-based path available for students without required certificates

A 1.02 Coding Procedure and Coding Rules

The index scores the indicators outlined in Table A1-1 and Table A1-2 for 16 Western European polities. In countries where education is federalized, we code one (in Germany two) among the biggest regions. The sample thus includes: Austria, Belgium (Flemish community after federalization), Denmark, Finland, France, Germany (Bavaria and North Rhine-Westphalia), Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland (Zurich), and UK (England).

We code the situation for each country year by year from 1945 to the present (2021). For each change of policy, we register the date in which the reform was passed (RY), the year in which it was implemented (IY), and the first cohort it affected (BY). We rely on case literature to assess whether reforms were implemented immediately, whether implementation was delayed, or whether they were introduced gradually, therefore affecting pupils in specific regions earlier than in others. Our calculations on which cohort was the first to be affected by the new system are based on this information. We calculate affected birth cohorts based on the actual or assumed date of implementation. More specifically, for each country and period of time, we identify the age at which a student would normally transfer from (a) from lower to upper-secondary education and (b) from upper-secondary education to higher education. We then calculate the affected birth cohort for each reform, based on the affected threshold.

If no information on timing and pace of implementation could be found in the literature or legislative documents, we apply the following assumption:

- Reforms that can be implemented immediately (modifying fees, modifying dead-ends and transitions, and limiting compulsory schooling, teacher-education reforms due to de-tracking) → IY 1 year after RY
- Reforms that require more planning (extending compulsory education periods, modifying age of streaming or number of streams, changing selection criteria into upper secondary or higher education) → IY 5 years after RY
- Reforms of teacher education that are not part of de-tracking reforms take longer to take effect in classrooms, since teachers trained under new programs have first to reach schools and gradually replace the existing teacher cohort → 15 years added to IY date to calculate affected BY

A2) Secondary Stratification Index: Coding Sources

Appendix 2 outlines the sources used to code the indicators mentioned earlier and their prioritization in data collection and analysis.

Some aspects of stratification, such as tracking or compulsory education periods, have been the object of extensive comparative and case-based research. Other aspects, including for instance teacher training or the specificity of upper-secondary paths have not received the same amount of attention. Scoring the 16 policies on the aforementioned 23 variables therefore required extensive research, based on both existing literature and primary sources such as legislation and policy documentation. We would like to thank the following research assistants for helping us with the coding: Filip Bubenheimer (Austria), Julie Dereymaeker (Belgium), Henri Haapanala (Finland), Matthias Haslberger and Victoria Christmann (Germany), Ioanna Gkoutna (Greece), Leonardo Carella (Italy), Anna-Lina Müller (Switzerland).

The coding relies on four types of sources, which we consulted in the following order of priority.

a) Comparative categorizations and descriptions of education reform

Comparative reports published by authoritative scholarly sources were our first point of reference. These include:

Brunello, Giorgio, Margherita Fort and Guglielmo Weber. 2009. "Changes in compulsory schooling, education and the distribution of wages in Europe." *The Economic Journal* 119(536): 516–539.

Cavaille, Charlotte, and John Marshall. 2019. "Education and Anti-Immigration Attitudes: Evidence from Compulsory Schooling Reforms across Western Europe." *American Political Science Review* 113(1): 254–63.

Garrouste, Christelle. 2010. *100 Years of Educational Reforms in Europe: A Contextual Database*. Luxembourg: Publications Office of the European Union.

Murtin, Fabrice and Martina Viarengo. 2011. "The expansion and convergence of compulsory schooling in Western Europe, 1950–2000." *Economica* 78(311):501–522.

Österman, Marcus. 2018. *Tracking Detracking Reforms*. PhD Dissertation. Uppsala University.

Salonen, Laura, and Heta Pölyiö. 2017. "Historical Dataset of Major Educational Reforms in Europe 1950-1990." *Working Papers on Social and Economic Issues*. Online: https://wpsei.utu.fi/historical-dataset-of-major-educational-reforms-in-europe-in-1950-1990/

b) Encyclopedias of education and reports issued by international organizations since the 1960s

Depending on the coding system and focus, the comparative reports under a) sometimes lack details needed to code the indicators or do not list all the relevant reforms. We therefore completed the information they provided with insights gathered from a systematic collection and analysis of encyclopedias and reports issued by international organizations and scholars from the 1960s to today. These include:

Blat Gimeno, José, and Ricardo Marín Ibáñez. 1981. *The Education of Primary and Secondary School Teachers*. Paris: Unesco.

Council of Europe. 1970. *School Systems: A Guide*. Strasbourg: Council for Cultural Co-operation.

Eurydice. 1986. *Initial teacher training in the Member States of the European Community*. Brussels: Eurydice.

Eurydice. 2021. *National Education Systems*. Online: https://eacea.ec.europa.eu/national-policies/eurydice/home_en

Hörner, Wolfgang. Ed. 2007. *The Education Systems of Europe*. Dodrecht: Springer.

Kurian, George. 1988. *World Education Encyclopaedia*. New York: Facts on File.

Richardson, C. A., Hélène Brûlé and Hardol E. Snyder. 1953. *The Education of Teachers in England, France and the USA*. Paris: Unesco.

Stenström, Marjia-Leena. 1999. "Reflections on Post-16 Strategies in European Countries." *Interim Report of the Leonardo da Vinci/Multiplier Effect, Working Paper 9*.

Unesco. 1958. *World Survey of Education: Primary Education*. Paris: Unesco.

Unesco. 1961. *World Survey of Education: Secondary Education*. Paris: Unesco.

Unesco. 1966. *World Survey of Education: Higher Education*. Paris: Unesco.

Unesco. 1974. *Education in a Rural Environment*. Paris: Unesco.

c) Case literature in English and local languages

For further details, we relied in case literature. This category of sources includes descriptions of education systems or single reforms published in comparative and national education journals in the past, as well as scholarly literature addressing the politics or impact of particular reforms. A list of the main sources used for each country is included in the endnotes to Table 3.

d) Original legislation or policy documents

Whenever, after consulting a-c, coding decisions were still unclear, we referred to original legislation, policy-documents, or governmental reports as stored in online and on-site archives.

A3) Secondary Stratification Index: Scores

Appendix 3 includes excerpts from the data collection. The following tables show the coding for all indicators and countries for selected birth-years. They therefore provide an insight into the stratification of education systems experienced by the 1940, 1970, and 2000 cohorts. The footnotes in Table A3 1 list the main case-specific sources used for coding the indicators. Table A3 1 and Table A3 2 include scores for lower-secondary differentiation and hierarchy, whereas Table A3 3 and Table A3 4 include scores for upper-secondary differentiation and hierarchy.

Table A3-1 Scores for Lower-Secondary Differentiation experienced by 1940, 1970, and 2000 cohorts

Countries	1) Streaming Age			2) Number of Streams			3) Common Curriculum			4) Common Teacher-Training Type		
	1940	1970	2000	1940	1970	2000	1940	1970	2000	1940	1970	2000
Austria[ii]		10		4	4	2		10			0	
Belgium Flanders[iii]		12			4		12	14	14		0	
Denmark[iv]	11	16	16	3	1	1	11	16	16	0	1	1
Finland[v]	11	16	16	2	1	1	11	16	16	0	1	1
France[vi]	11	15	15	2	1	1	11	15	15	0	1	1
Germany Bavaria[vii]		10			3			10			0	
Greece[viii]	12	15	15	2	1	1	12	15	15	0	1	1
Ireland[ix]	12	12	15	3	2	1	12	12	15	0	0	1
Italy[x]	11	14	14	2	1	1	11	14	14	0	1	1
Netherlands[xi]		12		5	4	3	12	13	13	0	0	0.5
Norway[xii]	14	16	16	2	1	1	14	16	16	0	1	1
Portugal[xiii]	10	15	15	2	1	1	10	15	15	0	1	1
Spain[xiv]	10	13	16	3	2	1	10	13	16	0	0.5	1
Sweden[xv]	11	16	16	2	1	1	11	16	16	0	1	1
Switzerland Zurich[xvi]		12		3	4	4		12			0	
UK England[xvii]	11	16	16	2	1	1	11	11	16	0	1	1

Table A3-2 Scores for Lower-Secondary Hierarchy experienced by 1940, 1970, and 2000 cohorts

Countries	5) Tuition Fees			6) Stream Bridging			7) Length of Full-Time Compulsory Schooling (years)			8) Length of Compulsory Education (years)		
	1940	1970	2000	1940	1970	2000	1940	1970	2000	1940	1970	2000
Austria	1	0	0	0.5	1	1	8	9	9	8	9	9
Belgium Flanders	0.5	0	0	0	1	1	8	9	9	8	12	12
Denmark		0		0	1	1	5	9	9	5	9	9
Finland	0.5	0	0	0.5	1	1	6	9	9	6	9	9
France	0.5	0	0	0	1	1	8	10	10	8	10	10
Germany Bavaria	1	0	0	0	1	1	8	9	9	12	12	12
Germany NRW	1	0	0	0	1	1	8	10	10	8	12	12
Greece	1	0	0	0	1	1	6	9	9	6	9	9
Ireland	1	0	0	0	1	1	8	9	9	8	9	9
Italy	1	0	0	0	1	1	5	8	10	5	8	12
Netherlands	0.5	0	0	0.5	1	1	8	10	11	8	12	13
Norway	1	0	0	0	1	1	7	9	10	7	9	10
Portugal	1	0	0	0	1	1	3	6	12	3	6	12
Spain	1	1	0	0	1	1	6	10	10	6	10	10
Sweden		0		1	1	1	7	9	9	7	9	9
Switzerland Zurich	1	0	0	0	0.5	0.5	8	9	9	8	9	10
UK England		0		0.5	1	1	10	11	11	10	11	13

Countries	9) Variation in Level of Teacher Training			10) Variation in Length of Teacher Training			11) Academic Dead-Ends			12) Onward Opportunities		
	1940	1970	2000	1940	1970	2000	1940	1970	2000	1940	1970	2000
Austria	0	0	1		0			0			0.5	
Belgium Flanders	0	0	0.5		0		1	0	0	0	0.5	0.5
Denmark	0	1	1	0	1	1	1	0	0	0.5	1	1
Finland	0	1	1	0	1	1	0.5	0	0	0	1	1
France	0	1	1	0	1	1	0	0	0	0.5	0.5	1
Germany Bavaria	0	1	1		0			0			0.5	
Germany NRW	0	0	1		0		0	0	0		0.5	
Greece	0	1	1	0	1	1	1	0	0	0	0.5	1
Ireland	0	0	1	0	0	1		0		0	1	1
Italy	0	1	1	0	1	1		0		0	1	1
Netherlands	0	0	1	0	0	0.5	1	0	0	0	0.5	0.5
Norway	0	1	1	0	1	1	1	0	0	0	1	1
Portugal	0	1	1	0	1	1	1	0	0	0	0	1
Spain	0	0	1	0	0.5	1	1	0	0	0	0.5	1
Sweden	0	1	1	0	1	1		0		0	1	1
Switzerland Zurich	0	0	0		0			0			0.5	
UK England	0.5	1	1	0.5	1	1		0		0	0.5	0.5

Table A3-3 Scores for Upper-Secondary Differentiation experienced by 1940, 1970, and 2000 cohorts

Countries	13) Specialization of Academic Paths			14) Specialization of Alternative Paths			15) Scope of Academic Paths			16) Common Curriculum		
	1940	1970	2000	1940	1970	2000	1940	1970	2000	1940	1970	2000
Austria		1		1	2	2		0.5			0	
Belgium Flanders	0	1	1	0	3	3		0.5			0	
Denmark		0.5		0	1	2		0.5			0	
Finland	1	0.5	0.5	0	2	2		0.5			0	
France		0.5		0	0	2		0.5			0	
Germany Bavaria	1	1	1	0	2	2		0.5			0	
Greece	1	0	0	0	0	2	0	0.5	1		0	
Ireland		0		0	0	2	0.5	1	1	0	0	0.5
Italy	0	1	1	1	3	3		0.5			0	
Netherlands	0	1	0.5	0	2	2		0.5			0	

Norway		0.5		0	0	3		0.5		0	0	1
Portugal	0	0.5	0	1	2	2		0.5			0	
Spain		1		1	1	2	0	0.5	0.5		0	
Sweden	1	0	0	0	1	2		0.5		0	0.5	1
Switzerland Zurich	0	1	1	0	0	1		0.5			0	
UK England		0.5		0	2	2	0.5	0.5	1		0	

Table A3-4 Scores for Upper-Secondary Hierarchy experienced by 1940, 1970, and 2000 cohorts

	17) Selectivity of Academic Paths			18) Selectivity of Alternative Paths			19) Tuition Fees			20) Extension of Compulsory Schooling		
	1940	1970	2000	1940	1970	2000	1940	1970	2000	1940	1970	2000
Austria	0	1	1	0.5	0.5	1	0	1	1		0	
Belgium Flanders	0	0	1	0	0.5	1	0.5	1	1	0	1	1
Denmark	0	2	2	0	1	1		1			0	
Finland	0	2	2	0	1	1	0.5	0.5	1		0	
France	0	1	1	0	1	1		1		0	0.5	0.5
Germany Bavaria		1		0	0.5	0.5	0	1	1		1	
Greece	0	0	3	0	0	1	0	1	1		0	
Ireland	0	2	2	0	0	1	0	1	1	0	0	0.5
Italy	0	3	3	0.5	1	1		0		0	0	1
Netherlands	0	1	1	0	1	1	0	0	1		0	
Norway	0	2	2	0	0	1	0	1	1		0	
Portugal	0	1	1	0.5	0.5	1	0	0	1	0	0	1
Spain	0	0	3	0.5	1	1	0	0	1		0	
Sweden	1	2	2	0	1	1		1			0	
Switzerland Zurich		0		0	0	1	0	1	1		0	
UK England	0	2	2	0	0.5	1		1		0	0	0

Countries	21) Range of Alternative Paths			22) Selectivity in Access to Higher Education from Academic Paths			23) Selectivity in Access to Higher Education from Alternative Paths			24) Certificate-based Paths into Higher Education		
	1940	1970	2000	1940	1970	2000	1940	1970	2000	1940	1970	2000
Austria	1	2	3	1	1	0.5	1	3	2		1	
Belgium Flanders	0	2	3		1		0	3	3	0.5	0	0.5
Denmark	0	1	2		0.5		0	1	2	0	1	1
Finland	0	3	3	0	0.5	0.5	0	2	2		0	
France	0	2	3		0.5		0	2	2	0.5	1	1
Germany Bavaria	0	3	3	1	0.5	0.5	0	3	3	0	0	0.5
Greece	0	0	3	0	1	0	0	0	2		0	
Ireland	0	0	2		0.5		0	0	2		1	
Italy	1	3	3	1	0.5	0.5	3	2	2		0	
Netherlands	0	2	3	0	1	0.5	0	1	1		0.5	

Norway	0	0	3	0	1	1	0	0	1	0	0	1
Portugal	1	2	3	0.5	0	0	3	2	2	0	0.5	1
Spain	1	3	3		0		3	3	2	0	0.5	0.5
Sweden	0	1	3	1	0	0	0	1	2		0.5	
Switzerland Zurich	0	0	3		1		0	0	3	0.5	0.5	1
UK England	0	2	2		0.5		0	1	2	0	0.5	1

A4) Secondary Stratification Index: Correlations

This section presents correlations among the individual indicators that comprise our scales of hierarchy and differentiation at both lower (Table A4-1) and upper-secondary levels (Table A4-2). All individual indicators are coded such that higher values equate to lower stratification. See **Error! Reference source not found.** and **Error! Reference source not found.** for details of coding.

Individual indicators of stratification at the lower-secondary level are generally positively correlated with one another (Table A4-2). In many cases these correlations are quite strong. A notable exception is that the tracking age, and number of streams is essentially uncorrelated with the length of full time and compulsory education. This is important because it suggests that the most commonly used indicators of hierarchy and differentiation are not in practice closely associated with one another.

The correlations among indicators of stratification at upper secondary are more variable, and negative in some cases. In particular, indicators of differentiation are negatively correlated with one another implying that some policies are substitutes for one another. For example the presence of compulsory schooling in the upper secondary years is negatively correlated with the range of certificates/qualifications giving access to higher education (-0.21). This implies that policymakers may see two distinct ways of reducing hierarchy in access to higher education: on the one hand extending compulsory education in the upper secondary years, while on the other reducing the importance of school based qualifications for access to higher education.

Table A4-1 Correlation among individual indicators of hierarchy and differentiation at lower-secondary level

	D: streaming age	D: number of streams (reversed)	D: common curriculum	D: teacher train type	H: length full-time	H: length compulsory	H: stream bridging	H: teacher train level	H: teacher train length	H: tuition fees (reversed)	H: onward opportunities	H: dead ends (reversed)
D: streaming age	1.00											
D: number of streams (reversed)	0.74	1.00										
D: common curriculum	0.88	0.60	1.00									
D: teacher train type	0.90	0.81	0.80	1.00								
H: length full-time	0.26	0.15	0.26	0.32	1.00							
H: length compulsory	-0.05	-0.09	0.03	0.06	0.79	1.00						
H: stream bridging	0.45	0.43	0.46	0.58	0.54	0.40	1.00					
H: teacher train level	0.65	0.68	0.58	0.82	0.41	0.29	0.65	1.00				
H: teacher train length	0.87	0.81	0.77	0.97	0.35	0.08	0.56	0.84	1.00			
H: tuition fees (reversed)	0.25	0.20	0.26	0.34	0.40	0.37	0.65	0.45	0.35	1.00		
H: onward opportunities	0.54	0.48	0.59	0.63	0.31	0.21	0.56	0.55	0.58	0.42	1.00	
H: dead ends (reversed)	0.13	0.27	0.14	0.28	0.39	0.35	0.49	0.34	0.29	0.30	0.38	1.00

All indicators coded such that higher values = lower stratification. H denotes indicators of hierarchy when reversed, D denotes indicators of differentiation when reversed. Estimated on N=817 country-years with valid mobility data and covariates.

Table A4-2 Correlation among individual indicators of hierarchy and differentiation at upper-secondary level.

	H: some US compulsory	H: fees	H: selection academic track	H: selection vocational track	H: HE range of paths	H: HE access academic	H: HE access vocational	H: HE entry alt. paths	D: common curriculum	D: scope academic paths	D: specialisation academic track	D: specialisation vocational track
H: some US compulsory	1.00											
H: fees	0.23	1.00										
H: selection academic track	-0.08	0.16	1.00									
H: selection vocational track	0.09	-0.03	0.41	1.00								
H: HE range of paths	0.29	-0.04	0.32	0.82	1.00							
H: HE access academic	0.13	0.01	-0.16	-0.10	-0.06	1.00						
H: HE access vocational	0.34	0.02	0.11	0.67	0.87	-0.01	1.00					
H: HE entry alt. paths	-0.21	0.12	0.01	0.23	-0.00	0.08	0.03	1.00				
D: common curriculum	-0.11	0.16	0.22	0.26	0.14	-0.14	-0.04	0.12	1.00			
D: scope academic paths	-0.08	0.20	0.32	0.02	-0.04	-0.14	-0.06	0.22	0.13	1.00		
D: specialisation academic track	0.30	0.04	-0.08	0.16	0.38	0.35	0.39	-0.15	-0.26	-0.42	1.00	
D: specialisation vocational track	0.16	-0.12	0.29	0.71	0.82	0.03	0.69	-0.02	0.16	-0.03	0.34	1.00

All indicators coded such that higher values = lower stratification. H denotes indicators of hierarchy when reversed, D denotes indicators of differentiation when reversed. Estimated on N=817 country-years with valid mobility data and covariates.

A5) Institutional Dead-Ends

As outlined in section A1 and the main text, a component of our institutional definition of hierarchy involves the presence of "dead-ends" and formal barriers to advancement. Given our interest is in pupil mobility, formal barriers to advancement would seem to pose a mechanical limit to mobility, potentially making separating the institutions as a cause from the mobility outcome difficult. While dead-ends are a mechanical barrier to further education for those in a track with a dead-end, we illustrate below that dead-ends are not a deterministic barrier in two regards.

First, while there was historically a strong class gradient in attending tracks with dead-ends, in no country was such attendance completely class segregated. Thus, the empirical relationship between dead-ends and inter-generational class/educational mobility is nonetheless one we need to examine. Second, while the presence of a dead-end limits advancement for some pupils, the removal of a dead-end does not mechanically deliver advancement. Pupils may still face other barriers to staying in school – or incentives to exit – even under conditions of removing dead-ends. This means that the institutional feature is conceptually separable from the outcome we are studying, and that the relationship between the outcome and the institution remains one to investigate empirically.

To show this separation, the following graphs show educational attainment in years by parental background (low v mid/high) by birth cohort and by respondent's own education. The former shows descriptively the link between years of attainment by parental background across birth cohorts, the latter shows the lengthening of years of education even within an educational category (here less upper secondary relative to upper secondary or above). The line on the x-axis shows the removal of a dead-end affecting a given cohort in their formative years. If dead-end removal were mechanically linked to attainment, we would expect a sharp upward bump among those with lower parental education or those that have low attainment. We do not observe this in the eight countries that had dead-ends at some point in time. These dead-ends, even before removal, only affected a fraction of pupils. We show this for three selected countries below – Belgium, Greece, and Netherlands. All eight cases are available on request.

Figure A5-1 Removal of dead-ends in Belgium

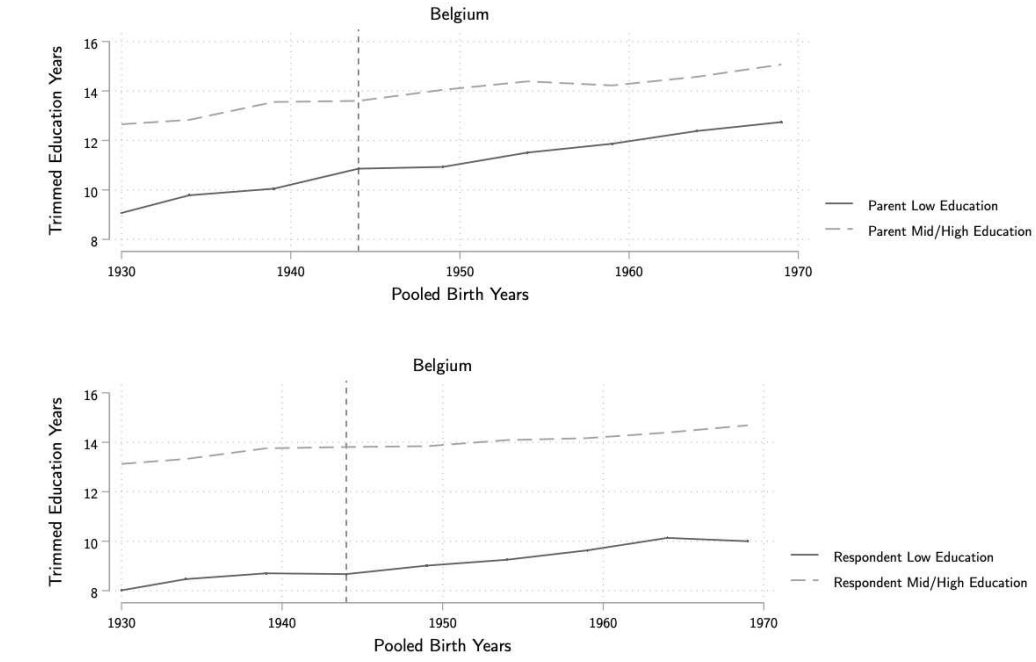


Figure A5-2 Removal of dead-ends in Greece

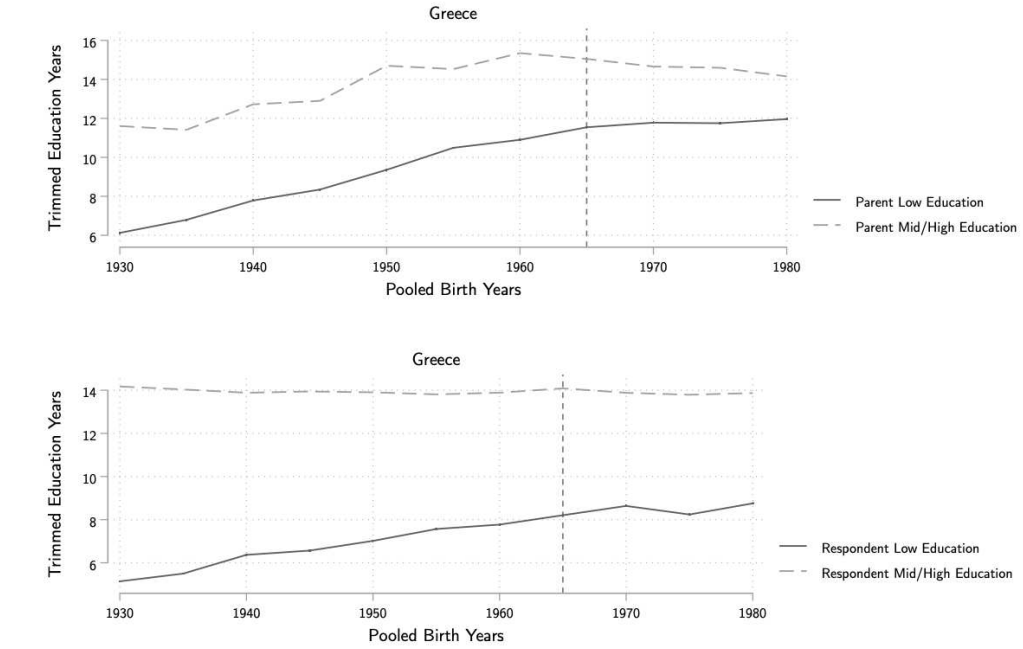
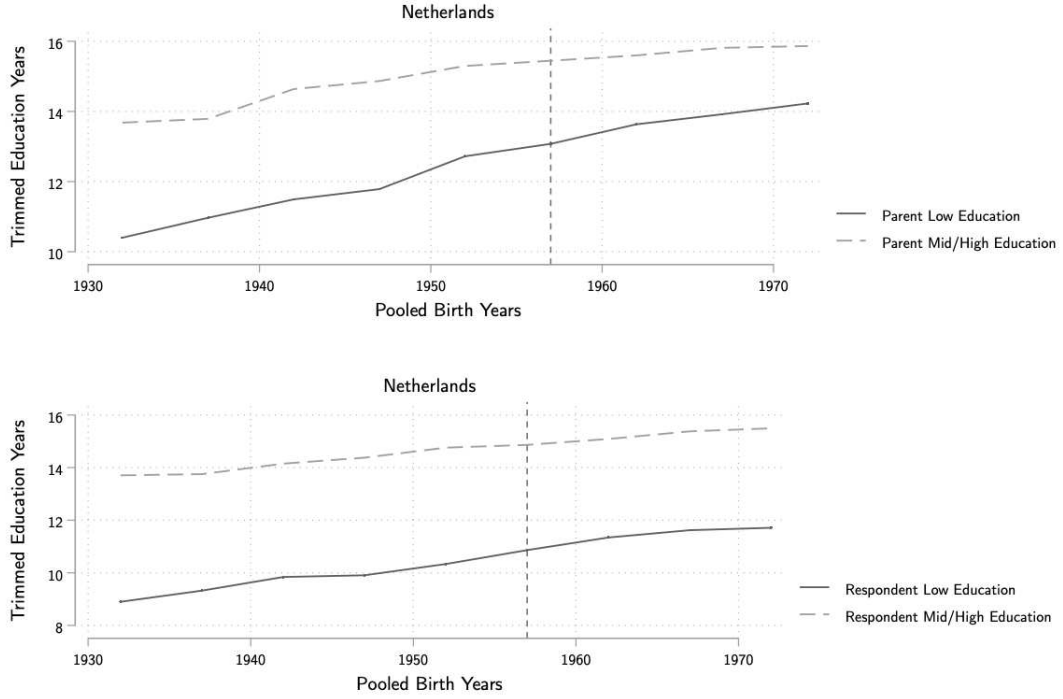


Figure A5-3 Removal of dead-ends in Netherlands



A6) Robustness checks

A 6.01 Descriptive statistics and plots

Table A6-1 Individual level descriptive statistics

Variable	Mean/ percentage	Std. dev.	Min	Max
Years of education	13.5	3.9	0	25
Parental SES				
Low	53.5%			
Medium	23.5%			
High	23.1%			
Gender				
Male	48.5%			
Female	51.5%			
Year of birth	1963.3	13.6	1936	1995
Age	47.5	13.7	25	83
Born in country				
No	6.1%			
Yes	93.9%			
Country/region				
Austria	7.9%			
Belgium - Flanders	5.4%			
Denmark	7.8%			
Finland	9.2%			
France	6.2%			
Germany - Bavaria	1.8%			
Greece	2.6%			
Ireland	10.2%			
Italy	5.3%			
Netherlands	9.7%			
Norway	8.9%			

Portugal	3.4%
Spain	4.4%
Sweden	8.0%
Switzerland - Zurich	1.0%
UK - England	8.3%

Notes: Data from 2002-2018 European Social Survey. 111,862 individuals in 817 country-years.

Table A6-2 Aggregate level descriptive statistics

Variable	Mean	Std. dev.	Min	Max
Differentiation	0.52	0.20	0.13	0.85
Hierarchy	0.43	0.20	0.16	0.95
Left party share of cabinet seats	0.42	0.41	0.00	1.00
Unemployment rate	5.46	4.03	0.003	24.10
GDP per capita growth	3.13	2.74	-6.36	27.60

Notes: See appendix 1 for construction of differentiation and hierarchy measures, left party share of cabinet seats from (xxx), unemployment rate from (xxx), GDP growth rate from (xxx). 817 country-years.

Figure A6-1 Trends in the association between parental SES and educational attainment by country and year of birth

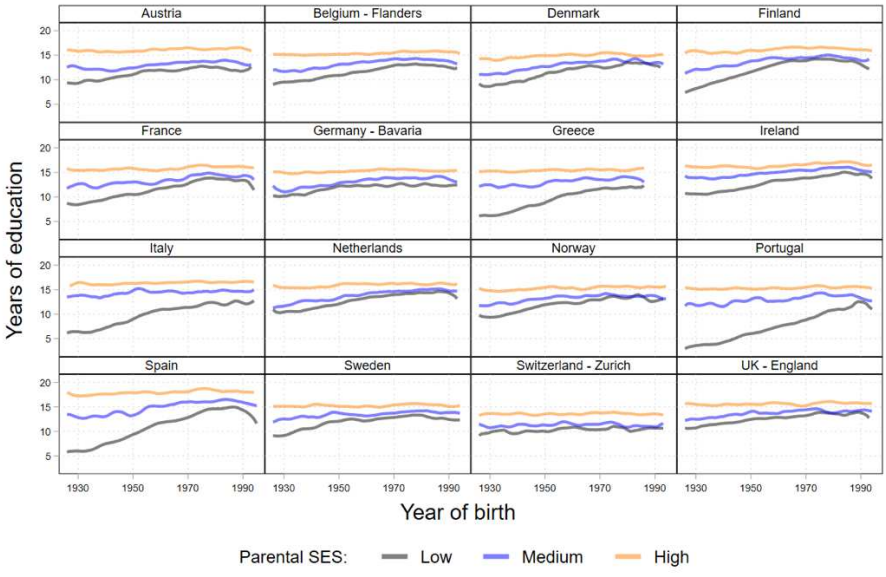
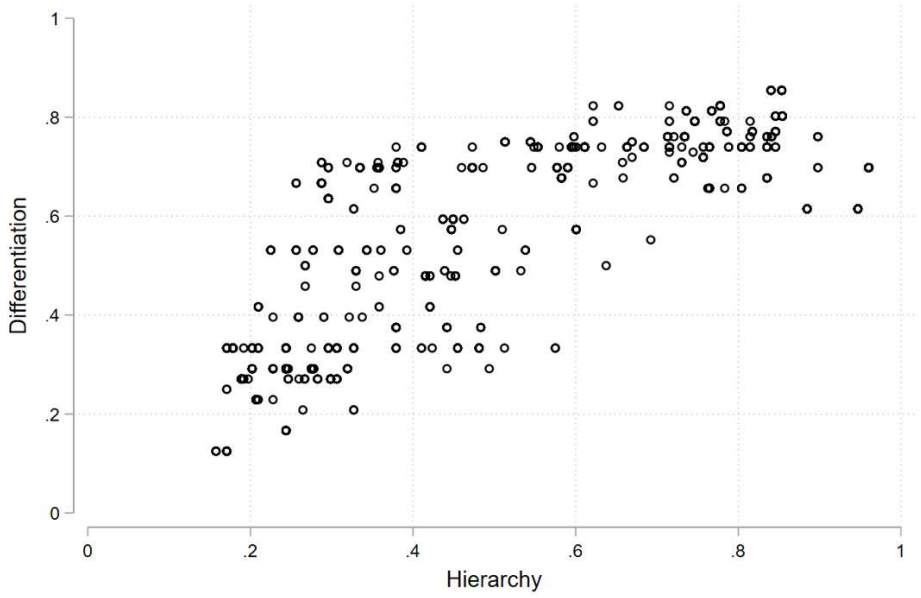


Figure A6-2 Correlation between differentiation and hierarchy



A 6.02 Results tables

Table A6-3 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES

	(1) Differentiation	(2) Hierarchy
Low parental SES	-0.0778 [-0.197,0.0414]	-0.213** [-0.373,-0.0525]
Medium parental SES	-0.0527 [-0.238,0.132]	-0.00212 [-0.204,0.200]
High parental SES	-0.00668 [-0.213,0.200]	-0.0807 [-0.325,0.164]
Observations	111862	111862

Estimates and 95% Confidence intervals are contrasts of marginal means from OLS model estimated following equation (1) and presented in figures 3 and 4. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A6-4 Marginal effect of differentiation on educational attainment conditional on hierarchy and parental SES

	Low parental SES	Medium parental SES	High parental SES
Low hierarchy	-0.103 [-0.227,0.0204]	-0.0416 [-0.233,0.150]	-0.0971 [-0.301,0.106]
Mid hierarchy	-0.184** [-0.313,-0.0542]	-0.218 [-0.437,0.00163]	0.150 [-0.0852,0.385]
High hierarchy	-0.623*** [-0.950,-0.296]	-0.676* [-1.293,-0.0585]	-0.114 [-0.790,0.563]

Estimates and 95% Confidence intervals are contrasts of marginal means from OLS model estimated following modified version of equation (1) presented in figure 5. Model based on three way interaction between parental SES, continuous measure of differentiation and hierarchy coded into tertiles. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. N = 111862. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

A 6.03 Robustness checks

This section contains robustness checks for results reported in main text.

Table A6-5 Measuring stratification in lower secondary vs. upper secondary education

	(1) Differentiation - lower secondary	(2) Hierarchy - lower secondary	(3) Differentiation - upper secondary	(4) Hierarchy - upper secondary
Low parental SES	0.0644 [-0.0569,0.186]	-0.231*** [-0.353,-0.110]	-0.112** [-0.185,-0.0396]	-0.155** [-0.272,-0.0381]
Medium parental SES	0.119 [-0.0630,0.301]	-0.116 [-0.286,0.0545]	-0.158** [-0.271,-0.0448]	0.0744 [-0.0697,0.219]
High parental SES	0.0230 [-0.164,0.210]	-0.0625 [-0.262,0.137]	-0.0309 [-0.152,0.0898]	-0.0516 [-0.234,0.131]
Observations	114563	114563	111862	111862

Estimated marginal means and 95% CIs from two OLS models. Models include country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-6 Estimated marginal effect of differentiation and hierarchy on probability of completing upper secondary education by parental SES

	Differentiation	Hierarchy
Low parental SES	0.0138	-0.0401***
	[-0.00242,0.0300]	[-0.0621,-0.0182]
Medium parental SES	0.00235	-0.00343
	[-0.0183,0.0230]	[-0.0251,0.0183]
High parental SES	-0.000113	0.00216
	[-0.0133,0.0131]	[-0.0151,0.0194]
Observations	112052	112052

Estimated marginal means and 95% CIs fromlLinear probability model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-7 Estimated marginal effect of differentiation and hierarchy on probability of completing tertiary education by parental SES

	Differentiation	Hierarchy
Low parental SES	-0.00910	0.00213
	[-0.0218,0.00357]	[-0.0135,0.0178]
Medium parental SES	-0.00917	0.0160
	[-0.0329,0.0145]	[-0.0115,0.0435]
High parental SES	-0.0117	0.0175
	[-0.0379,0.0145]	[-0.0155,0.0506]
Observations	112052	112052

Estimated marginal means and 95% CIs from linear probability model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-8 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES. No covariates.

	Differentiation	Hierarchy
Low parental SES	0.0187	-0.409***
	[-0.110,0.148]	[-0.584,-0.234]
Medium parental SES	0.0468	-0.304**
	[-0.140,0.234]	[-0.511,-0.0966]
High parental SES	0.0550	-0.292*
	[-0.157,0.267]	[-0.541,-0.0437]
Observations	111862	111862

Estimated marginal means and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. No additional covariates beyond fixed effects specification. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-9 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES. Individual level covariates only.

	Differentiation	Hierarchy
Low parental SES	-0.0341	-0.248**
	[-0.152,0.0840]	[-0.408,-0.0892]
Medium parental SES	-0.0285	-0.0445
	[-0.210,0.152]	[-0.243,0.154]
High parental SES	-0.0111	-0.0580
	[-0.223,0.201]	[-0.311,0.195]
Observations	111862	111862

Estimated marginal means and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-10 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES. Aggregate covariates only.

	Differentiation	Hierarchy
Low parental SES	0.0260	-0.379***
	[-0.0998,0.152]	[-0.551,-0.207]
Medium parental SES	0.0102	-0.208
	[-0.180,0.201]	[-0.421,0.00627]
High parental SES	0.0513	-0.293*
	[-0.160,0.263]	[-0.546,-0.0392]
Observations	111862	111862

Estimated marginal means and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-11 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES. Alternate aggregate covariates.

	Differentiation	Hierarchy
Low parental SES	0.00112	-0.207**
	[-0.112,0.114]	[-0.357,-0.0571]
Medium parental SES	-0.0590	0.0362
	[-0.233,0.115]	[-0.160,0.232]
High parental SES	-0.0649	0.0384
	[-0.269,0.139]	[-0.202,0.279]
Observations	131827	131827

Estimated marginal means and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, exposure to war, democracy, GDP growth. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-12 Estimated marginal effect of differentiation and hierarchy on years of education by parental education OR parental occupation.

	(1) Parental education		(2) Parental class	
	Differentiation	Hierarchy	Differentiation	Hierarchy
Lower secondary or less	0.0235	-0.319***		
	[-0.0906,0.138]	[-0.474,-0.164]		
Upper secondary or vocational	-0.128	0.0361		
	[-0.289,0.0336]	[-0.161,0.233]		
Tertiary	0.00846	-0.150		
	[-0.218,0.235]	[-0.424,0.123]		
Unskilled occupations			0.0118	-0.364***
			[-0.135,0.159]	[-0.571,-0.157]
Intermediate occupations			-0.0734	-0.199*
			[-0.196,0.0490]	[-0.350,-0.0476]
Service class			0.0301	-0.0443
			[-0.184,0.245]	[-0.311,0.223]
Observations	119862	119862	116242	116242

Estimated marginal means and 95% CIs from two OLS models. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors

clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p <$ 0.05, ** $p < 0.01$, *** $p < 0.001$

Table A6-13 Estimated marginal effect of differentiation and hierarchy on years of education by parental education and parental occupation.

	Parental education		Parental class	
	Differentiation	Hierarchy	Differentiation	Hierarchy
Lower secondary or less			0.00211	-0.211*
			[-0.122,0.127]	[-0.377,-0.0457]
Upper secondary or vocational			-0.126	0.0559
			[-0.291,0.0394]	[-0.140,0.252]
Tertiary			0.0128	-0.279
			[-0.236,0.261]	[-0.588,0.0291]
Unskilled occupations	-0.0184	-0.274*		
	[-0.172,0.135]	[-0.484,-0.0628]		
Intermediate occupations	-0.0625	-0.143		
	[-0.187,0.0619]	[-0.299,0.0120]		
Service class	0.0521	-0.0334		
	[-0.160,0.264]	[-0.315,0.249]		
Observations	111862	111862	111862	111862

Estimated marginal means and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors

clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p <$ 0.05, ** $p < 0.01$, *** $p < 0.001$

Table A6-14 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES - Individuals born before 1960

	(1) Differentiation	(2) Hierarchy
Low parental SES	0.112 [-0.0549,0.280]	-0.235* [-0.437,-0.0339]
Medium parental SES	0.338 [-0.0355,0.711]	-0.0792 [-0.420,0.262]
High parental SES	0.212 [-0.135,0.560]	0.174 [-0.257,0.605]
Observations	74028	74028

Estimated marginal means and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth. Country level controls excluded to maximize sample size. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-15 Estimated marginal effect of differentiation and hierarchy on years of education by parental SES - Individuals born after 1960

	(1) Differentiation	(2) Hierarchy
Low parental SES	0.142 [-0.0581,0.341]	-0.203 [-0.478,0.0726]
Medium parental SES	-0.0316 [-0.327,0.264]	0.0270 [-0.350,0.404]
High parental SES	0.105 [-0.197,0.407]	-0.206 [-0.725,0.313]
Observations	67095	67095

Estimated marginal means and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth. Country level controls excluded to maximize sample size. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-16 Robustness of results to removal of dead-ends and/or onward opportunities from hierarchy measure

	(1) Diff	Hierarchy - no dead ends	(2) Diff	Hierarchy - no onward opportunities
Low parental SES	-0.0747	-0.203**	-0.100	-0.738*
	[-0.192,0.0428]	[-0.350,-0.0554]	[-0.210,0.00902]	[-1.340,-0.136]
Medium parental SES	-0.0646	0.0171	-0.0484	-0.0415
	[-0.247,0.118]	[-0.171,0.205]	[-0.219,0.122]	[-0.818,0.735]
High parental SES	-0.0116	-0.0681	-0.0219	-0.248
	[-0.218,0.195]	[-0.299,0.163]	[-0.207,0.163]	[-1.104,0.608]
Observations	111862	111862	111862	111862

Estimated marginal means and 95% CIs from two OLS models. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-17 Robustness of results to dropping countries

Country dropped	(1) Austria	(2) Belgium - Flanders	(3) Switzerland - Zurich	(4) Germany - Bavaria	(5) Denmark	(6) Greece
DIFFERENTIATION						
Low parental SES	-0.0410	-0.0620	-0.0226	-0.0244	-0.0393	-0.0810
	[-0.159,0.0771]	[-0.193,0.0691]	[-0.139,0.0943]	[-0.141,0.0922]	[-0.157,0.0779]	[-0.201,0.0388]
Medium parental SES	-0.114	0.0127	-0.0383	-0.0472	-0.0374	-0.0507
	[-0.305,0.0771]	[-0.184,0.210]	[-0.224,0.147]	[-0.233,0.139]	[-0.225,0.151]	[-0.236,0.135]
High parental SES	-0.0247	-0.0102	0.0147	-0.0149	0.00284	-0.0100
	[-0.240,0.191]	[-0.239,0.218]	[-0.198,0.227]	[-0.228,0.198]	[-0.213,0.219]	[-0.217,0.197]
HIERARCHY						
Low parental SES	-0.236**	-0.206*	-0.263**	-0.260**	-0.236**	-0.214*
	[-0.400,-0.0724]	[-0.381,-0.0311]	[-0.422,-0.104]	[-0.419,-0.100]	[-0.397,-0.0759]	[-0.378,-0.0502]
Medium parental SES	0.0936	-0.0494	-0.0212	-0.00852	-0.0146	-0.00803
	[-0.124,0.311]	[-0.271,0.172]	[-0.229,0.187]	[-0.218,0.201]	[-0.227,0.198]	[-0.212,0.196]
High parental SES	-0.0688	-0.0689	-0.126	-0.0676	-0.0664	-0.0774
	[-0.332,0.194]	[-0.345,0.207]	[-0.384,0.132]	[-0.325,0.189]	[-0.337,0.204]	[-0.324,0.169]
Observations	103065	105876	110699	109798	103105	108976

Estimated marginal means and 95% CIs from OLS model. Each column shows results when stated country is dropped from sample. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-17 cont. Robustness of results to dropping countries

Country dropped	(7) Spain	(8) Finland	(9) France	(10) Ireland	(11) Italy
DIFFERENTIATION					
Low parental SES	-0.0441	0.0596	0.00780	-0.0617	0.0326
	[-0.157,0.0691]	[-0.0593,0.179]	[-0.117,0.133]	[-0.205,0.0817]	[-0.0887,0.154]
Medium parental SES	-0.0587	-0.0264	0.0780	0.00312	-0.0206
	[-0.245,0.128]	[-0.227,0.174]	[-0.108,0.264]	[-0.223,0.230]	[-0.207,0.166]
High parental SES	-0.0224	0.0612	0.101	0.0225	0.0144
	[-0.238,0.194]	[-0.147,0.270]	[-0.117,0.318]	[-0.241,0.286]	[-0.199,0.228]
HIERARCHY					
Low parental SES	-0.216**	-0.335***	-0.291***	-0.194*	-0.235**
	[-0.370,-0.0607]	[-0.503,-0.167]	[-0.459,-0.123]	[-0.376,-0.0115]	[-0.392,-0.0771]
Medium parental SES	-0.00870	-0.0730	-0.123	-0.0165	-0.0161
	[-0.217,0.199]	[-0.296,0.150]	[-0.330,0.0839]	[-0.251,0.218]	[-0.222,0.190]
High parental SES	-0.0672	-0.0140	-0.199	-0.0714	-0.100
	[-0.326,0.191]	[-0.282,0.254]	[-0.454,0.0567]	[-0.369,0.226]	[-0.357,0.156]
Observations	106993	101605	104913	100412	105988

Estimated marginal means and 95% CIs from OLS model. Each column shows results when stated country is dropped from sample. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6-17 cont. Robustness of results to dropping countries

Country dropped	(12) Netherlands	(13) Norway	(14) Portugal	(15) Sweden	(16) UK - England
DIFFERENTIATION					
Low parental SES	-0.0181	-0.00393	-0.00794	-0.0863	-0.0466
	[-0.135,0.0988]	[-0.121,0.113]	[-0.125,0.109]	[-0.209,0.0359]	[-0.166,0.0729]
Medium parental SES	-0.0434	-0.0804	-0.0411	-0.113	-0.0913
	[-0.229,0.142]	[-0.271,0.110]	[-0.226,0.143]	[-0.306,0.0804]	[-0.274,0.0917]
High parental SES	-0.0303	0.0694	-0.00623	-0.117	-0.0550
	[-0.242,0.182]	[-0.156,0.295]	[-0.218,0.206]	[-0.334,0.100]	[-0.277,0.167]
HIERARCHY					
Low parental SES	-0.272**	-0.346***	-0.280***	-0.269**	-0.221**
	[-0.434,-0.110]	[-0.517,-0.176]	[-0.440,-0.120]	[-0.431,-0.107]	[-0.380,-0.0615]
Medium parental SES	-0.00384	0.0164	-0.0111	-0.0140	0.0511
	[-0.211,0.203]	[-0.217,0.250]	[-0.217,0.195]	[-0.223,0.195]	[-0.154,0.256]
High parental SES	-0.0754	-0.267	-0.0853	-0.0688	-0.0442
	[-0.333,0.182]	[-0.544,0.0105]	[-0.340,0.170]	[-0.326,0.188]	[-0.311,0.222]
Observations	100967	101937	108038	102935	102623

Estimated marginal means and 95% CIs from OLS model. Each column shows results when stated country is dropped from sample. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A 6.04 Unconditional and conditional results

This section examines the evidence that greater hierarchy is associated with wider parental SES gaps in attainment, and hence lower relative mobility. As reported in the text the confidence intervals for the interactions between parental SES and both hierarchy and differentiation overlap 0, and are hence consistent with both positive and negative effects of stratification on relative mobility. However, we believe that there is still some suggestive evidence that greater hierarchy is associated with lower relative mobility while differentiation is not. This evidence comes from considering models that include only hierarchy, or only differentiation, alongside our main model specification that includes both together.

We look at the estimated interaction effects between differentiation and parental SES and hierarchy and parental SES for the sake of simplicity rather than calculating marginal effects. These are presented in Table A6-18 below. Model 1 includes only differentiation, model 2 includes only hierarchy, and model 3 includes both of them, and is hence equivalent to the model reported in the main text.

We look first at the coefficients on differentiation and hierarchy, which represent the effect of hierarchy and differentiation on attainment among individuals with low SES parents. We can see that the coefficient on differentiation is negative (-0.20, 95% CI: -0.28,-0.12), but declines a lot when controls for hierarchy are added (-0.08, 95% CI: -0.20,0.04). By contrast the coefficient for hierarchy remains similar whether or not differentiation is controlled for (0.28 vs. 0.21).

If we look at the interaction between parental SES and differentiation or hierarchy a similar pattern emerges. The interactions between differentiation and medium and high parental SES are weak with confidence intervals just overlapping 0 (0.15, 95% CI: -0.01, 0.31 and 0.15, 95% CI: -0.00, 0.30 respectively). These coefficients are reduced almost to 0 by controls for hierarchy (0.03, 95% CI: -0.20, 0.25 and 0.07, 95% CI: -0.15,0.30 respectively). The interactions between hierarchy and parental SES are larger with 95% CIs not including 0 (0.24, 95% CI: 0.06, 0.41 and 0.20, 95% CI: 0.02, 0.38 for medium and high parental SES respectively). These point estimates are not changed as much by controls for hierarchy but have 95% confidence intervals consistent with small positive effects (0.21, 95% CI: -0.04, 0.46 and 0.13, 95% CI: -0.13, 0.40 respectively).

This pattern of associations suggests that the association between differentiation and attainment reported in column 1 of table A6-18 is mainly an artefact of confounding by hierarchy. Hierarchy and differentiation are strongly correlated, and when we control for hierarchy we are left with essentially no evidence for an independent effect of differentiation on attainment. However, with hierarchy we find evidence for an association with absolute upward mobility even after differentiation is controlled for. In the case of relative mobility we find evidence for a substantively meaningful but statistically insignificant relationship. However, the weakness of this relationship may reflect the high correlation between differentiation and hierarchy giving little independent variation and hence leading to high standard errors on our estimates.

Table A6-18 Effects of including hierarchy and differentiation separately and together in models

	(1)	(2)	(3)
Medium parental SES (ref= low parental SES)	1.36***	1.57***	1.54***
	[1.08,1.63]	[1.30,1.85]	[1.18,1.91]
High parental SES	4.22***	4.41***	4.34***
	[3.86,4.57]	[4.06,4.77]	[3.91,4.76]
Differentiation	-0.20***		-0.08
	[-0.28,-0.12]		[-0.20,0.04]
Medium parental SES X Differentiation	0.15		0.03
	[-0.01,0.31]		[-0.20,0.25]
High parental SES X Differentiation	0.15		0.07
	[-0.00,0.30]		[-0.15,0.30]
Hierarchy		-0.28***	-0.21**
		[-0.40,-0.17]	[-0.37,-0.05]
Medium parental SES X Hierarchy		0.24**	0.21
		[0.06,0.41]	[-0.04,0.46]
High parental SES X Hierarchy		0.20*	0.13
		[0.02,0.38]	[-0.13,0.40]
Observations	111862	111862	111862
R^2	0.263	0.263	0.263

Coefficients and 95% CIs from OLS model. Model includes country fixed effects, year trend, country interacted with year, country interacted with parental SES, year interacted with parental SES, and three way interaction between year, country, and parental SES. Controls for gender, age, age^2, parental country of birth, unemployment rate, GDP growth, and left-party share of cabinet posts. Aggregate level controls interacted with parental SES. Standard errors clustered by country-cohort, weight using ESS post-stratification weight. See equation 1 for details of specification. 95% confidence intervals in brackets * p < 0.05, ** p < 0.01, *** p < 0.001

[i] Note that we are using a more restrictive definition than Salonen, L., & Pölyiö, H. (2017). Historical dataset of major educational reforms in Europe 1950-1990. *Working Papers on Social and Economic Issues*. Online: https://wpsei.utu.fi/historical-dataset-of-major-educational-reforms-in-europe-in-1950-1990/

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