

# Long-Term Trends in Adult Socio-Economic Resemblance between Former Schoolmates and Neighbouring Children

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## Abstract

Schools and residential neighbourhoods constitute key contexts of development beyond the family of origin. Yet, few prior studies address whether the overall impact of these childhood contexts on adult life chances has changed over time. In this article, we investigate changes in socio-economic resemblance between former schoolmates and neighbouring children using Norwegian administrative data covering three decades. We use cross-classified multilevel models to decompose the variance in children's educational attainment and adult earnings into the contributions found within and between their school and neighbourhood contexts in adolescence. We find that unadjusted school and neighbourhood correlations in educational attainment are relatively modest and declining over time. These trends largely reflect declining socio-economic segregation between schools and neighbourhoods over time. After adjusting for sorting by family background, schools account for 2 per cent or less of the total variation in completed years of education in the more recent cohorts and neighbourhoods even less. For adult earnings, the adjusted school correlations are very low, accounting for around 1 per cent of the total variance, while the contribution of neighbourhoods is close to zero. Our findings suggest that adolescent school and neighbourhood contexts are not major determinants of children's later-life socio-economic attainments in the Norwegian welfare state setting.

## Introduction

Developmental theories describe children and youth as embedded within a series of social contexts, where schools and neighbourhoods often constitute the key settings of learning and socialization beyond the family of origin (Bronfenbrenner, 1979). Ever since the Coleman *et al.* (1966) report, a longstanding focus has been to identify the impact of these contexts on children's future life chances. Recent studies provide evidence of a causal influence of childhood neighbourhood environments on

later educational and socio-economic outcomes (Wodtke, Harding and Elwert, 2011; Chetty and Hendren, 2018). Further, various school-level characteristics, such as peer composition, class size, the presence of skilled teachers, and the effectiveness of local school administrations, have also been shown to matter for children's education and later-life socio-economic well-being (Scheerens and Bosker, 1997; Fredriksson, Öckert and Oosterbeek, 2013; Chetty, Friedman and Rockoff, 2014). Yet, studies identifying the partial effects of

specific characteristics of schools and neighbourhoods are less informative on the overall influence of these contexts. Further, prior studies assessing the overall influence of adolescent contexts on later-life outcomes often report relatively modest effect sizes (e.g., Solon, Page and Duncan, 2000; Duncan, Boisjoly and Harris, 2001; Altonji and Mansfield, 2011).

To address questions regarding the overall contribution of these contexts for children's life chances, we assess the resemblance in adult socio-economic outcomes between former schoolmates and neighbouring children, i.e., so-called school and neighbourhood correlations (Jencks and Brown, 1975; Bryk and Raudenbush, 1988; Solon, Page and Duncan, 2000), after adjusting for sorting by observed family background.<sup>1</sup> Inquiries into such peer-level correlations are, given some assumptions, informative for the scope of interventions aimed to equalize children's opportunities at the level of schools and neighbourhoods. The existing literature is very limited, however, when it comes to the issue of whether the importance of these contexts for children's later-life outcomes has changed over time (Raaum, Salvanes and Sørensen, 2006; Altonji and Mansfield, 2011).

In this study, we present new evidence on long-run trends in adult socio-economic resemblance between former schoolmates and neighbouring children using Norwegian administrative data covering three decades. Instead of focusing on particular characteristics of schools and neighbourhoods, we use multilevel models that exploit the clustering of children within these contexts to decompose the variance in educational attainment (years of completed education) and earnings rank in adulthood into their within and between context components. The school or neighbourhood correlations (more technically, the intraclass correlation coefficient, ICC) is then given by the proportion of the total variance that is found between each of these contexts with or without taking observed characteristics of children's family background into account. By estimating school and neighbourhood correlations separately across many birth cohorts, we are able to address whether there has been any change in these contextual influences on children's adult attainments across a period of three decades. Beyond estimating school and neighbourhood correlations across several decades, we contribute to the existing literature by using cross-classified multilevel models that take into account the complexity of how schools and neighbourhoods correlations are intertwined with each other.

Later-life resemblance between children who attended the same school or grew up in the same neighbourhood is not necessarily indicative of school or

neighbourhood effects, as it might also reflect systematic sorting of children and their families across these contexts (Duncan and Raudenbush, 1999; Sobel, 2006). Given variation in economic constraints between households, differences in the desirability of local schools and their surrounding residential catchment areas are likely to result in a clustering of children that resemble each other according to parental socio-economic resources and various unobserved traits. While we are able to control for several relevant and well-measured family background traits, remaining unobserved sorting may lead to an overstatement of the importance of school and neighbourhood contexts for children's later-life outcomes. Consequently, our variance-decomposition approach provides an upper-bound estimate of the long-term causal influence of these contexts (Jencks and Brown, 1975; Solon, Page and Duncan, 2000).<sup>2</sup>

Our results reveal low adjusted school and neighbourhood correlations in adult socio-economic attainments and this pattern is relatively stable across the birth cohorts we focus on. To the extent that former schoolmates and neighbouring children resemble each other in terms of education and earnings as adults, this mostly reflects sorting across childhood contexts by observed family background. Overall, we find that the variation in adult socio-economic attainments between children who attended the same school or grew up in the same neighbourhood is far larger than the variation across these contexts. Before moving to the empirical part, we briefly discuss the theoretical background, previous research, and the Norwegian setting.

## Background and Previous Literature

There are several reasons to expect school and neighbourhood contexts to matter for life chances. Influential theories argue that neighbourhood contexts matter for adolescent development through processes such as peer interactions in local friendship networks, the role model functioning of adult community members, variation in the quality of local institutions, and the broader social organization of neighbourhood life (Jencks and Mayer, 1990; Sampson, Morenoff and Gannon-Rowley, 2002; Sharkey and Faber, 2014). Schools are key arenas structuring peer interaction among adolescents, but they also matter for children's later-life outcomes because of the didactic inputs they provide to their students, such as teacher quality, school curricula, student-teacher ratios, and access to high-quality learning facilities and other financial resources (Scheerens and Bosker, 1997; Hanushek, 2006; Sørensen and Morgan, 2000). If there is considerable spatial variation in the socio-economic

characteristics of neighbourhoods and the quality of local schools, we expect that the school and neighbourhood contexts that individuals are exposed to while growing up would contribute to substantial variation in their adult outcomes. By contrast, if there is less contextual variation across schools and neighbourhoods, or if these contexts just matter less for adolescent development than often assumed, we would expect lower levels of adult socio-economic resemblance between former schoolmates and neighbouring children.

Importantly, the influence of adolescent school and neighbourhood contexts on adult attainments may change across historical periods. To begin with, increased spatial segregation over time may lead to more variation in children's social contexts, such as access to high-quality schools, exposure to skilled teachers, and classmate composition, or the type of adult supervision or role models children encounter in their local neighbourhood communities (Bischoff and Owens, 2019). In this regard, many industrialized countries have experienced a marked increase in economic inequality starting around 1980 (Roine and Waldenström, 2015), after a preceding period of decline in inequality throughout most of the earlier part of the 20th century. Norway is no exception, as the Gini coefficient of gross family income increased from a low of 0.40 in 1980 to a level of about 0.46 in the early 2000s (Aaberge, Atkinson and Modalsli, 2016). As a consequence, overall inequality trends may translate into increased segregation of children by parental socio-economic resources across schools and neighbourhoods (Reardon and Bischoff, 2011; Owens, 2016; Owens, Reardon and Jencks, 2016). A key mechanism that may link rising economic inequalities to increased segregation is changes in housing prices and spatial variation in affordability across residential areas (Matlack and Vigdor, 2008; Dewilde and Lancee, 2013). Overall, increased socio-economic segregation would likely lead to both more variation between the schools and neighbourhoods children are exposed to and increased later-life inequalities between children from different contexts beyond sorting by family background.

Further, quality differences among schools are likely to depend on the degree to which schools are funded by local (municipality) taxes, and on the amount of school autonomy. Changes in educational policies may therefore affect the variation in children's adult outcomes across schools contexts. Cross-national research have found that between-school variation and socio-economic inequalities in student outcomes often are smaller in countries with less differentiation between schools (e.g., absence of between-school tracking) and higher levels of

standardization (e.g., less school autonomy and more standardized curricula) in their educational systems (Van de Werfhorst and Mijs, 2010; OECD, 2016). To the extent that educational policies and the related distribution of resources across schools change over time, this could lead to changes in the role of attending given schools for student outcomes.

### Prior Studies on School and Neighbourhood Correlations in Children's Adult Attainments

Given the above considerations, our aim is to examine how school and neighbourhood correlations have developed across three decades drawing on Norwegian administrative data. In the educational literature, variance decomposition methods (i.e., school correlations) are frequently used to examine the extent to which between-pupils variation in achievement can be attributed to differences between schools (e.g., Marks, 2006; Jennings *et al.*, 2015).<sup>3</sup> However, few studies apply the variance decomposition methods to study educational attainment or earnings in adulthood, and the number of studies of the importance of neighbourhoods for such outcomes is particularly small.

An early and influential study from the United States found that the neighbourhood correlation for educational attainment was in the 0.15–0.19 range and the 0.06–0.10 range, respectively, before and after taking parental resources into account (Solon, Page and Duncan, 2000), while a companion study found a neighbourhood correlation of 0.16 in adult earnings between neighbouring children in adolescence after adjusting for family background (Page and Solon, 2003). A lower neighbourhood correlation of 0.05 was found in a Canadian study (Oreopoulos, 2003). With regard to school correlations in adult outcomes, Altonji and Mansfield (2011) found that school correlations in enrolment in 4-year college between former high school students in 1972 and 2002 had increased from 0.14 to 0.22 and from 0.11 to 0.15 before and after taking student background characteristics into account. During this period, the socio-economic segregation of students between schools had also increased. Adult earnings was only observed for the 1972 cohort, where the corresponding school correlations before and after taking student sorting into account were 0.16 and 0.11, respectively (Altonji and Mansfield, 2011: Figures 16.3 and 16.4).

While there are few comparable studies from Europe, there are some from Scandinavian countries. Using Swedish data on early 1950's cohorts in Stockholm, Lindahl (2011) found that unadjusted neighbourhood and school correlations in completed

education were of a similar magnitude at about 0.08 for men and 0.05 for women, but declined to 0.02 and 0.01, respectively, after taking parental education and earnings into account. For earnings, the neighbour and schoolmate correlations were similar for both genders and very small both before (0.02 or less) and after (0.01 or less) adjusting for family background. In Norway, prior research has found declining neighbourhood correlations in socio-economic outcomes for children born in the first two decades after World War II. Comparing adolescent neighbours observed in the censuses from 1960 and 1970, [Raaum, Salvanes and Sørensen \(2006\)](#); see also [Raaum, Salvanes and Sørensen, 2003](#)) found that unadjusted correlations in education decreased from about 0.10 to 0.06. The same reduction after adjusting for parental characteristics was from about 0.04 to 0.02. For adult earnings, the unadjusted neighbour correlation declined from 0.06 to 0.03 for men and from 0.03 to 0.02 for women. With adjustment for parental education and family structure, the corresponding reduction was from 0.05 to 0.02 for men and from 0.02 to 0.01 for women. Thus, for both outcomes the overall trend is moving from moderate effects in the oldest cohorts to very low levels in the younger cohorts.

None of the abovementioned studies on neighbourhood or school correlations in children's educational attainment or adult earnings has used methods that take nesting into both of these contexts into account simultaneously. However, several studies of other outcomes such as educational achievement (e.g., test scores or grades) have found very small neighbourhood correlations in cross-classified multilevel models which also take the school into account ([Brännström, 2008](#); [Leckie, 2009](#); [Rasbash et al., 2010](#); [Sykes and Musterd, 2011](#)). [Brännström \(2008\)](#), for instance, found that the adjusted correlations in grade point averages between grademates in upper-secondary schools (0.07) was considerably higher than between those growing up in the same neighbourhoods (0.01) in Swedish metropolitan areas.

## The Norwegian Setting

Norway, alongside the other countries in the Nordic region, is characterized by redistributive welfare-state institutions, low income inequality, and high rates of intergenerational mobility ([OECD, 2015](#); [UNICEF, 2016](#)). High-quality basic services, such as health care, are offered to all residents. Norway also has a relatively egalitarian educational system, with publicly financed education at all levels and no tuition fees ([Van de Werfhorst and Mijs, 2010](#)).

The Norwegian comprehensive education system is mandatory and publicly funded. For the cohorts covered in this study, compulsory education consisted of 9 years of schooling starting at age 7, and was split into primary schools (grades 1–6) and lower-secondary schools (grades 7–9). Students generally graduate from compulsory education at age 16 and there is no formal tracking by student ability during these grades. Municipalities run comprehensive public schools, school attendance is based on place of residence, and rules specifying that students attend the school in their local catchment area are strictly enforced. Importantly, there are minimum standards for schools set by the central government. There is also a high degree of resource redistribution from relatively rich to relatively poor municipalities, and in particular there is considerable resource compensation towards schools serving disadvantaged student bodies ([Hægeland, Raaum and Salvanes, 2005](#); [Hægeland, Kirkebøen and Raaum, 2009](#)).

Studies of educational achievement such as PISA also suggest that the between-school variation is small in Norway, although the cohorts covered by these studies overlap only with the very latest cohorts in our data. Analyses of OECD's PISA 2000 data on eighth-graders indicate, for instance, that the between-school part of the total variation in test scores was less than 10 per cent in Iceland, Finland, Sweden, and Norway, whereas the average for all 30 countries included was 33 per cent ([Marks, 2006](#): Table 6).<sup>4</sup> More recent PISA results largely confirm this, as do analyses of PIRLS and TIMSS data on both eighth-graders and fourth-graders ([Martin et al., 2011](#); [Caponera and Losito, 2016](#)).

Although the basic features of Norwegian compulsory education have been quite stable in the period we study, some developments may nevertheless be mentioned. During the first decades after World War II, schools were subject to very detailed national (state) control ([Telhaug, Mediås and Aasen, 2004, 2006](#)). From the 1970s, Norwegian educational policy was strongly influenced by progressive, pupil-centred, and anti-authoritarian pedagogical ideas. As a result, central government control over curriculum content, teaching methods, and other aspects of education was reduced. Special schools for children with disabilities or other special needs were abolished, and these children were to be included in ordinary schools. By the end of the 1980s, the influence of radical pedagogy had waned. During the 1990s, the aims of the school were redefined with a greater focus on subject matter and learning. The amount of monitoring of schools was increased and detailed standardized curricula for all schools were implemented ([Telhaug, Mediås and Aasen, 2006](#): pp.

273–274). The process culminated with an educational reform in 1997, in which the school starting age was also changed from 7 to 6 years and the duration of compulsory school extended from 9 to 10 years.

In comparative terms, levels of residential segregation by economic status in metropolitan areas are generally quite low in Norway (Musterd, 2005; Musterd *et al.*, 2017). In spite of increasing income inequality, Wessel (2000) found that the level of segregation in Oslo, Norway's capital city, remained stable, or declined slightly, in the period from 1970 to the 1990s. During the 2000s, however, economic segregation in both Oslo and Norway as a whole has increased quite markedly and this seems largely to reflect recent immigration (Wessel, 2016; Markussen and Røed, 2018). Despite immigration-related increases in segregation, recent studies indicate very modest effects of exposure to immigrant-origin peers in school on student outcomes once sorting is adequately addressed (Hermansen and Birkelund, 2015; Hardoy, Mastekaasa and Schøne, 2018).

## Data and Methods

We use matched data on children and their schools and residential neighbourhoods during adolescence emanating from population-wide Norwegian administrative registries. Information on sociodemographic characteristics of children and their parents, as well as unique identifiers of each child's residential location in adolescence and their school of graduation observed at the end of compulsory lower-secondary education, were matched across several registries using unique personal identifiers. For the current purposes, we follow children in 29 entire birth cohorts (born 1959–1989) from adolescence into adulthood. We exclude all foreign-born individuals who immigrated after school-starting age at seven. With these restrictions, our final sample for the analysis consists of 1,671,784 children. The average number of children per cohort is about 59,000, who graduate from about 1,000 different schools and reside in about 10,500 different neighbourhoods (cf. Supplementary Table A1). Table 1 provides summary statistics for the variables used in the empirical analysis.<sup>5</sup>

### Measurement of Schools and Neighbourhoods

To measure children's adolescent contexts, we use information on their school of graduation at the end of lower-secondary education and their neighbourhood of residence while growing up. Unique school identifiers are available for all graduating cohorts from 1975 and onwards and are used to identify schoolmates.<sup>6</sup> For the early cohorts, there were about 900 schools with an

average of about 65 graduating students in each cohort, while the corresponding figures are 1,150 schools and 50 students per cohort towards the end of our period (Supplementary Table A1). A school typically recruits students from a large number of neighbourhoods (on average 15 for the earliest cohorts and 12 for the latest, see Supplementary Table A2). Children from the same neighbourhood often go to the same school, but a substantial number of neighbourhoods are split between two or more schools (nearly 50 per cent of the neighbourhoods in the earliest cohorts and about 25 per cent in the latest, see Supplementary Table A3).

Neighbourhoods are measured using detailed information on children's residential location in the year of graduation from lower-secondary school. For most of our cohorts, these neighbourhood units are defined in terms of Statistics Norway's detailed 'Basic Statistical Unit (BSU)' classification (i.e., *grunnkretser*). There are about 13,700 such units with on average about 350 individuals in each unit, which are designed to resemble genuine neighbourhoods and are relatively homogeneous with respect to location and type of housing (Statistics Norway, 1999). For each cohort in our sample, there are about 10,500 neighbourhoods with on average 5–6 students from the same birth cohort in each neighbourhood (cf. Supplementary Table A1). The BSU is available only for cohorts born 1964 and forward. For the 1959–1964 cohorts, we use census tracts from the 1970 and 1980 Census, which are slightly fewer (about 7,200) and larger (cf. Supplementary Table A1).

As stated above, information on residential neighbourhood location is available in the 1970 and 1980 Census and, then, annually from 1990 and onwards. For children born 1975–1989, we measure neighbourhood location when graduating from compulsory education (age 16). For children born in 1959–1974, we use information on neighbourhood location in the 1970 Census (1959–1963 birth cohorts) and 1980 Census (1964–1974 birth cohorts). For these birth cohorts, neighbourhood context is measured between ages 7 and 11 (i.e., born 1959–1963) or between ages 6 and 16 (i.e., born 1964–1974).

### Children's Later-Life Socio-Economic Outcomes and Family Background Characteristics

To capture the socioeconomic status of children and their parents, we use information on educational attainment and annual earnings. Child education refers to the highest level of educational attainment reached by age 25 using the Norwegian Standard Classification of Education (NUS2000). We recode this educational

**Table 1.** Descriptive statistics by birth cohorts

	1959–1968		1969–1978		1979–1988	
	Mean	SD	Mean	SD	Mean	SD
Educational attainment (years)	12.475	2.108	13.169	2.121	13.381	2.263
Earnings (NOK)	214,554	155,681	276,830	166,030	323,816	185,750
Father's education (years)	11.225	2.970	12.101	2.999	12.951	2.873
Mother's education (years)	10.441	2.295	11.416	2.498	12.574	2.726
Father's earnings (NOK)	237,652	102,161	255,424	125,961	299,683	220,262
Mother's earnings (NOK)	74,323	64,314	102,900	75,972	149,672	98,845
Father zero earnings	0.010	0.098	0.012	0.109	0.020	0.142
Mother zero earnings	0.060	0.238	0.072	0.259	0.054	0.226
Gender	0.490	0.500	0.488	0.500	0.488	0.500
First-generation immigrants	0.001	0.028	0.003	0.052	0.011	0.106
Second-generation immigrants	0.002	0.039	0.003	0.053	0.013	0.111
Birth order	2.170	1.225	1.986	1.131	1.871	0.983
Number of siblings	2.224	1.350	1.943	1.250	1.981	1.241
Mothers' age	27.331	6.037	26.162	5.211	27.151	4.980

Notes: For all variables but earnings, the numbers of observations for the birth cohorts 1959–1968, 1969–1978, and 1979–1988 are 486,633, 417,911, and 447,034, respectively. For earnings, the numbers observations are 470,812, 408,943, and 174,096.

attainment level into years of completed education. We measure the father's and the mother's education separately, based on their level of education attained when the child was 16 years old using the same classification. For the father's and the mother's education, we include each of these as continuous variables and their squared terms.

Child earnings refer to pre-tax annual income from gainful employment (including self-employment); capital income and social welfare transfers are not included. This information is taken from tax files that include annual gross income subject to taxation in various forms and is captured with high accuracy. We measure children's average earnings between ages 32 and 34. Following recent contributions in the literature on inter-generational income mobility, we then rank children in percentiles based on their earnings relative to other children in the same birth cohort, irrespective of gender and including those with zero earnings (Dahl and DeLeire, 2008; Mastekaasa, 2011). This yields a symmetric variable that captures earnings ranks measured as the cohort-specific percentile in the earnings distribution, which ranges from zero (lowest) to 100 (highest).

Parental earnings are also measured in terms of pre-tax annual income from gainful employment. We average the father's and the mother's annual earnings over the years the child was aged 11–15 years and then rank each parent's earnings position relative to other fathers or mothers with children in their child's birth cohort (i.e., percentile rank), irrespective of the child's gender

and including parents with zero earnings. Father's and mother's earnings rank are entered as continuous variables in our models (with squared terms), but we also include dummy variables indicating whether the mother or the father had earnings equal to zero throughout the whole time period.

We also include additional sociodemographic background characteristics. This includes information on children's gender, immigrant background (i.e., dummy variables for first generation and second generation), number of siblings (with squared term), birth order (with squared term), and mother's age at the child's birth (with squared term).

## Empirical Approach

Since schoolmates often live in the same neighbourhoods, there are good reasons to estimate school correlations while also taking neighbourhood clustering into account, and vice versa. In line with several of the more recent studies in the field, we therefore supplement separate two-level neighbourhood and school models with cross-classified models in which individuals are treated as clustered within both schools and neighbourhoods (Brännström, 2008, Dundas, Leyland and Macintyre, 2014, Rasbash *et al.*, 2010, Sykes and Musterd, 2011).

The two-level models can be written as:

$$y_{ij} = \beta_0 + u_j + e_{ij}, \quad (1a)$$

$$y_{ik} = \beta_0 + v_k + e_{ik}. \quad (1b)$$

In equation (1a),  $y_{ij}$  is the educational level (or earnings) of individual  $i$  from school  $j$ ,  $\beta_0$  is mean education (or earnings) across all schools,  $u_j$  is the effect of school  $j$ , and  $e_{ij}$  is an individual-level error term. The school effect and the individual-level error term are assumed to be independent of each other. In equation (1b), a similar model for neighbourhood variation is obtained by replacing  $u_j$  with  $v_k$ , where the latter is the effect associated with neighbourhood  $k$ .<sup>7</sup> The variance across schools (neighbourhoods) is denoted as  $\sigma_u^2$  ( $\sigma_v^2$ ), and the variance within schools (neighbourhoods) as  $\sigma_e^2$ . Then, the intraclass correlation coefficients for schools ( $ICC_u$ ) and neighbourhoods ( $ICC_v$ ) are:

$$ICC_u = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}, \quad (2a)$$

$$ICC_v = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_e^2}. \quad (2b)$$

The cross-classified model can be written as:

$$y_{ijk} = \beta_0 + v_k + u_j + e_{ijk}. \quad (3)$$

In this equation,  $y_{ijk}$  is the educational level (or earnings) of individual  $i$  from neighbourhood  $k$  and school  $j$ ,  $\beta_0$  is mean education (or earnings) across all schools and neighbourhoods,  $v_k$  is the effect associated with neighbourhood  $k$ , and  $u_j$  is the effect of school  $j$ . The random effects  $v_k$  and  $u_j$  and the individual error term  $e_{ijk}$  are all assumed to be independent of each other.<sup>8</sup> Then the ICCs for schools ( $ICC_u$ ) and neighbourhoods ( $ICC_v$ ) are:

$$ICC_u = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2 + \sigma_e^2}, \quad (4a)$$

$$ICC_v = \frac{\sigma_v^2}{\sigma_u^2 + \sigma_v^2 + \sigma_e^2}. \quad (4b)$$

The intra-school correlation coefficient ( $ICC_u$ ) is interpreted as the correlation in education (or earnings) between two randomly selected students who attend the same school but live in different neighbourhoods, or, equivalently, as the proportion of variance accounted for by school affiliation. The intra-neighbourhood correlation coefficient ( $ICC_v$ ) is interpreted as the correlation between two students who attend different schools but live in the same neighbourhood (Leckie, 2013; Dunn *et al.*, 2015).

While we focus mainly on the ICC's in our presentation, it should be noted the variances, or rather the standard deviations of the random effects,  $\sigma_u$  and  $\sigma_v$ , are also of interest in their own right, as they indicate how much variation in the absolute level of earnings and educational attainment there is among the schools and the

neighbourhoods.<sup>9</sup> With  $y$  measured, e.g., in terms of years of education, a  $\sigma_u$  of 1.5 means that students from a school one standard deviation higher than another in the distribution of school effects can expect to attain 1.5 years more of education.

The two-level and the cross-classified models described above contain no explanatory variables other than school and neighbourhood. In addition to these unadjusted multilevel models, we estimate adjusted models. We expand on the models described in equations 1a, 1b, and 3 by including parental education, parental earnings, gender, immigrant background, number of siblings, birth order, and mother's age at children's birth. We estimate all models separately for each birth cohort, using Markov Chain Monte Carlo estimation as implemented in the MLwiN program (both for cross-classified and two-level models).<sup>10</sup>

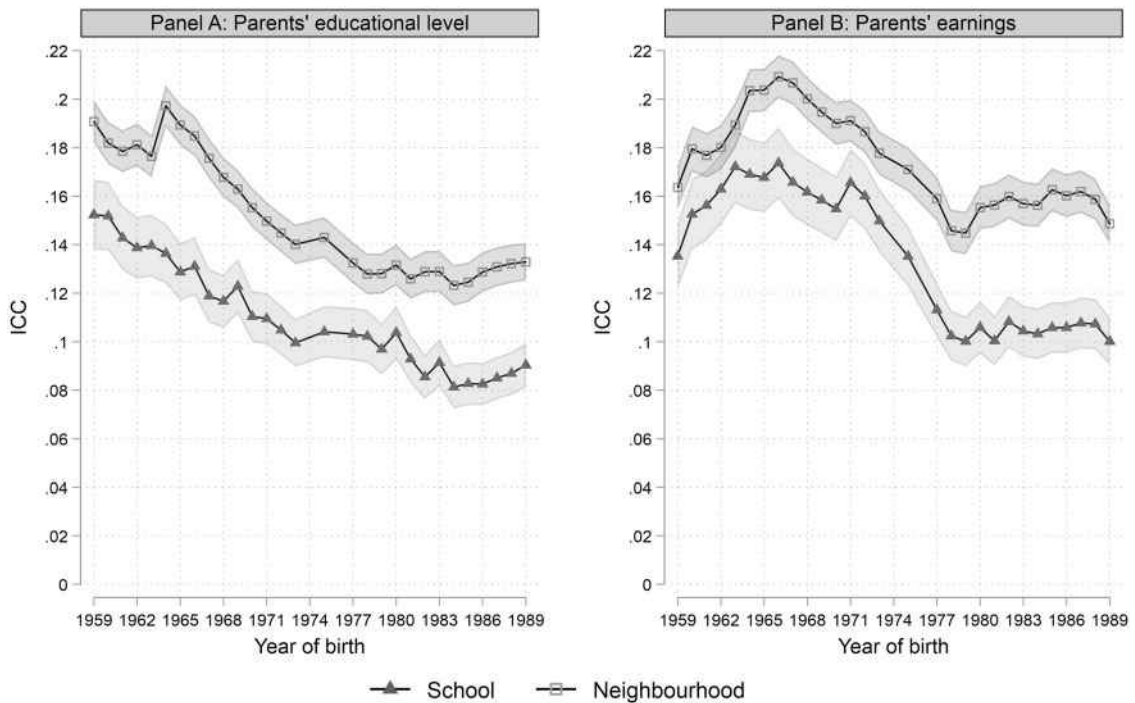
## Results

The degree to which socio-economic origin, as captured by parents' earnings and education, contribute to school and neighbourhood level variation in children's adult outcomes depends, among other things, on the extent to which such parental characteristics are themselves unequally distributed across schools and neighbourhoods. Before moving to the main analyses, we therefore present results from two-level models with parents' level of schooling and earnings as outcome variables using equations 1a and 1b.

Figure 1 shows how school and neighbourhood correlations in parents' education and earnings (i.e., segregation by socio-economic background) have developed over the 1959–1989 birth cohorts. With regard to parental education, a steady downward trend is found in both correlations for cohorts until about 1980, followed by stability over cohorts born during the 1980s. With regard to parents' earnings, the development over time is also very similar for the school and the neighbourhood correlations, but there is no monotonic trend over time. There was an increase for the 1959–1966 cohorts, followed by a decline, and then stability for those born in 1980 or later. Both with regard to parents' earnings and education, neighbourhoods are more uneven than schools.

## Educational Attainment

Figure 2 presents the school and neighbourhood correlations for years of completed education;<sup>11</sup> the ICC estimates as well as the variance of the random effects ( $\sigma_u^2$



**Figure 1.** Intra-class correlations (ICC) in schools and neighbourhoods for parental education and earnings with 95% confidence intervals.

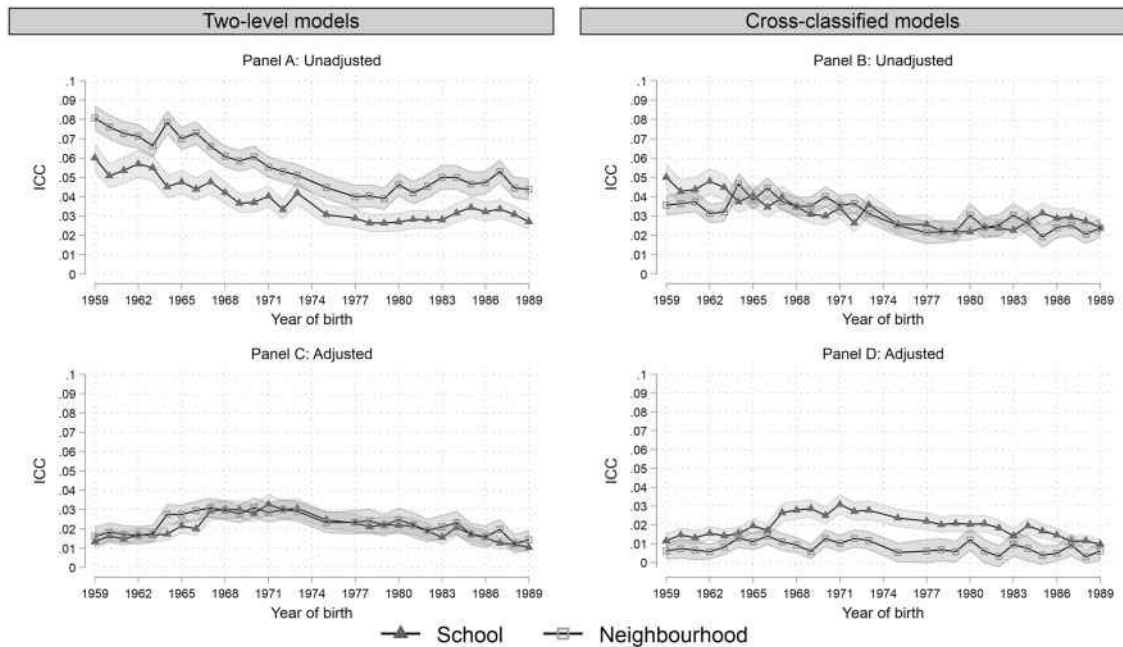
and  $\sigma_v^2$ ) and the variance of the within-subject residual ( $\sigma_e^2$ ) are reported in the [Supplementary Tables A4 to A9](#). We start with the unadjusted ICC's for schools and neighbourhoods (i.e., without controls for child and parental background characteristics); results from the two-level models are in Panel A and from the cross-classified model in Panel B. The school correlations are very similar in the two models, declining from about 0.05 for the earliest cohorts to about 0.03 among those born in the mid 1970's and with no clear trend after that. The neighbourhood correlations, on the other hand, are considerably lower in the cross-classified model than in the two-level model. Similar to the school correlations, the neighbourhood correlations also decline over cohorts, but less clearly in the cross-classified model than in the two-level model, as the correlations there are much lower even in the earliest cohorts. In the cross-classified model, the neighbourhood correlations are in the 0.03 to 0.04 interval for the pre-1973 cohorts and in the 0.02 to 0.03 interval thereafter.

The adjusted school and neighbourhood correlations (i.e., with controls for child and parental background characteristics) are shown in Panels C (two-level models) and D (cross-classified model). As far as the adjusted

school correlations are concerned, the results from the two-level models (Panel C) and the cross-classified model (Panel D) are extremely similar. The correlations increase from slightly above 0.01 in the earliest cohorts to 0.03 for cohorts from about 1970, but return to about 0.01 for those born in the late 1980's. In the two-level model, the neighbourhood correlations display a somewhat similar pattern over time, but this similarity disappears in the cross-classified model. In this model, the adjusted neighbourhood correlations are generally low in all cohorts, mostly below 0.01. The finding that the neighbourhood correlations (both unadjusted and adjusted) are much lower in the cross-classified than in the two-level models is consistent with the idea that neighbourhood effects to a considerable extent operate through the school context.<sup>12</sup>

Apart from the unadjusted correlations in the earlier cohorts, the general impression from the analyses of educational attainment is that both the school and the neighbourhood correlations are small and in some cases almost negligible. This is also evident if we examine the standard deviations of the random effects. Averaging over the five latest cohorts, the standard deviation of the random school effects ( $\sigma_u$ ) is





**Figure 2.** Intraclass correlations (ICC) in schools and neighbourhoods for education with 95% confidence intervals. *Notes:* The adjusted models control for mother's and father's level of education and earnings (including dummy variables for zero earnings), mother's age at child's birth, child's gender, immigrant background, number of siblings, and birth order.

0.24. As mentioned earlier, this number can be interpreted as the difference in expected years of completed education between students attending schools one standard deviation apart in the school effects distribution. The corresponding five-cohort average standard deviation for the neighbourhood effects ( $\sigma_v$ ) is even lower, namely 0.15.

### Adult Earnings

The results for earnings rank are shown in Figure 3, which, as for education, presents estimates from both two-level (Panels A and C) and cross-classified (Panels B and D) models both before and after the inclusion of controls for the observed parental and child background characteristics. The variances of the random effects ( $\sigma_u^2$  and  $\sigma_v^2$ ) and the variance of the within-subject residual ( $\sigma_e^2$ ) are reported in the Supplementary Tables A10 to A15.

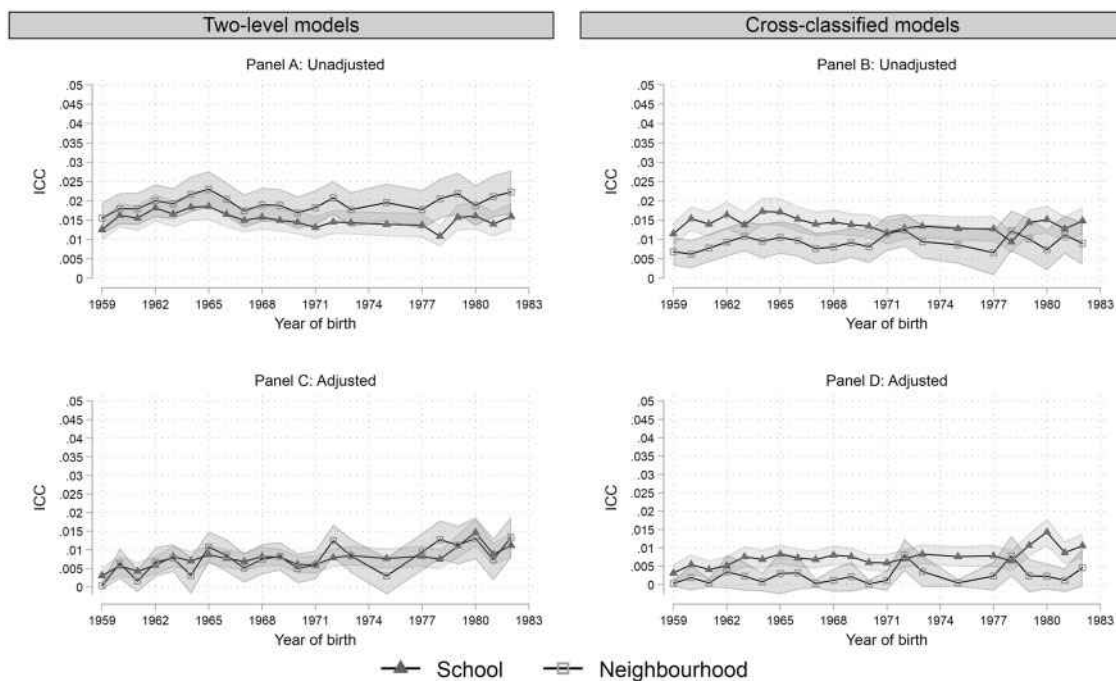
The most striking feature of the results for earnings is that the correlations are generally low across all the cohorts studied and without any evidence of trends.<sup>13</sup> As far as the school correlations are concerned, the results for the two-level models and the cross-classified models are very similar. This parallels the results for educational attainment above. Also similar to the

educational attainment results, the neighbourhood correlations are clearly lower in the cross-classified models. In the two-level model, the unadjusted neighbourhood correlations fluctuate mainly between 0.015 and 0.020 (Panel A), while the adjusted neighbourhood correlations are mostly lower than 0.01 (Panel C). In the cross-classified models, the unadjusted school correlations are mainly in the 0.010–0.015 interval (Panel B) and the adjusted correlations in the 0.005–0.010 interval (Panel D).

Overall, these school and neighbourhood correlations suggest that these adolescent contexts have a very limited long-term influence on individuals' adult earnings in Norway. This is also evident if we look at standard deviations of the school and neighbourhood random effects. For the five most recent cohorts, a move of one standard deviation in the distribution of school effects ( $\sigma_u$ ) amounts to about 2.5 percentile earnings ranks. The corresponding number for the neighbourhood effects ( $\sigma_v$ ) is 1.5 percentile earnings ranks.

### Discussion and Conclusions

This study has explored trends in the adult socio-economic resemblance between children who graduated



**Figure 3.** Intra-class correlations (ICC) in schools and neighbourhoods for adult earnings with 95% confidence intervals.  
*Notes:* The adjusted models control for mother's and father's level of education and earnings (including dummy variables for zero earnings), mother's age at child's birth, child's gender, immigrant background, number of siblings, and birth order.

from the same school or who lived in the same residential neighbourhood during adolescence across three decades in Norway. We have used intraclass correlations from two-level and cross-classified multilevel models to assess change over time in the contribution of school and neighbourhood contexts for children's later-life outcomes before and after taking observed family background into account. For educational attainment, our results revealed a clear decline in the unadjusted school and neighbourhood correlations over birth cohorts born between 1959 and the late 1970s, followed by a relatively stable pattern of low correlations across the younger cohorts. After taking into account sorting by observed family background, we did not find a corresponding decline in school and neighbourhood correlations but instead stable and low correlations. In line with this, we found a declining trend in the school and neighbourhood level clustering by parental socio-economic characteristics that ran more or less parallel with the decline in the unadjusted school and neighbourhood correlations. Thus, declining segregation by parental socio-economic background seems to be the key driver for the developments in the unadjusted correlations in children's educational attainment.

Further, the school-level correlations in educational attainment were very similar in two-level and cross-classified multilevel models. This indicates that school correlations are not strongly biased even if neighbourhood clustering is not taken into account. However, the neighbourhood correlations dropped to about half when we simultaneously took nesting within schools into account. Thus, neighbourhood effects appear to be mediated by schools to a considerable extent. Overall, our results suggest that the upper-bound contribution of the school contexts, net of observed family background, is very small, only slightly above 1 per cent of the total variation in completed years of education in the more recent cohorts. The contribution of the neighbourhood is even smaller. The relatively low importance of the contextual variation is also evident if we look at the standard deviations of the random effects, which on average are 0.24 for schools and 0.15 for neighbourhoods in recent cohorts.

Turning to adult earnings, we found that both neighbourhood and school correlations are very small. We found no downward trend in the resemblance between former schoolmates and neighbouring children similar to the one found for educational attainment. Instead,

the unadjusted school and neighbourhood correlations were low throughout the period. As for education, we found that the school correlations from the ordinary two-level and the cross-classified multilevel models were quite similar, whereas the neighbourhood correlations were considerably lower in the latter. The unadjusted intraclass correlations show that the upper-bound contribution of school and neighbourhood contexts to the total variation in children's percentile earnings rank is not much higher than 1 per cent across these birth cohorts. Moreover, this estimate was further reduced after accounting for family background characteristics, for the neighbourhood effects to the point where it was hardly distinguishable from zero.

In summary, we arrive at two main conclusions. First, the consistently low levels of the correlations between former schoolmates and neighbouring children, after taking sorting into account, suggest that these adolescent contexts are not important sources of later-life socio-economic inequalities between children growing up in contemporary Norway. Both before and after adjusting for observed family background, there is far more variation in educational attainment and adult earnings within schools and neighbourhoods than between these contexts. Second, we find that adjusted school and neighbourhood correlations in education and earnings are relatively stable across birth cohorts. This suggests that the overall influence of childhood conditions that vary between different schools and neighbourhoods has not exhibited considerable change during the three last decades in Norway.

Some limitations in our study should be noted. To begin, we measure school and neighbourhood context at one occasion during adolescence, which might underestimate the overall cumulative effects of these contexts on children's outcomes. Previous studies have found stronger effects of neighbourhood context once cumulative effects of sustained exposure to given neighbourhood contexts are taken into account (Wodtke, Harding and Elwert, 2011, Chetty and Hendren, 2018), although others argue that cross-sectional measures are reliable as children often do not experience high levels of variation in their local surroundings over time (Jackson and Mare, 2007). Further, measurement errors in lifetime earnings due to yearly fluctuations and a relatively short observation period might contribute to a downward bias in the estimated school and neighbourhood correlations for this outcome. The age at which earnings are measured is also a potential issue, but our approach here is in line with recommendations in studies of life-cycle variation in earnings (Bhuller, Mogstad and Salvanes, 2017). Finally, since we are not able to measure all factors at

the family level that may both influence families' school and neighbourhood selection and children's later-life outcomes it is evident that remaining (unobserved) non-random sorting will result in some degree of omitted variable bias. Consequently, we may overstate the importance of school and neighbourhood factors due to unobserved variation in children's family characteristics across different contexts and, as such, our estimates likely represent upper-bound estimates of these effects.

Nonetheless, the relatively stable and low influence of school and neighbourhood contexts that we show for children born during the 1960s, 1970s, and 1980s is interesting when compared to previous Norwegian studies (Raaum, Salvanes and Sørensen, 2003, 2006), which have shown a clear decline in the importance of local childhood context for those born in early post-WWII decades. While the early post-war period was characterized by extensive educational reforms and expansion of the welfare state, we focus on a period when Norwegian welfare-state institutions were well developed. Interestingly, our estimates are comparable to those found in egalitarian Sweden (Lindahl, 2011) while studies from the high-inequality context in US report considerably higher neighbourhood and school correlations (Solon, Page and Duncan, 2000; Page and Solon, 2003; Altonji and Mansfield, 2011). As far as school correlations are concerned, there is also no sign of a decline over time in the US studies. To the contrary, Altonji and Mansfield (2011) report an increase from 0.11 to 0.15 when comparing adjusted school correlations for 4-year college enrolment among high school students in 1972 and 2002.

Interestingly, the pattern of increasing school-level correlations in educational attainment in this period coincides with a stark increase in economic inequality in US society, which has led to increased segregation by family income across children's schools and neighbourhood contexts (Reardon and Bischoff, 2011, Owens, 2016, Owens, Reardon and Jencks, 2016). Norway, like most Western societies, has also experienced growing economic inequalities since the late 1970s (Aaberge, Atkinson and Modalsli, 2016), but our results show that the trend towards increased inequalities so far has not been translated into larger between school or between neighbourhood inequality in children's outcomes. For the birth cohorts covered in the current study, changes in income inequality have not been accompanied by increased school or neighbourhood segregation with regard to parental income (cf. Figure 1), suggesting that inequality mainly increased within neighbourhoods and school catchment areas. This pattern is in line with a recent Norwegian study, which also found stable or

slightly declining neighbourhood segregation throughout the 1990s (Markussen and Røed, 2018). Importantly, however, Markussen and Røed (2018) document a reversal in this trend, leading to increased levels of residential segregation by income towards the end of the 2000s. Further, this reversal is largely explained by increased immigration and less so by overall changes in income inequality. To assess whether increased school and neighbourhood segregation in recent years has accentuated the influence of these contexts on adolescents' life chances should be a key task for future research.

In conclusion, one interpretation of the stable and low adjusted school and neighbourhood correlations in our data is that the Norwegian educational system and broader welfare-state institutions have been able to limit the importance of contextual variation in children's socio-economic opportunities in life. As long time series of administrative data is becoming available in a growing number of countries, a fruitful avenue for future research would be to provide comparative cross-national evidence using variance decomposition methods to assess variation in the upper-bound importance of school and neighbourhood contexts for children's socio-economic attainments in different institutional settings and over extended periods of time.

### Notes

- 1 In a related literature, correlations between siblings in later-life socioeconomic attainments provide a method of estimating the total influence family background (Corcoran, Jencks and Olneck, 1976) and sibling correlations are often used to assess changes in the importance of family background over time (for recent studies from Norway, see Pekkarinen, Salvanes and Sarvimäki, 2017; Wiborg and Hansen, 2018).
- 2 The upper-bound interpretation of school correlations relies on some assumptions. The most important one is probably that potential sorting on unobserved characteristics contributes to greater and not to smaller outcome differences between schools. This will not be the case if there is in fact an *inverse* sorting with strong students attending poor schools and weak students attending good schools. In principle, such a scenario could arise under strong public policies of resource redistribution in favour of schools with weak students. Similar reasoning applies to the upper-bound interpretation when applied to neighbourhood correlations.
- 3 We limit our attention to previous research that has attempted to estimate the overall importance of schools or neighbourhoods and do not include literature on specific school or neighbourhood variables (such as their ethnic or socioeconomic composition).
- 4 The reported percentages refer to the unadjusted school correlations and are based on averaging across the reading, mathematics, and science tests.
- 5 Note that the earnings variables are given in raw form (Norwegian NOK) in Table 1, but they are transformed to percentile ranks within each child's birth cohort in the analyses.
- 6 School of graduation is missing for all students who graduated in 1990, who are (mostly) born in 1974. Some data on schools are also missing in 1992, affecting mainly the 1976 cohort. We exclude all children from these two cohorts.
- 7 For simplicity, we reuse terms across equations (e.g.,  $\beta_0$ ) although the parameters and variables thus denoted are of course not expected to be identical in the various equations.
- 8 As in ordinary regression, correlated error terms will lead to bias in the coefficient estimates. There is a large literature on selection effects leading to, e.g., correlation between the individual error term and the school (or neighbourhood) effect and resulting bias in the latter (e.g., Sørensen and Morgan, 2000). We are not aware of any discussion of correlations of the group level random effects in hierarchical or cross-classified multilevel models, but parallel problems arise there.
- 9 The standard deviation of the random effects can be found by taking the square root of the variance of the random effects.
- 10 We used a burn-in of 1,000 and a chain of 100,000.
- 11 In Supplementary Figure A1, we report very similar results for year of completed education measured at age 30, but for a shorter time series (i.e., birth cohorts 1959 to 1984).
- 12 The fact that the school correlation is little affected by whether a cross-classified or a two-level model was estimated, whereas the neighbourhood correlation was considerably higher in the two-level model compared to the cross-classified model, is in line with Luo and Kwok (2009). According to their results, the omission of a cross-classified factor  $j$  (e.g., schools) means that most of the variance associated with that factor is transferred to the remaining factor  $k$  (e.g., neighbourhoods), if  $k$  is to a great extent nested within  $j$ , which is the case for

neighbourhoods within schools in our data. The omission of  $k$ , however, has little impact on the estimated variance component for  $j$  (maintaining the assumption that  $k$  is largely nested within  $j$ ). This makes intuitive sense, as the between-school variance is also to a great extent between-neighbourhood variance and will add to that if the school factor is removed. By contrast, the between-neighbourhood variance comprises variation both within and between schools, and adds to both between-school and individual-level variance if the neighbourhood factor is dropped (cf. Moerbeek 2004, for similar results in a standard hierarchical multilevel model).

- 13 Since earnings are measured in the age interval 32–34, the latest cohort covered is those born in 1982.

## Supplementary Data

Supplementary data are available at ESR online.

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