# Social origins and socioeconomic outcomes**:**
# A combined twin and adoption study


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## Abstract

Parents and children tend to have similar socioeconomic status (SES). The extant literature has emphasised the role of social mechanisms in intergenerational transmission, including the influence of the broader rearing environment as well as parental investments and aid, but often not allotted an important role to genetics. Accumulating evidence suggests that genetics play an important role in the transmission of SES from parents to children. Yet, estimates differ substantially across data sets, measures and methods. Using two research designs that account for potential genetic confounding, and high-quality data from Norway, we estimate the strength of the intergenerational social transmission of a range of SES indicators. By triangulating data and designs, we obtain estimates that are more robust to idiosyncratic modelling assumptions. Measures of Norwegian parents' socioeconomic position predict their children's socioeconomic outcomes, but purely social mechanisms only account for a fifth of the total explained variance in intergenerational transmission.



**Key words:**

Intergenerational transmission; Social transmission; Genetic confounding; Socioeconomic status; Adoption design; Multiple-Children-of-Twin Design

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**Authors' contributions:**

AVH conducted data preparation, the adoption analyses, created visualizations and wrote part of the theory, data and methods, results, and discussion section. AFR wrote part of theoretical sections and conducted the literature as well as methods review. CTC helped to conduct the literature and methods review. OR revised the paper and wrote parts of the theory, data and methods, results, and discussion section. THL acquired data, conducted the Multiple-Children-of-Twin Analysis, and wrote parts of the data and methods, results, and discussion section. All authors took part in the design and planning of the study, and in finalizing the manuscript.

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The authors report no conflicting interests.

## 1. Introduction

The reproduction of inequality is a core topic in the social sciences. In brief: Wealthier, more educated parents with high-status jobs tend to have children with higher socioeconomic status (SES) as well. This is true for a wide range of SES indicators, such as education, occupational prestige, income, wealth, and social class (Breen, Ermisch, and Helske 2019; Bukodi, Paskov, and Nolan 2019; DiPrete 2020; Ganzeboom, Treiman, and Ultee 1991; Gregg and Kanabar 2022; Narayan et al. 2018). Parent-child associations are especially strong for education, with parental education serving as a strong predictor of several child socioeconomic outcomes (Mastekaasa and Birkelund 2023).

In the social sciences, explanations for this strong intergenerational persistence typically focus on what parents *have* and *do.* Children from different social backgrounds will face different parenting styles and child rearing practices, have different material circumstances, social environments, role models, neighbourhoods, etc. This influences their abilities, preferences and aspirations, their educational opportunities and financial support, their educational and occupational careers, and thus their income and wealth (Becker and Tomes 1986; Bourdieu 1984; Goldthorpe 1996; Heckman 2006). Such explanations are prima facie plausible. We would expect many affluent, high-status parents to use their financial, social and cultural capital to help their children succeed in important life domains. Assessing such mechanisms in empirical work, however, also requires accounting for a second source of similarity in parent-child outcomes: genetic relatedness.

Genetic differences contribute to variation in multiple traits and abilities that may influence educational and occupational success. Parents are genetically more similar to their offspring than they are to a random stranger, and this similarity should be expected to induce a similarity in traits and abilities that in turn leads to more similar life outcomes. Genetically influenced traits include cognitive abilities (Okbay et al. 2022), personality traits (Constantinou et al. 2023), physical and mental health (Gatt et al. 2014; Steenstrup et al. 2013), physical appearance (Mobius and Rosenblat 2006), or indeed - as a massive review of the twin-study literature put it - “all human traits” (Polderman et al. 2015). Social and genetic transmission are both plausible contributors to intergenerational persistence in socioeconomic status. Empirical studies in the social sciences, however, have often failed to adequately account for the role of genetics (Freese 2008).

Identifying the relative contribution of social and genetic mechanisms is challenging both conceptually and empirically. Parental genes will have an influence on parental behaviour and socioeconomic status, so parental genes should be expected to make children similar to their parents both directly (genetic transmission), and through the behaviours they induce in the parent (i.e. “genetic nurture"; Kong et al. 2018). An influence of parental genes on parental SES also implies that we should expect gene-environment correlation. E.g., children growing up in affluent environments may tend to also have genetic endowments that predict higher earnings. Such gene-environment correlations may also arise in other ways, as when those showing early academic promise receive more encouragement, resources and opportunities - causing them to diverge further from their peers. And finally, genetically influenced traits in children may be expressed differently depending on the social environment provided by the parents (Breinholt and Conley 2023) - in effect gene-environment interactions (GxE). Nevertheless, social science theory puts much emphasis on a “main effect” of parents’ socioeconomic position, and estimating this independent effect of social origins is the main concern of this study.

This article contributes to the literature on intergenerational socioeconomic persistence in three important ways. First, we present an overview of research designs appropriate for disentangling social and genetic transmission mechanisms, along with a broad overview of what researchers have found using these.

Second, we present novel results on the importance of social transmission of socioeconomic status in Norway using two research designs that control for genetic confounding. We estimate the social transmission of SES between and across four different measures of social position: years of education, occupational prestige, income, and wealth. By comparing estimates across designs using different sources of identifying variation, results should be more robust to the idiosyncratic methodological weaknesses present in any single approach.

Specifically, we compare the transmission of social status from parents to adoptive and biological children (method 1), and employ a biometric model to separate the role of genetics and social environments, using data on twins, their spouses and their children (method 2). Although genomic data represents an exciting development for the social sciences, we believe that various types of pedigree designs perform markedly better for our research question. For example, designs using polygenic scores as control variables (see further) cannot yet effectively control for genetic confounding in models of intergenerational transmission (as geneticists have pointed out; cf. Zietsch, Abdellaoui, and Verweij 2023). Both employed pedigree designs are used to estimate how each of the four indicators of parental SES predicts each of these four SES outcomes in the offspring generation. Importantly, outcome data in both studies are taken from high quality administrative registers covering educational attainment, occupational prestige, income and wealth, avoiding sample attrition, recall bias, and many other sources of measurement error.

While our empirical strategies produce results that differ in some important ways, the overall conclusions from our study can be summarised as follows: 1) Raw parent-child associations are strongest for education, echoing previous findings. 2) Both maternal and paternal education, occupational prestige and income rank are strong predictors of the same outcomes in children, while only paternal wealth rank is a good predictor of child wealth rank. 3) Intergenerational correlations in SES indicators are found for both genetically related and unrelated parents and children, but they are, generally, substantially stronger when parents and children are more closely genetically related. 4) In the relatively egalitarian context of Norway, social mechanisms of transmission do appear to play a role in the transmission of educational attainment and occupational prestige, but this social transmission only accounts for around one fifth of the total transmission.

## 2. A brief overview of the extant literature on intergenerational transmission of socioeconomic status

### *2.1. Suggested theoretical mechanisms of the social transmission of status*

To what extent is equality of opportunity realised in western societies? The question lies at the core of social mobility research (Breen and Jonsson 2005). Empirical analyses typically proceed by examining how different indicators of socioeconomic status - e.g., categorical class positions, educational levels, occupational status, income and wealth - are correlated across generations (Erikson and Goldthorpe 2002). Generally, this approach finds that origins matter: parental SES predicts offspring SES.

Multiple mechanisms and factors have been proposed to explain this intergenerational transmission of SES, typically focusing on the social childrearing environment and the material and social resources that parents provide (Boudon 1974; Erikson et al. 2005; Stocké 2007; Roksa and Potter 2011). These factors include parenting styles, family resources, help with homework, parental involvement in school relations (Lareau 2011), financial and practical aid in education (Goldthorpe 1996; Raftery and Hout 1993), social closure and opportunity hoarding (Goldthorpe 2000), the direct transfer of economic capital (Hansen and Toft 2021), the accumulation of cultural capital through socialisation and the role of parental social capital (Bourdieu 1984, 1986), parental investments in children's early development and human capital (Becker and Tomes 1986; Heckman 2006), the role of schools and neighbourhoods (Massey 1990), rational action, differences in initial positions and relative risk aversion (Breen and Goldthorpe 1997; Goldthorpe 1996), and parents acting as a resource or role model (Helland and Wiborg 2019).

These factors, which have to do with what parents *have* and *do*, paint a picture of affluent well-educated parents doing what they can to advantage their children over others. In the words of Bukodi et al. (2020: 967): *"Advantaged families will seek always to use their superior resources—economic but also cultural and social—to the extent necessary in order to maintain their children's greater chances of success in educational systems and labor markets, relative to those of children from less advantaged class positions."*

This perspective is certainly plausible, and our expectation is that many of these mechanisms will contribute to the transmission of socioeconomic status across generations. Determining the net impact of such social environmental factors, however, requires a research design that can filter out the second main source of intergenerational transmission: the shared genetics of parents and their children. Several alternative approaches have been suggested to separate genetic and social transmissions or to at least remove genetic confounding when estimating social transmission effects. In what follows, we give a short overview of these potential methods as well as of the available research using each of these designs.

### *2.2. A review of research designs and findings*

The main problem with disentangling the role of social and genetic transmission of socioeconomic status is that they tend to operate simultaneously: parents transmit genes to their children, and typically also raise them and provide a home environment and neighbourhood. The net similarity generated by both the genetic and social transmission can be estimated using intergenerational correlations (Mastekaasa and Birkelund 2023), but this does not tell us the relative contribution of the two transmission channels. Identifying the separate impact of social and genetic transmission requires a source of identifying variation in the data. Put differently, we need to find situations where the two transmission channels will be blended in a different way so that we can see how this alters the net induced parent-child similarity. In large lines, previous research has used and built upon five different methods or empirical strategies to assess the pure social transmission while accounting for genetics: the Adoption design, the Multiple-Children-of-Twin design, the Nuclear Twin Family Design, the Instrumental Variable approach and the Polygenic Index control design.

The strengths and weaknesses of these designs as well as intergenerational correlations are shown in Table 1, while a more detailed discussion of each of the methods can be found in the Supplementary Materials part A. Our argument is that while all research designs discussed rely on assumptions that, if violated, may bias the results, they also rely on different assumptions and are sensitive to different sources of bias. Therefore, by triangulating methods and comparing their results, researchers can more critically assess the role of social factors in intergenerational socioeconomic reproduction.

The interpretation of results from these study designs differs. For intergenerational correlations, results should be interpreted as reflecting the *total transmission* of the given trait, encompassing both social and genetic, and causal and non-causal pathways. While researchers in practice often interpret these as estimates of social transmission, this would only be correct under the implausible assumption that there was no genetic confounding at all (Freese 2008). In the other presented designs, the goal is to avoid genetic confounding. Thus, conditional on idiosyncratic modelling assumptions, these estimates can be interpreted as the total *social transmission* of the given trait. However, only the IV design inherently addresses confounding from other family-level characteristics, which means that results from other designs cannot be interpreted as representing causal effects.

**Table 1.** Research designs and their strengths and weaknesses with regards to identifying the *social* transmission of SES

| **Method** | **Strategy for identification of social transmission** | **Critical assumptions for inference on social transmission**<br>**(bias as an estimate of social transmission if assumption is violated)** | **Internal validity and generalizability** |
|---|---|---|---|
| *Intergenerational correlations/ associations* | Compare parents and children | No genetic confounding<br>(Upwards bias)<br><br>No confounding from other parental/family characteristics<br>(Upwards bias)* | Low internal validity as estimate of social transmission<br><br>High generalizability as estimate of total transmission; low generalizability as estimate of social transmission |
| *Conditional intergenerational correlations* | Compare parents and children and control for observed potential confounders* | No genetic confounding<br>(Upwards bias)<br><br>No confounding from unobserved parental/family characteristics<br>(Upwards bias)* | Low internal validity as estimate of social transmission<br><br>High generalizability as estimate of total, conditional transmission; low generalizability as estimate of social transmission |
| **Adoption studies** | Compare adopted and non-adopted children to their parents | As-good-as-random adoption process; no correlation between characteristics of biological and adoptive parents<br>(Upwards bias)<br><br>Adopted and non-adopted siblings are treated similarly<br>(Likely upwards bias)<br><br>No confounding from unobserved parental/family characteristics<br>(Upwards bias)* | High internal validity as estimate of social transmission if assumptions hold.<br><br>Limited generalizability due to unrepresentative samples |
| **(Multiple) children of twins designs** | Compare children of MZ and DZ twins to their parents, uncles, aunts and cousins | No assortative mating - may be corrected for on observed characteristics<br>(Upwards bias)<br><br>Equal environments<br>(Downwards bias)<br><br>No non-additive genetic effects<br><br>No confounding from unobserved parental/family characteristics<br>(Upwards bias)* | Medium internal validity as estimate of social transmission due to potential assumptions violations (primarily NAM if not corrected, and EEA)<br><br>Medium generalizability as estimate of social transmission due to potential bias and unrepresentative samples |

| Method | Strategy for identification of social transmission | Critical assumptions for inference on social transmission<br>(bias as an estimate of social transmission if assumption is violated) | Internal validity and generalizability |
|---|---|---|---|
| Nuclear twin family design | Compare MZ and DZ twins to their parents and non-twin siblings | Equal environments<br>(Downwards bias)<br><br>Genetic influences are similar across generations<br><br>No confounding from unobserved parental/family characteristics<br>(Upwards bias)* | Medium internal validity as estimate of social transmission due to potential assumptions violations (EEA and constant genetic influences)<br><br>Medium generalizability as estimate of social transmission due to potential bias and unrepresentative samples |
| Instrumental variable designs | Exploit exogenously induced variation in parental characteristics, compare those affected by the instrument to those who are not | Instrument exogeneity/exclusion restriction<br><br>Instrument relevance<br>(Upwards bias)<br><br>Stable unit treatment value assumption (Downward bias) | High internal validity as an estimate of social transmission, if assumptions hold.<br><br>Limited generalizability due to unrepresentative samples/compliers |
| Polygenic index control designs | Compare parents and children, and control for children's polygenic indices (PGI) and observed potential confounders* | All relevant genetic confounding is captured by PGIs<br>(Upwards bias)<br><br>Requires unbiased SNP weights from relevant GWAS<br><br>No confounding from unobserved parental/family characteristics<br>(Upwards bias)* | Low internal validity as estimate of social transmission due to large measurement error in PGIs and unmeasured genetic variants.<br><br>Medium generalizability as estimate of social transmission due to potential bias |

* Such confounding is a problem if estimates are interpreted as representing the causal effect of the specific characteristic in parents, but not if they are interpreted as the total social intergenerational transmission, net of genetic confounding. This issue is therefore not relevant for Instrumental Variable designs, which explicitly address the endogeneity of the parental characteristic to estimate causal effects.

To provide an overview of the previous research using these different designs and hence on evidence on the social transmission of SES, we reviewed results from nearly 40 studies that measure intergenerational associations while attempting to account for the role of genetic transmission. This should not be considered a comprehensive systematic review, but provides an overview of the literature on social transmission effects: the strength of transmission and how it varies by SES indicator, context and methodological choices. Detailed results are given in the Supplementary Material section A.

Although direct comparisons between studies are difficult, some patterns become clear. Studies of the intergenerational transmission of years of schooling generally produce coefficients around 0.1 or less in Scandinavian contexts, with a few notable exceptions (for instance Suhonen and Karhunen 2019). This suggests that one year of additional schooling for the parent increases the schooling of the child by a tenth of a year. Estimates tend to be considerably larger in US samples. Several of the studies presented also include estimates based on raw intergenerational associations between parents' and children's outcomes that do not account for genetic influences (not shown). Such estimates are typically considerably larger, suggesting substantial genetic confounding of these associations. This is in line with findings in previous literature summaries (Holmlund, Lindahl, and Plug 2011; Mogstad and Torsvik 2023). PGI control studies have found limited evidence for genetic confounding, but it is worth reiterating that these studies come with important caveats, and may underplay the magnitude of genetic confounding (Zietsch et al. 2023). Figure 1 is a visual summary of parameter estimates for the social component of the intergenerational transmission of years of education by research design, illustrating the variation in estimates across designs and contexts.

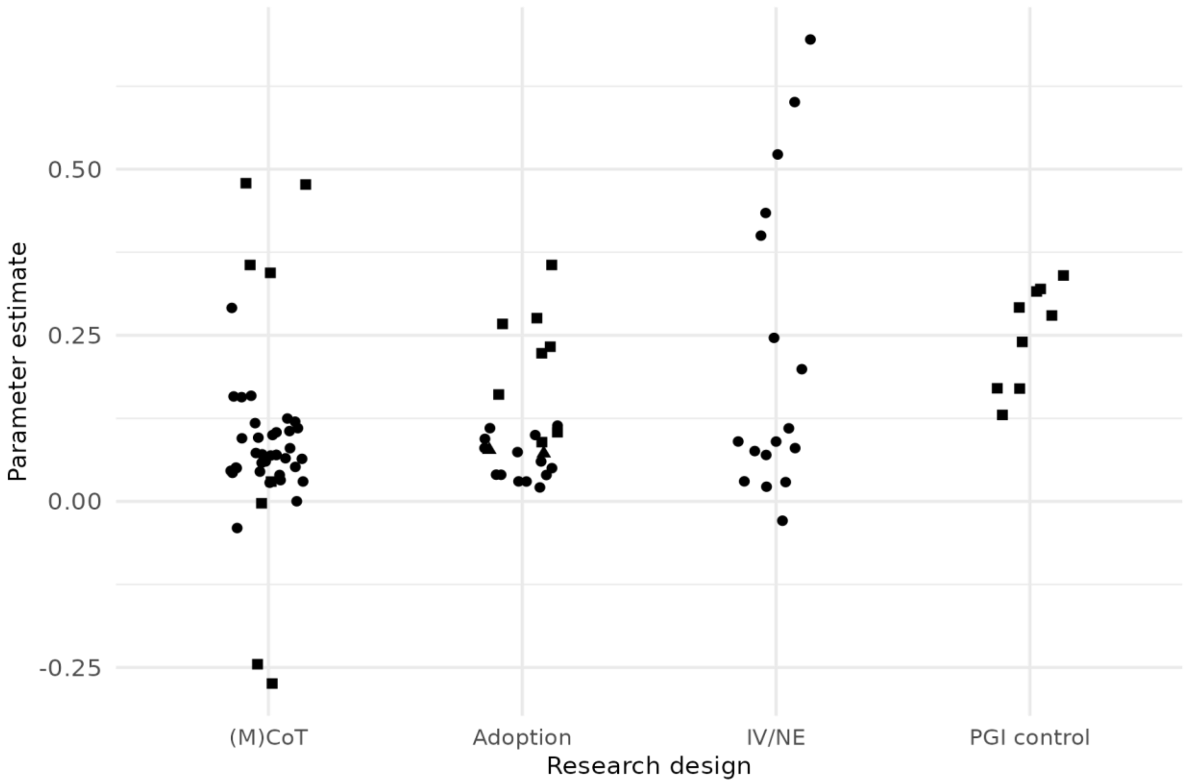


**Figure 1.** Parameter estimates from studies of the social component of intergenerational transmission of years of education across research designs and contexts (boxes indicate UK/North America, triangles Nordic, and circles other contexts).

However, based on this overview of the literature, we can see several important caveats that make consistent conclusions about the magnitude of social transmission difficult. First, there is a strong skewness towards analysing years of education as both the independent and dependent variable, making conclusions based on other SES dimensions such as occupational prestige or wealth tenuous. Second, most of the previous research uses a single method, which, combined with inconsistent samples, complicates the comparison of the magnitude of social transmissions across designs. In this way, we can say little about how the differing assumptions of each design might lead to differences in estimates. Third, previous studies have used different measures, definitions and scaling of the variables, limiting comparability across studies and SES indicators. In response to this, the current study expands previous research by making use of two distinct approaches to evaluate social transmission, namely the Adoption and the Multiple-Children-of-Twin design, across four main indicators of SES: education, occupational prestige, income and wealth. These two methods are chosen as they can be applied on the same cohorts on Norwegian register data, thereby facilitating comparisons across designs. We also provide standardised estimates to facilitate comparisons across measures.

## 3. Methods

Our study uses two separate research designs, adoptive families and Multiple Children-of-Twins. In the first, we break the relatedness link by using data on adopted children and their adoptive parents. In the second, we model the role of genetic relatedness using monozygotic and dizygotic twin pairs. The two approaches require different analysis samples, but both draw on the same administrative register data, ensuring consistency in the definition of socioeconomic position across the analyses.

### *3.1. Data*

We use data from the Norwegian Twin Registry (NTR) as well Norwegian administrative register data on loan from Statistics Norway, with individual level pseudonymous identifiers allowing for cross-file linkages. The administrative registers cover the whole population resident in Norway. From the administrative registers, we obtain demographic information, information on SES indicators, and parent-child links (Røed and Raaum 2003). NTR is a large twin panel study including a wide range of information on twin pairs born in Norway (Harris, Magnus, and Tambs 2002; Nilsen et al. 2013). From the NTR, we obtain demographic information on twin pairs and their zygosity.

### *3.2. Measures*

We assess four indicators of socioeconomic position, allowing us to explore differences in the strength of transmission across indicators (Strømme and Wiborg 2024): educational attainment, occupational prestige, and income and wealth rank.

To capture persistent differences in socioeconomic position, observed earnings, income, wealth and occupational prestige are averaged across an age range. Child outcomes are measured across all ages 30-45 present in the data. Parental outcomes are measured later in life, to correspond to the socioeconomic position attained at the time their children are potentially affected by social transmission. For earnings, income and education we use ages 45-60, while occupational prestige is measured across ages 50-65 as occupational codes are only available from 2003 onwards.

*Educational attainment* is measured using annual NUS2000 codes (Barrabés and Østli 2016), from which we extract the first digit to obtain educational levels. From this, we calculate the number of years of education required to complete the level attained and save the highest obtained years of education recorded within the target age range.

*Income rank* uses total income, defined as income from work, capital gains and transfers. Ranks are calculated within birth cohort, age and sex (using the full population as the base), and averaged across the target age range for each individual.

*Wealth ranks* use net wealth (gross wealth deducted by any debt) from tax records. Ranks are calculated within birth cohort, age and sex and averaged across the target age range for each individual.

*Occupational prestige* uses occupational ISCO88 codes, and assigns values (0-100) on the SIOPS scale (i.e. as "Treiman scores"). SIOPS is a validated and widely used score of occupational prestige in mobility research (Ganzeboom et al. 1991; Treiman 1970) based on international surveys on the perceived prestige of various professions.

### *3.3. Adoptee sample definition and research design*

The adoptee sample starts with the identification of adopted children from South Korea. Adoptees are identified from the population register as individuals born in the Republic of Korea (South Korea) with two Norwegian-born registered parents. The adoptees are further restricted to those born between 1965 and 1985, whom past research has shown to be quasi-randomly assigned to parents (Fagereng et al. 2021) - as required by our research design. More information on the reason for using South Korean adoptees and on the exact identification strategy of adoptees can be found in the Supplementary Materials (Section B).

The adoption design compares transmission between biological children and parents to that of adopted children and their adoptive parents, where there is no genetic material transmitted from parent to child. If adopted and biological children are equally similar to their parents, this would be strong evidence that intergenerational correlations primarily reflect social transmission. However, the adoption design does rely on assumptions such as conditional randomness of the adoption process, a similar treatment of adopted and biological children and the generalizability of results for adopted children to the general population. More details on this design and its assumptions can be found in Supplementary Material (see Section A).

To facilitate the comparison between adopted and biological children, we use a matching procedure on a random 5 percent sample of Norwegian-born individuals born to Norwegian-born parents in the years 1965-1985. The matching procedure uses a 1:1 nearest neighbour propensity matching without replacement, with a logistic regression of the treatment on various covariates. Based on this, 2152 adoptees and 2152 matched Norwegian-born children were retained in the analysis sample. Preliminary checks found the overall distributions of social positions of adoptees and Norwegian-born children to be similar, especially after matching, and hence suggest that we are comparing similar families. More information on the matching procedures and descriptive statistics for matched and unmatched samples can be found in the Supplementary Materials (Section C).

For each of the (adopted and biological) children in the adoptee sample we now have eight indicators of parental social position (four from each parent) and four indicators of the child's own social position. The intergenerational transmission is assessed using linear regression in R. This is done separately for each parental indicator (controlling for the SES indicator of the other parent to account for assortative mating) to each child indicator and separately for adoptees and biological children, resulting in 8 x 4 x 2 = 64 separate estimates.

### *3.4. Twin sample definition and Multiple-Children-of-Twins research design*

Twins are identified from the Norwegian Twin Registry, which is a national database that provides information on twin pairs and their zygosity. We limit the sample to twin pairs belonging to birth cohorts born between 1940 and 1960 ($N_{pedigrees}$ = 7023; $N_{observations}$ = 42867). These twin cohorts were also used in recent research on the intergenerational transmission of educational attainment (Baier et al. 2022).

Based on this sample, we apply a second research design: the Multiple-Children-of-Twins (MCoT) design (McAdams et al. 2018). This design builds on genetic similarity variances by comparing children of MZ twins who share 100% of their genetic material and children of dizygotic twins who are assumed to on average share 50% of their genes. It compares associations within a family defined as a twin pair, and their respective partners and children. The design allows us to directly estimate the *social* transmission of fathers' and mothers' SES measures to child outcomes. However, it does entail several assumptions as well, such as the equal environments assumptions, no assortative mating and no non-additive genetic effects. More information on this method and its assumption can be found in the Supplementary Material (section A).

The MCoT model is specified as a structural equation model with latent variables for sources of variance in the outcome variables (see section D of the Supplementary Materials for the path diagram). The models were estimated using the structural equation modelling package OpenMx in R (Neale et al. 2016). Estimates of the social transmission from mother and father are both estimated simultaneously, and the model was estimated 16 times (4 parental SES indicators x 4 child SES indicators).

### *3.5. Sensitivity analyses*

We also performed a number of additional analyses in order to gauge the sensitivity of our results (see Section G of the Supplementary Materials for details):

a) estimating intergenerational associations for adoptees and their non-adopted siblings in families with both adoptive and own-birth children,
b) using gross wealth rather than net wealth as the operational definition of wealth,
c) estimating models with only mothers or only fathers, and
d) estimating associations for adoptees in unmatched samples.
Overall, the results from these sensitivity analyses produce estimates that are consistent with our main results.

### *3.6. Availability of code and data for replication*

Data was made available under strict conditions that prohibit sharing, but all code used to produce the results in this study will be made available in an online repository at time of publication (at the latest). Researchers may apply to Statistics Norway and the Norwegian Institute of Public Health for access to linked data identical to those we received.

## 4. Results

This section is organised by research design. We first present results obtained from the adoptive family design, and then present results obtained from the MCoT design. We only present the main results from each design in plots showing estimates from different models, with child SES indicators (the dependent variables) as headings. Numerical results in tabular form for the displayed plots and results for alternative outcome definitions and model specifications are available in the Supplementary Materials (Sections E and F). Finally, we summarise our results across designs, outcomes and predictors.

### *4.1. Estimates from analyses of adoptive families*

Results from the 16 regressions on the adoptee sample and corresponding regressions for the Norwegian own-birth sample are shown in Figure 2 (see Section E in the Supplementary Material for a tabular version of the main results). Estimates express the expected difference (in standard deviation units) of two children on some indicator Y of social position when their mother or father differs by 1 standard deviation on some indicator X.

Overall, the estimates find substantially stronger parent-child associations for Norwegian-born matched children than for adoptees, with estimates for adoptees often about half as large. Substantial differences are discernible across SES indicators, reinforcing the point that multiple measures are required to understand intergenerational transmission. Social origins seem to matter relatively little for income and wealth, as most coefficients are not significantly different from zero for adoptees. There is an exception of direct transfers: models of fathers' wealth and child wealth yield somewhat stronger estimates. Yet for education and occupational prestige, there is important intergenerational transmission also for adoptees, which runs purely through social mechanisms. Last, father's SES appears to matter somewhat more than the mother's SES for educational attainment. All in all, these findings are in line with previous studies finding intergenerational associations to be stronger for non-adopted children (cf. Supplementary Materials, Section A).

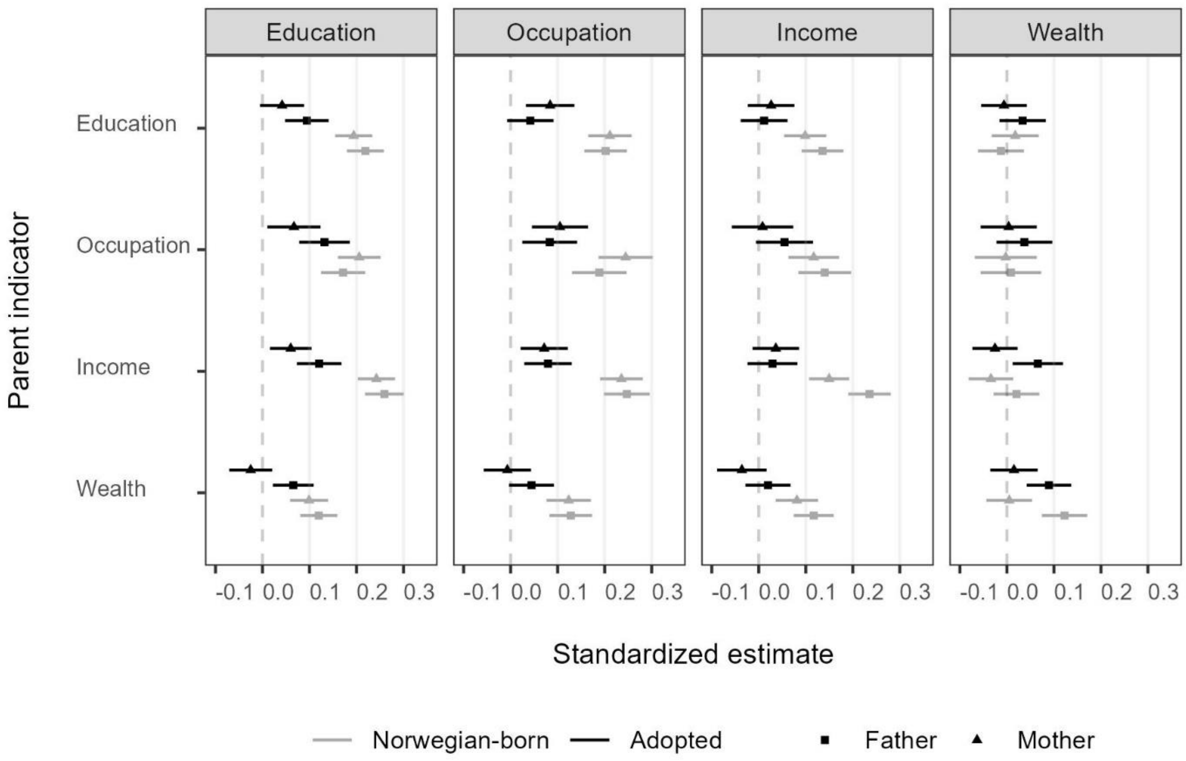


**Figure 2.** Forest plot of estimates of standardised regression coefficients for the intergenerational transmission of status for adoptees and Norwegian-born children from 16 model specifications each (with clustered standard errors by family identifier to account for siblings in the data).

### *4.2. Estimates from Multiple-Children-of-Twins analyses*

Figure 3 shows a similar set of results from estimations of parameters in the MCoT design. Full numerical results are available in the Supplementary Materials, section F. We focus on the path coefficients for the paternal (p) and maternal (m) status indicator on the latent factor representing shared environmental influences on the family's children (denoted F component in the path model, cf. Supplementary Materials section D). As can be seen from the panel, nine of the coefficients have confidence intervals overlapping with 0. The largest coefficients are generally seen for models where the outcome is a child's educational attainment or occupational prestige. Estimates are generally lower for models of wealth rank and income rank. There is also a weak tendency for higher coefficients when outcomes and predictors measure the same SES dimension.

These path coefficients are not directly comparable to standardised coefficients obtained in the adoptees analysis, as the path coefficients in the MCoT design were modelled to affect the amount of variance in a variance component and not the outcome directly. Yet, the results are substantively very similar as those obtained from the sample of adoptees.

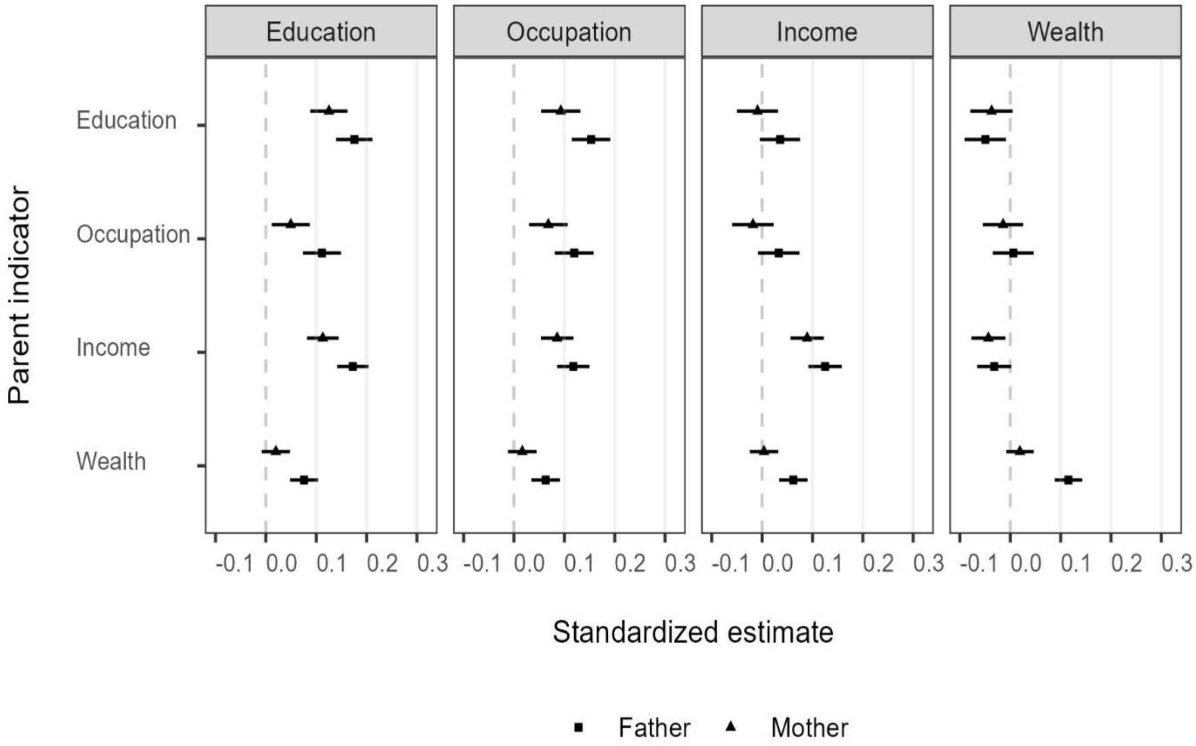


**Figure 3.** Forest plot of estimates of standardised coefficients for the intergenerational transmission of SES for mothers and fathers from 16 Multiple-Children-of-Twins models. Coefficients shown are *m* and *p* coefficients in the MCoT path diagram (cf. Supplementary Materials part D).

### *4.3. How much of intergenerational transmission is social? A comparison of methods*

A question that remains is how much the social transmission - what parents have and do - contributes to the overall intergenerational transmission. To answer this and to meaningfully synthesise results obtained with two different research designs and from 48 different models, we can compare how much of the variation in the outcomes are explained by the relevant predictors. In the models of adoptees and Norwegian-born children, the statistic of interest would be the $R^2$ from each model. In the MCoT results, the relevant statistic is the relative variance component for the shared family environment in the offspring generation (denoted F in the path model). These estimates are comparable to the readily available $R^2$ values from OLS models. Total transmission – both genetic and social components – would then best be represented by the $R^2$ for the Norwegian-born children, while $R^2$ values obtained from adoptees and MCoT models would represent estimates of social transmission for the otherwise corresponding model. Figure 4 plots estimated levels of social transmission against levels of total transmission by design and outcome. The black line reflects a scenario where the variance explained by social transmission is 100 percent of the total variance explained by transmission, while the red lines reflect the average explained variance by social origins relative to the full explained variance for both designs together (solid) as well as separate (dashed and dotted). The greyed-out area represents the unrealistic scenario where social transmission is stronger than total transmission.

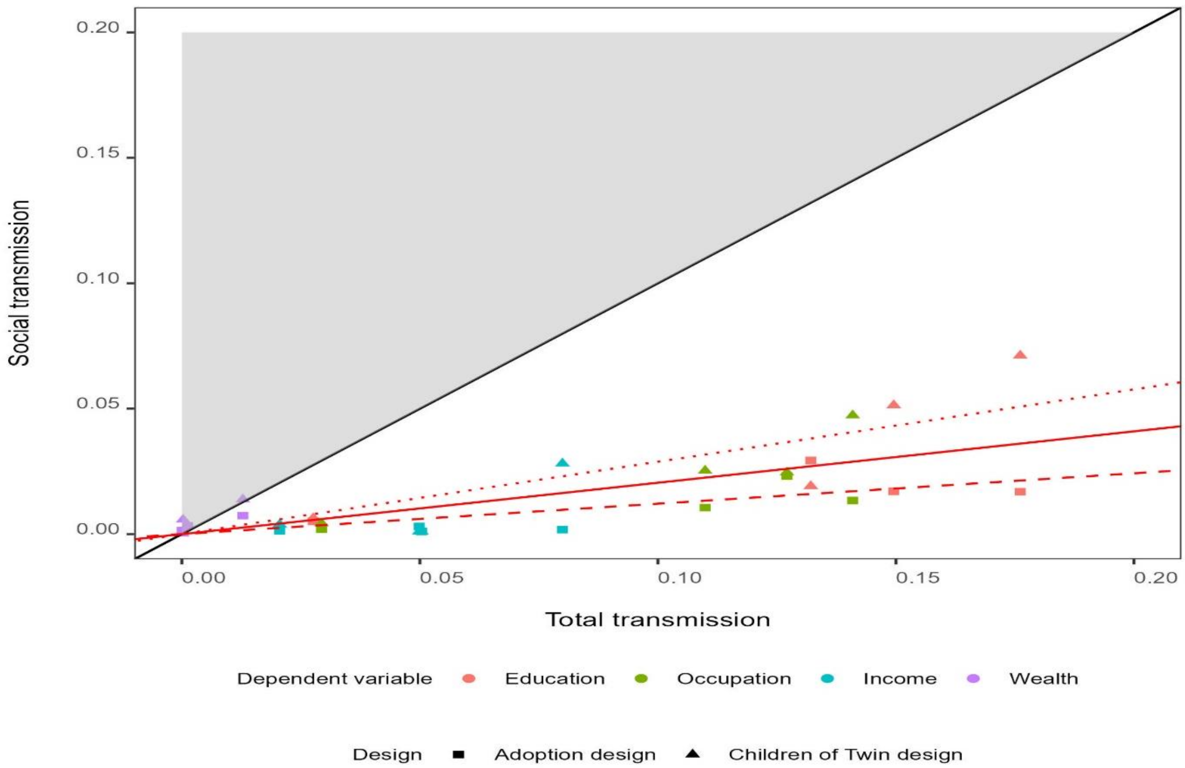


**Figure 4.** Explained variance from OLS models on adoptees and Norwegian-born and shared family environment variance component (F) from MCoT models. The solid red line represents the linear trend in social transmission as a function of total transmission. The other red lines represent the results separately for the adoption (dashed) and MCoT (dotted) design. The greyed-out area represents unrealistic scenarios where social transmission is stronger than total transmission.

From Figure 4 we can isolate several key patterns in the intergenerational transmission of socioeconomic status. Firstly, the social transmission is significantly lower than total transmission, as all points lie below the solid black line. Secondly, social origins contribute about 20 percent to the overall transmission of socioeconomic outcomes, as indicated by the solid red line, which represents the average level of social transmission given total transmission. This suggests that social factors play a substantial, albeit partial, role in intergenerational processes. Lastly, there is marked variation in social transmission of socioeconomic status across outcomes and predictors. Explained variances are generally lowest for models where income or especially wealth is the outcome variable, and highest for models where education or occupational prestige is the outcome variable. Comparing designs, we can see that explained variances by social origins are on average systematically lowest for the adoption design (dashed red line) and slightly higher for the Multiple-Children-of-Twin design (dotted red line).

### *4.4. Sensitivity analyses*

All results from our sensitivity analyses are reported in Section G of the Supplementary Materials. First, we compared the results for adoptees to the transmission for their Norwegian-born siblings, for the subsample of adoptive families that also have own-birth children (cf Figure S5). Coefficients for adoptees were slightly higher in these analyses. The presence of own-birth siblings in the family could contribute to between-sibling interaction effects, leading to similarity of adoptees and siblings and in turn more similarity with the parents as has been alluded to in the literature (Nielsen 2006; Wolfram and Morris 2023). The coefficients for Norwegian-born siblings were nevertheless larger than those for adoptees. Sample sizes are smaller and statistical uncertainty is greater for these analyses.

Second, we conducted the main analyses with a measure of gross wealth rather than net wealth (see Figures S6 and S7 in the Supplementary Material). The results highlight that intergenerational transmission is substantially larger when using gross wealth measures. Both for the adoption and MCoT analysis, there are quite substantial impacts of social origins in explaining gross wealth measures. However, this is mainly observable from parental wealth to child wealth and less so for parental education for instance. We also see that for the MCoT analyses, many of the estimates for gross wealth are substantially more uncertain with large confidence intervals.

Third, we run the models with the status of mothers and fathers separately instead of including both in the same regression model (see Figures S8 and S9 in Supplementary Material). While the results are very similar in terms of the differences between adoptees and Norwegian-born children, the estimates are larger for each parent in these models compared to when we control for the status of both parents. Assortative mating and partner effects make parents similar to each other, which hence makes their socioeconomic status indicators correlated.

Finally, we conduct the adoption analysis with unmatched samples (see Figure S10). Only the Norwegian-born sample is different here, as the adoptees are the same before and after matching. The results were substantively very similar to reported results, but with smaller confidence intervals for the Norwegian-born children, as the sample sizes are much larger.

## 5. Discussion and Conclusion

The main finding of this study is the significant intergenerational reproduction of socioeconomic status (SES), with social origins playing a moderate role in this transmission. Genetic relatedness is likely an important confounder in the social transmission of SES indicators. Our results are specific to the cohorts reaching adulthood in the last decades of the 20th Century in Norway, a wealthy social-democratic welfare state where education is free and accessible, social benefits are many, and inequality is generally lower than in many other contexts.

We observe the strongest social transmission for educational attainment and occupational prestige, while the influence of social origins is weaker for economic outcomes like income and wealth, with the exception of paternal wealth and child wealth. Wealth can be directly transferred from parents to children, and in vivo transfers and bequests are crucial for intergenerational social reproduction (Adermon et al. 2018; Hansen 2014). Our estimates of social transmission were larger using a Multiple Children of Twins (MCoT) design compared to an adoption design, though both designs produced substantively compatible results. Accounting for genetic confounding yielded smaller estimates of intergenerational transmission of SES, with coefficient sizes around 0.1 for education, consistent with previous Scandinavian studies (cf. Supplementary Materials part A).

Triangulating different methods, our results indicate that genetics are important to consider when estimating the role of social environments. This is crucial for understanding how inequalities are reproduced and why advantages and disadvantages are transmitted across generations. Assuming that intergenerational correlations are entirely due to social origins markedly overestimates the impact of rearing environments on children's outcomes, as illustrated by contrasting the estimates for Norwegian-born children and adoptees. While genetics interact with social environments, they should be taken seriously as a separate and confounding source of variation.

Our study has several implications for theory and empirical research on intergenerational mobility and social reproduction. First, for important SES indicators, intergenerational persistence involves both social and genetic mechanisms. Theoretical explanations for intergenerational associations in socioeconomic outcomes should incorporate both genetic and social origins and study these forces of inequality in interaction with each other. Second, empirical studies assessing the social mechanisms of intergenerational reproduction should account for genetic confounding, also in comparative research. Robust comparisons of intergenerational correlations and social mobility measures require acknowledging the alloy of social and genetic transmission or methodologically robust comparisons of actual social or genetic main transmission effects. Third, most variance in outcomes remains unexplained in our models, indicating that genetic and social origins do not have any kind of deterministic influence on socioeconomic attainment. Future research should prioritise exploring factors unrelated to the family of origin that matter for SES outcomes (Sauder 2020).

It is important to consider that our study was conducted in Norway, a Nordic welfare state with policies designed to reduce social inequalities, such as free or affordable education and healthcare, extensive welfare benefits, and progressive taxation. Intergenerational transmission is generally lower in the Nordics compared to other regions (Hertz et al. 2008). This makes our case particularly interesting, offering results close to a "lower bound" for social origin effects, but also less generalizable to other contexts. In less egalitarian, more market-oriented political economies, social origins may play a more significant role (Björklund and Salvanes 2011; Engzell and Tropf 2019; Holmlund et al. 2011).

Our analysis involves designs with different assumptions that produced similar substantive results. However, limitations should be considered when assessing these results. Neither adoptees nor the included twin families are fully representative of the general population, limiting the generalizability of the findings. The adoption design used matched samples to increase comparability to the reference group, but differences may remain in parenting styles or parental involvement between adoptive and non-adoptive families. Adoptees may have experienced adverse early childhood environments or face differential treatment, discrimination, prejudice, and institutional barriers, limiting their ability to achieve higher SES despite abundant parental resources. The Multiple Children of Twins Design relies on several identifying assumptions, such as the Equal Environment Assumption, which could potentially underestimate the role of social origins. Our analysis focuses on the independent role – the "main effect" – of social origins, paying little attention to gene-environment interactions. We encourage researchers to consider these drawbacks in future work.

Finally, we stress that a genetically rooted component to the intergenerational reproduction of SES does not imply that social inequalities are 'fair' or that policies cannot mitigate the impact of family background (Harden 2021; Swift 2004). Many policies can effectively reduce inequalities and level the playing field for children from different socioeconomic backgrounds (Björklund and Salvanes 2011). A proper understanding of intergenerational transmission requires integrating knowledge about how socioeconomic outcomes are influenced by both the DNA inherited from parents, the social practices of those parents, the environments in which the children grow up and live their lives, and the resources at the disposal of both generations. Integrating these elements is a major challenge for sociology and other social sciences.

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