# Heritability of class:

# Implications for theory and research on social mobility

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**Abstract**

Most individual-level outcomes of interest to sociologists are influenced by genetics. Yet, we know very little about how much genetics contribute to the attainment of class positions; which is central to stratification and mobility research. We estimate how much variation in class positions can be attributed to genetic and environmental factors in roughly 5000 Norwegian twin pairs. We show that class attainment is strongly influenced by genetics. Shared environmental factors play a modest role. Our study suggests that sociological theories explaining class outcomes in terms of social origins have little explanatory power, and should be reformulated to consider genetics.

**Key words:** Class; Heritability; Social mobility; Sociogenomics; Twin study

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**Data access and replication:** Norwegian privacy regulations limit our ability to share our register data. Individual researchers may apply to obtain permissions and subsequently access the data. We can provide guidance on how to request access to these data. The scripts for the data preparation and analyses can be found on the Github page of the lead author: https://github.com/arnovanhootegem/heritabilityofclass

## 1. Introduction

Systematic similarities in socioeconomic outcomes between parents and their children, and between siblings, come from two broad types of sources: environmental and genetic. The role of genetics is well-established for educational attainment, and to some extent for income and wealth. However, the role of genetic influences in the attainment of occupations or class positions has largely been overlooked in both sociological stratification research and behavioral genetics.

Both additive genetics and environmental influences shared by siblings explain a substantial share of the variation in educational outcomes (Heath et al. 1985; Lichtenstein et al. 1992; Branigan et al. 2013; Amin et al. 2015; Nielsen and Roos 2015; Engzell and Tropf 2019; Harden 2021; Baier et al. 2022a). For wealth, shared environmental influences appear to play a more important role than genetics (Black et al. 2020; Fagereng et al. 2021), while for income and earnings genetic influences are on par with those found for education or stronger (Hyytinen et al. 2019; Erola et al. 2022) though some studies also find that the home environment plays an important role (Bowles and Gintis 2002). Class and related labor market outcomes are central to sociological theories of social mobility and are arguably the most important link between educational attainment and economic outcomes. Despite this, we know very little about the extent to which they are influenced by genetics. A better understanding of the role of genetics in class attainment will inform theory and research on social mobility, and may have important theoretical and policy implications.

Two research literatures have largely existed in parallel, despite being concerned with different aspects of the same question; why do people's socioeconomic outcomes resemble those of their parents and siblings? The first is the sociological literature on occupation-based class mobility, or social mobility. This rich research tradition has produced many important empirical and theoretical contributions to understanding social stratification and intergenerational persistence in social positions (a few notable examples: Breen 2004; Erikson and Goldthorpe, 1992; Wright, 2005). Characteristic of this research tradition is the use of theoretically informed, occupation-based, categorical class schemes to study intergenerational mobility and persistence in class attainment (Wright 2000). The other literature links genetics to socioeconomic outcomes. This research, originating in behavior genetics, is focused on conventional measures of education, income, and wealth as indicators of social advantages and disadvantages. Using twin and family designs and, more recently, measured genotype data, researchers have produced important findings on the role of genetics for socioeconomic outcomes (Mills and Tropf 2020; Harden 2021). However, with a few notable exceptions (Lichtenstein et al. 1992; Belsky et al. 2018), this literature has not paid much attention to certain aspects of socioeconomic outcomes that are central to sociology, namely occupational status and class.

There are several reasons why these two research traditions have not interacted. First, the sociological research tradition on class mobility is based on a set of theories and theoretical traditions attempting to explain, first, how social hierarchies are structured in terms of social classes, and second, how social origins affect individuals' chances of attaining different class positions. As we describe below, these theoretical traditions have almost exclusively focused on social or shared environmental factors in explaining intergenerational persistence. They have paid little attention to the possibility of genetics playing a central role (Freese 2008). Second, geneticists have also not been particularly concerned with sociological theories or operationalizations of class or sociological explanations for intergenerational persistence (Mills and Tropf 2020), but have used other indicators of socioeconomic status that are more compatible with the conventional twin model framework.

Our study is, to the best of our knowledge, the first to estimate the heritability of class attainment, based on the definitions and theoretical conceptualizations of class that are central to sociological mobility research. In the following, we begin by outlining central sociological theories on class mobility, emphasizing the social mechanisms they postulate as important for intergenerational persistence in class positions. We then estimate a range of behavioral genetic models on class attainment data for more than 5000 Norwegian twin pairs, using adaptations of the classical twin study design for categorical outcomes. This allow us to decompose the variation in class outcomes into components that can be attributed to additive genetics, environmental influences shared by twins, including their social origins, and environmental influences not shared by twins. We end with a discussion of the implications of our findings for sociological theory and research, and for policy.

## 2. Theories of class mobility and persistence

We aim to provide overall estimates of the heritability of class as it is commonly conceptualized in sociological mobility research – a research tradition characterized by a wide heterogeneity of operationalizations. Sociological class schemes are all based on different theoretical understandings of what 'class' is and how inequalities are reproduced across generations[1]. We employ three different class schemes and a scale of occupational prestige in our analyses. It is valuable to include a variety of class schemes in order to provide estimates that are robust, to assess whether they are sensitive to the specific empirical operationalization of class, and to

[1] These understandings roughly sort into four main research traditions that progressively emphasize a wider array of explanations for inequalities and intergenerational persistence in social positions (Wright 2015). The 'status attainment' tradition focuses on the impact of individual-level characteristics. The 'neo-Weberian' tradition additionally emphasizes mechanisms of closure, exclusion and opportunity hoarding. The 'neo-Marxist' tradition additionally emphasizes dominance and exploitation. The 'Bourdieusian' tradition can be seen as a fourth tradition, that also emphasizes cultural dominance and symbolic violence.

consider the differences and similarities between them. The ability to include multiple measures of class and status is an important strength of this paper.

The motivation for including these specific operationalizations of class and status is that the Neo-Weberian, Bourdieusian and gradational (prestige score) traditions are all central to sociological studies of social mobility[2]. Further, the class scheme by Oesch represents a new and modernized approach to class that is valuable to include. The use of prestige scores additionally allows us to employ a classical twin study design with a metric outcome variable to test if our results are sensitive to studying ordinal or categorical outcomes. Focusing on each of these class schemes recognizes the heterogeneity of approaches within social mobility research and allows us to incorporate various sociological traditions into social genetics research.

### *2.1. Neo-Weberian theory and the Erikson-Goldthorpe-Portocarero (EGP) scheme*

The class scheme developed by Erikson, Goldthorpe, and Portocarero (1979; EGP) has widely been used as the *de facto* international standard for social mobility research. The theoretical framework it is based on has been developed and elaborated by John H. Golthorpe and colleagues over several decades (Erikson and Goldthorpe 1992; Goldthorpe 1996, 2000; Breen 2005; Erikson et al. 2005; Bukodi and Goldthorpe 2022). It emphasizes the labor market, the employment contract, and the concept of 'life chances' as central to the concept of class. An individual's life chances; their chances of attaining specific class positions, are assumed to be strongly affected by individual-level characteristics such as skills, training and education that

[2] We intended to also include the neo-Marxist theories and class scheme developed by Erik Olin Wright in our analyses, but the scheme was unfortunately not possible to reproduce with our register data.

are valued in the labor market, but also by mechanisms of rational action, social closure, exclusion and opportunity hoarding by upper-class families.

The core idea behind the scheme is that class positions are defined by their employment contract. Class is seen primarily as an economic category, and access to class positions depends on one's position in the labor market. For positions requiring highly valued skills, employers will find it difficult to monitor employees' work output, and they are also incentivized to keep individuals employed within these positions. The resulting work relationship takes the form of a service relationship, where high salaries, flexibility, retirement plans, health benefits, opportunities for career advancement, stock options and other types of benefits are used to incentivize loyalty and work effort. In the opposite end of the spectrum are positions requiring low and/or unspecific human assets, where the work relationship takes the form of labor contracts, defined by wages directly related to the work output, low autonomy and a high degree of monitoring (Goldthorpe 2000; Breen 2005). The resulting class scheme, shown in Figure A1 in the Online Appendix, comes in different versions with different aggregations, ranging anywhere from 3 to 11 classes (Erikson and Goldthorpe 1992: Chapter 2). While not all classes are intended to be hierarchically ordered, there is a clear hierarchy in the structure of the scheme (Breen and Whelan 1985).

This tradition emphasizes several important mechanisms generating intergenerational class mobility and persistence. First, the approach is based on rational action theory. Individuals (and families) are assumed to primarily attempt to avoid downward social mobility and to, secondarily, attain (or have their children attain) a higher class position than their origins. Second, educational attainment is affected by class origins through two pathways; primary and secondary effects. Primary effects are effects of the home environment, childrearing practices, family resources, help with homework etc. on individual ability and school performance. Secondary effects are the effects of class origins on educational attainment that are net of ability and school performance. Such differences may be due to differences in absolute or relative aspirations, but may also be due to structural obstacles and differences in family resources; direct costs, indirect costs and opportunity costs of education may be prohibitive for those from lower social origins (Goldthorpe 1996, 2000; Erikson et al. 2005; Jackson et al. 2007; Karlson and Holm 2011). Third, individuals in advantaged class positions are assumed to employ strategies of social closure and opportunity hoarding, such as licensing and credentialization, to protect their privileged positions and ensuring that upward social mobility is more difficult for those from lower origins (Goldthorpe 2000).

### *2.2. Bourdieusian theory and the Oslo Register Data Class Scheme (ORDC)*

The works of Pierre Bourdieu emphasize both the economic, cultural and symbolic aspects of class, and their importance for social mobility and reproduction. In his work, Bourdieu envisioned different forms of capital as constitutive of class (Bourdieu 1984). Most relevant for the present purposes are economic, cultural and social capital (Bourdieu 1986). Economic capital simply refers to economic assets (money, land, property, stocks etc.), while social capital can be understood as the resources of one's social network (friendships, family ties acquaintances etc.). Cultural capital can exist in three forms (Bourdieu 1986); as the possession of cultural objects and goods (objectified form); as academic qualifications and documented skills and knowledge (institutionalized form); or as familiarity with and mastery of the dominant culture in society and modes of speaking and acting that signal such distinction (embodied form).

These forms of capital all function to maintain intergenerational social reproduction and they are seen as central to understanding why privileged class positions are transmitted across generations. In addition to economic capital, cultural capital in its embodied and institutionalized forms are often seen to play particularly important roles in social reproduction. Internalizing and displaying an affinity with the dominant culture is assumed to convey many advantages in education and social relations, and parents with more cultural capital are assumed to aid and encourage their children to do well in school and achieve higher education, thus increasing both their aspirations and chances of success (Lareau 1987; Lareau and Weininger 2003; Hansen 2011; Andersen and Hansen 2012).

According to Bourdieu, the class structure can, in simplified terms, be seen as structured according to two main dimensions; the total volume of capital, and the relative balance of economic versus cultural capital (Bourdieu 1984). This conceptualization has been used to generate categorical class schemes. One prominent example of this, conveniently designed specifically for use with Norwegian register data, is the Oslo Register Data Class Scheme, developed by Hansen et al. (2009). This scheme (cf. Figure A2 in the Online Appendix) distinguishes between 13 classes, and three class fractions for the upper and middle classes; a cultural fraction characterized by a dominance of cultural capital, an economic fraction characterized by a dominance of economic capital, and a balanced fraction. The cultural and balanced fractions are distinguished and stratified based on occupational codes, while the economic fraction is stratified internally, based on relative incomes. A class of welfare dependents are defined by their recipiency of welfare benefits.

### *2.3. Horizontal work logics and the Oesch class scheme*

The class scheme developed by Daniel Oesch (2006) represents an attempt to redraw the class structure in light of recent structural changes in the labor market, building on the work of Goldthorpe, Wright, Bourdieu, Esping-Andersen and others. The most important changes addressed by Oesch are feminization (increased participation of women in paid employment), tertiarization (expansion of the service sector at the expense of manufacturing) and educational upgrading (rising levels of general and vocational education). Oesch employs a pragmatic approach to class by avoiding a theoretically overloaded class concept and conceptualizes class as a more or less purely economic category, as opposed to a concept that assumes classes are, or may form, social or political groups (Oesch 2006: Chapter 1).

In this class scheme, classes are comprised of positions that share a similar hierarchical position and relation to the labor market (owners/self-employed vs employees) and marketable skills (primarily educational attainment and expertise), but the classes are also horizontally differentiated into positions that share a similar 'work logic', referring to qualitative aspects of the work experience. Oesch differentiates between four work logics. The 'independent work logic' captures the divide between owners/self-employed and employees, while the 'technical', 'organizational' and 'interpersonal service' work logics delineate between occupations primarily based on skills and expertise, organizational authority and command structures, and interpersonal, face-to face-interactions, respectively (Oesch 2006: Chapter 5).

This horizontal differentiation is meant to capture qualitative aspects of work that are salient from the point of view of the employee and may be central to understanding political cleavages within the middle classes. It also entails abandoning the strict divide between the manual and non-manual classes. The resulting class scheme (shown in Figure A3 in the Online Appendix) consists of 16 classes categorized by occupational codes, that may be collapsed into an 8-class version. Oesch does not go into great detail in elaborating what mechanisms are central to social reproduction in this theoretical framework but emphasizes the social origins gradient in educational attainment and cumulative disadvantages in further career development (p. 213). In addition, he argues that current divides in social mobility are a function of changing labor market structures at the macro-level, whereby people in menial jobs have declining prospects for mobility in a knowledge economy, while high-skilled and educated individuals have larger opportunities for upward class movements (Oesch 2015).

### *2.4. Gradational approaches and the Standard International Occupational Prestige Score (SIOPS)*

The SIOPS scale (Treiman 1977) is a measure of occupational prestige, rather than class, as it is commonly conceptualized in sociology. This gradational scale was developed by using international surveys asking people to assign prestige scores to different occupations. The result is a metric measure of occupational prestige meant to capture the hierarchical ordering of occupations. This scale has been shown to be relatively stable across contexts and over time, and has been widely used in social mobility research, particularly in comparative studies (Treiman 1970; Treiman and Terrell 1975; Ganzeboom et al. 1991).

While this scale is not explicitly tied to a specific theory of what mechanisms produce intergenerational persistence, it is often associated with the 'status attainment' tradition in sociology, and often applied in conjunction with references to industrialization theory. This theoretical framework states that industrial development should bring about a shift from ascription to achievement as the most salient forces in attainment of socioeconomic positions. The result is that education should play an increasingly important role as a mediator between social origins and destinations, while the direct effect of social origins should diminish over time (Ganzeboom et al. 1991; Pfeffer and Hertel 2015).

Unlike conventional class schemes, metric measures of occupation-based socioeconomic outcomes have been employed to study heritability previously. Though the scales may not be identical to SIOPS, such scales are often strongly correlated (Ganzeboom et al. 1992).

Lichtenstein et al. (1992) found substantial influences of both additive genetics and shared environments on socioeconomic index scores, but also notable gender differences, where genetics was more important for males and in later cohorts. Using a similar index, Belsky et al. (2018) found polygenic scores for education to be positively related to both socioeconomic index scores and upward mobility. Erola et al. (2022) found additive genetics to play a major role, and shared environments to matter very little for socioeconomic index scores in Finland.

## 3. Should we expect class positions to be heritable?

While they emphasize different factors (closure and exclusion, rational action, forms of capital, education, prestige etc.), all the above-mentioned sociological theories strongly emphasize the role of social mechanisms in intergenerational reproduction[3], perhaps except for SIOPS, which is not tied to a specific theory of social reproduction. Broadly speaking, these theories have not considered genetics as a relevant factor, and studies employing these theories generally do not take the potential role of genetics into account (Freese 2008). Nor do these theories give any reason to assume that same-sex monozygotic twins should be more similar in terms of their class outcomes than dizygotic twins, aside from reasons related to direct inheritance (as in the case of the first-born child inheriting a farm) or chance. Goldthorpe and colleagues have discussed the potential role of genetics for intergenerational persistence in class positions. While emphasizing the potential relevance of genetic heritability for primary effects in education (Jackson et al. 2007), their conclusions have been dismissive with regards to its relevance for class attainment, based on a critique of the equal environments assumption and the generalizability of twin study estimates (Erikson and Goldthorpe 2002). In recent work updating and re-formulating their theoretical framework on class mobility, Bukodi and

[3] The same can be said for the neo-Marxist theories of Wright.

Goldthorpe (2022), do not mention the potential role of genetics at all. As such, based on these theories, we should expect shared environmental influences (C) to explain a substantial share of variation in class outcomes, and additive genetics (A) to matter very little, if at all.

When discussing whether 'class' is heritable, heritability does not mean that there are specific genes or combinations of genes that directly or deterministically cause people to attain different class positions. There is no 'lower middle-class gene', 'white collar gene' or 'secondary school teacher gene'. Instead, individual-level traits that affect people's opportunities, advantages and disadvantages in education and the labor market, or lead people to hold different preferences or make different choices, may in part be affected by their genetics. As a result, we can attempt to estimate how much of the variation in such outcomes can be ascribed to genetics. Genetic heritability may be relevant for class attainment through several of the mechanisms described by the abovementioned theories, such as by affecting educational attainment (Branigan et al. 2013), through factors affecting abilities and test performance (Baier et al. 2022b), by influencing cultural tastes and cultural consumption (Jæger and Møllegaard 2022), and more. But genetic heritability may be relevant for class attainment through mechanisms that these theories do not emphasize, including job preferences, dispositions and personality traits (Keller et al. 1992; Vukasović and Bratko 2015), mental health (Gatt et al. 2014), physical health (Steenstrup et al. 2013) and other physical characteristics (Zempo et al. 2017). Even physical appearance might affect labor market outcomes and thus class attainment (Mobius and Rosenblat 2006), including racialized phenotypical traits that may make individuals victims of racial or ethnic discrimination in the labor market (Bowles and Gintis 2002; Quillian and Midtbøen 2021). As the latter example illustrates, high heritability of socioeconomic outcomes does not imply that inequalities are inevitable, immutable, or fair. The relationship between genetics and socioeconomic outcomes is always contextual, and depends heavily on what traits are rewarded and penalized in a given society, at a given point in time (Harden 2021).

In sum, we expect to find that class positions are at least to some extent influenced by genetics. But how much? The heritability of education has frequently been estimated to be somewhere in the range of 20 to 60 %, depending on the data source and context. Recent evidence from Norway suggests a relatively high heritability component here (Baier et al. 2022a). But heritable characteristics may affect people's class attainment through other pathways besides education, which might produce a higher heritability of class outcomes than what is commonly found for education. On the other hand, post-educational socioeconomic outcomes may have a lower heritability (Black et al. 2020; Fagereng et al. 2021), possibly because children from upper-class families may use their family resources to find other ways to succeed in the labor market, if they do not succeed in education. We also add that individual choices, idiosyncrasies, randomness and path dependency in education and the labor market may lead very similar people to end up in different jobs. Such jobs may be similar in terms of wages, prestige or other characteristics, yet be categorized as belonging to different discrete classes. This leads to the potential of a relatively high E-component and deflated A- and C-components when studying discrete class outcomes.

## 4. Data and methods

### *4.1. Data*

Two separate data sources are used to answer our central research questions. To begin with, data from the Norwegian Twin Register (NTR) is used to identify twin pairs and hence determine heritability estimates. The NTR includes a total of 47989 twins born in the years 1895-1960 and 1967-1979, who are above 18 years of age and who have consented to being included in the registry (Nilsen et al. 2013). For 14692 twin pairs and hence 29384 individual twins, information is available on zygosity, which makes them eligible for classical twin studies

(Nilsen et al. 2016). Zygosity indicates whether twins are monozygotic (identical) and hence share 100 percent of genetic material or whether they are dizygotic (fraternal), which implies that siblings are (on average) 50 percent genetically similar. In our study, we restrict the sample to same-sex twins born between 1941 and 1979. This is because we have data on occupations from between 2003 and 2017, which for the oldest individuals would render the occupation at age 62 (the earliest age of old-age retirement).

The second data source is administrative register data from Norway, which can be linked to the NTR through a unique personal identification number. The register data include individual-level information on annual earnings, education levels, employment status, company identifiers and, useful for our purposes, occupational codes (based on ISCO-88). After data harmonization, the observed occupation closest to the age of 50 is used, so that careers are sufficiently established, and birth cohorts can more easily be compared. Based on this, 6830 twin pairs (13360 individuals) are maintained. However, as not all of these pairs have information on the occupation of both twins, the analytical sample is roughly equal to 5000 twin pairs (this varies across class schemes and analyses). Descriptive statics are displayed in Table A1 in the Online Appendix. These compare the means and standard deviations of the twin sample to those obtained in the full population of people born between 1941 and 1979. The statistics indicate that overall, the twin sample is similar to the full population (see also Nilsen et al., 2013), although women and older individuals are slightly overrepresented.

### *4.2. Variables*

As elaborated upon in section 2, we construct several class schemes based on the indicators available in the register data. Table 1 shows the classes used in each class scheme for the ordinal analyses, as well as which subcategories they are comprised of. Four classes per class scheme are retained for the ordinal analyses, as this makes the results more harmonized and comparable across operationalizations.

The Erikson-Goldthorpe-Portocarero class scheme is devised from the ISCO-88 codes. As a first step, we construct the eleven-class version of this scheme (see Figure A1 in the Online Appendix), which also utilizes variables that indicate whether individuals are self-employed and the number of employees that work in the company of the self-employed. Unfortunately, the class of "Farmers and other self-employed workers in primary production" cannot be constructed, as no information is available on the type of work (occupational codes) for those who are self-employed. In the ordinal analyses we further reduced this eleven-class scheme to five classes, as this version is more clearly hierarchically ordered, which makes it easier to use in twin models based on ordinal variables. In addition, the self-employed are excluded from these analyses, as they cannot be ordered in the class hierarchy, resulting in four classes. However, all classes, including the self-employed, are included in the binary models (see below).

Second, we construct the Oslo Register Data Class Scheme (ORDC). Most classes are based on occupational codes, but this class scheme also distinguishes between various economic groups based on relative incomes. To construct the three classes in the economic fraction within ORDC, we use deciles of annual income each year. The class of individuals primarily receiving welfare transfers unfortunately cannot be constructed, as no specific information is available on benefit recipiency. This results in a total of twelve classes. For the ordinal analyses, a four-class version of the ORDC is constructed that distinguishes between the elite, upper-middle class, lower-middle class and working class (see Figure A2 in the Online Appendix). Binary models are based on all the twelve classes (see below).

Third, we construct the Oesch class scheme, which originally consists of sixteen distinct classes. As with EGP, this classification is based on occupational codes, self-employment status and the number of employees of the self-employed. Here there is also one category that cannot be distinguished, namely the "self-employed professionals". This is because occupational codes are only available for those in employment, and it is hence impossible to distinguish the nature of the work of self-employed individuals. This results in the construction of fifteen classes, which are further reduced to four ordered categories for the ordinal analysis. This ordinal analysis also excludes the self-employed, as they are difficult to situate within a hierarchical class ordering. However, the binary models include all fifteen classes.

Last, we code the Standard International Occupation Prestige Score (SIOPS), which is purely based on occupational codes, and assigns a pre-determined prestige score to each occupation. Based on prestige studies in 60 countries, Treiman (1977) constructed SIOPS by matching the ranked occupational titles to ISCO codes and averaging national prestige scores for each of the codes. This is the only metric scale and hence no groups are omitted, but the scores are only assigned to employees.

[TABLE 1]

### *4.3. Modelling strategy*

To assess the heritability of class, we apply a classical twin design (Plomin et al. 2008). Twins are not only related, but also largely exposed to the same environmental circumstances in their families of origin, including the same class and socioeconomic origins. The classical twin design decomposes the variability in an outcome into three distinct components: a component measuring variation related to additive genetic factors (the A-component, or the heritability), a part that is due to shared environments (the C-component) and environmental variation that is specific to individuals, i.e. the non-shared environment (the E-component). The E-component also incorporates any measurement error. Decomposing the variation in these three components is done by estimating so-called ACE-models, which allow us to give an approximation of the heritability of class.

The classical twin design is underpinned by several assumptions. The equal environments assumption (EEA) stipulates that monozygotic and dizygotic twin pairs are treated similarly by (agents in) the environment (Hettema et al. 1995). Although this can be questioned (Evans and Martin 2000) and violations of this assumption generally lead to an overestimation of heritability, it has been shown that violations and the resulting biases are usually small to modest (Felson 2014). The random mating assumption requires that parents of twins are matched randomly, i.e. without any assortative mating. If there is assortative mating on genetic factors related to the outcome, the genetic similarities between siblings would increase. If this assumption is violated, which likely is the case for socio-economic outcomes for which there is very strong observed spousal similarity, we will generally underestimate the heritability of the outcome. Third, the models assume additive influences of genes and environments, implying that they operate independently of each other. However, genes and the environment could both be interacting and be correlated, which can lead to an overestimation of heritability (Plomin et al. 1977). Last, classical twin studies also assume that different genes do not interact with each other, which is not a given, and could lead to an overestimation of heritability (Zuk et al. 2012).

The twin methodology provides an intuitive and useful tool to provide heritability estimates from pedigree data. In recent years, measured genotype data has also been used to estimate heritability coefficients in socioeconomic and other phenotypes (e.g. Okbay et al., 2022; Savage et al., 2018). Estimates from such data have benefits over pedigree data, but also come with their own weaknesses. An important issue in the case at hand is that most large-scale genomic data sources only include the most common genetic variants (SNPs) and not all genetic variation. This is likely a reason for the generally lower heritability estimates from genomic data. Genomic methods often provide a lower-bound estimate of heritability and may lack power to pick up on all relevant genes (Young 2019). Additionally, polygenetic scores for class attainment have not been produced, limiting the usefulness of genomic data for our purposes. As this is the first study assessing the heritability of class attainment, it is preferable to provide a first estimate that includes all genetic variation, even if it is inferred from pedigrees. Our results can in turn serve as benchmarks for future studies relying on genomic data.

The SIOPS model is estimated using a traditional twin analysis with a metric outcome, but for the other class schemes, we conduct ordinal analyses where we assume a hierarchical ordering of the categories. We also estimate a series of binary models that provide ACE estimates for each class in every class scheme relative to all other social classes (i.e., analyzing membership in each class as a set of dummy variables). Based on these analyses, a general ACE estimate is also provided per class scheme by calculating an average over all the A-, C- and E-components for each class. This strategy is truer to the intended use of the original class schemes, as it does not force us to collapse classes and allows us to include classes that cannot be hierarchically ordered (like the self-employed). However, the estimates for each of these groups separately might be noisy, as we are dealing with limited sample sizes and small groups. These models are all estimated using the umx package, which sets up thresholds matrices for ordinal and binary variables and models them as thresholds of latent variables (Bates et al. 2019). All our models control for the age at which occupation is measured, expressed as the deviation from the ideal age of 50 years.

Although it is not our main interest in this paper, we also briefly touch upon subgroup differences, by conducting the metric and ordinal analyses separately for women and men as well as for the 1941-1960 and 1961-1979 cohorts. We focus only on two cohorts to have sufficiently large samples to compare estimates. This is meant to explore if the variance shares explained by genes, the shared environment and the unshared environment are stable across social groups or whether there are pronounced differences. However, as this is a supplementary analysis that merely aims to offer a more detailed perspective, no theoretical expectations are formulated, and they are only displayed in the Online Appendix (see Tables A2-A5). In addition, unstandardized variance estimates for A, C and E in the metric and ordinal models are also provided in the Online Appendix (see Tables A6-A10) to gauge absolute variances.

## 5. Results

### *5.1. Metric and ordinal twin analyses*

Estimates and 95% confidence intervals for the A-, C- and E-components of the analyses for metric and ordinal outcomes are displayed in Table 2 (see Table A6 in Online Appendix for unstandardized results). The results for the conventional analysis of the SIOPS scale indicate that about 38 percent of the variability is due to genetic differences (A-component), 12 percent is accounted for by shared environments (C-component) and 50 percent is roughly attributable to unshared environmental influences and measurement error (E-component). This illustrates that quite a high share of variation in occupational status relates to genetics, while the shared environmental component (which includes social origins) is relatively small. This is in line with the general finding in behavioral genetics that the environmental component is usually smaller than the impact of genes (Turkheimer 2000). A heritability of 40 percent is comparable to the results found for educational attainment, but with a C-component that is smaller than what is conventionally found for education (Branigan et al. 2013).

Turning to the models that use the ordinal recoding of class schemes, we observe relatively similar results. For the Oesch scheme, the variability attributable to genetics is estimated to 44 percent, while the shared and nonshared environment account for 12 and 44 percent of the variability, respectively. For the ORDC scheme, estimates of heritability are of a similar magnitude, at 46 percent. The C-component is estimated to 19 percent, which suggests a larger role of shared environmental influences, while the A-component is lower than for Oesch and SIOPS at 35 percent. Last, for the EGP scheme, estimates of heritability are the highest. Roughly half of the variance is attributable to genetics, 9 percent is accounted for by the shared environment and 40 percent is related to nonshared influences and measurement error. We observe larger heritability estimates for the ordinal schemes than for the SIOPS scale, although only the estimate for the EGP is well outside the confidence interval of the metric estimate for SIOPS. All in all, these estimates seem to point to the conclusion that roughly 40-50 percent of the variation in class attainment is attributable to genetic differences, while shared environments account for 10-20 percent of this variation, and 40-50 percent is due to nonshared environmental factors.

To inspect subgroup differences, we briefly compare these estimates for men and women as well as for different cohorts. First, comparing men and women (see Tables A2-A3 and A7-A8), we find that for SIOPS, the A-component is larger for women, but for the other three class schemes, the heritability is substantially larger for men. This is in line with previous research, indicating that men usually have a higher share of variability accounted for by genetic differences in education compared to women (Silventoinen et al. 2004). Women may face more institutional barriers in acquiring higher education or class positions, especially in older cohorts, which could mean that that the expression of genetic differences is constrained by structural barriers. However, the confidence intervals do overlap with the point estimates for both genders, meaning that these differences are not statistically significant. Turning to the differences across the two cohorts (see Tables A4-A5 and A9-A10), it is evident that individuals from older cohorts have consistently larger heritability estimates than younger generations and this is outside of the confidence intervals for three of the class schemes. Younger generations appear to be, to a much larger degree, influenced by the shared environment, as indicated by the higher C-components (except for the ORDC scheme). Although relatively surprising, these results could be related to a democratization of higher education and a more diversified labor market in more recent cohorts, which could make it easier for similar individuals to end up in different occupations and class positions.

[TABLE 2]

### *5.2. Binary twin analysis*

As a next step, binary models are estimated for each class compared to all other classes in each of the full class schemes. This allows us to also take into consideration classes that cannot be hierarchically ordered, like the self-employed[4], and to employ the class schemes in a way that is closer to their intended use. We focus on the average estimates obtained by averaging each component over all the classes in each class scheme (see Table 2), instead of on the estimates for each class. The estimates for each class are nevertheless visualized in Figure 1. No subgroup analyses are conducted for the binary models, as sample sizes would be too small. In addition, no confidence intervals are displayed, as they are not available when manually averaging over the class-specific estimates.

[4] We opt to only include people into the binary models who have an occupational status. However, when including individuals that have not worked as a category into our binary models, our results change very little (not shown). Our estimates are hence also robust to the inclusion of the inactive into the class schemes.

To begin with, it is important to note that for the Oesch scheme, all self-employed were merged into a single category, to make sure the size of this group was large enough. Skilled and low-skilled clerks are also put in a single category, for the same reason. The estimate for the Oesch scheme averaged over the binary models indicates that 41 percent of the variability is accounted for by genetic differences, while 9 percent and 49 percent is attributable to the shared and unshared environment, respectively. This is a slightly lower heritability estimate than in the ordinal models but is similar to the estimates from the metric models for SIOPS. Although the coefficients for each class should be interpreted with caution because they rely on relatively small groups, it is interesting to observe that especially the self-employed, skilled and low-skilled manual workers have high A-component estimates.

For ORDC, the A-component is also considerably smaller than in the model based on an ordinal grouping, at 0.38. The same is true for the C-component, which drops to 0.10. Instead, the variability due to nonshared environments seems to increase in the binary models. Looking at Figure 1, we see especially high heritability for the professional and economic elites and the working classes, while class attainment in cultural fractions seems more influenced by shared environments than in the other fractions.

Last, for EGP, the same conclusion can be reached as with the other class schemes. The heritability drops slightly (to 0.40), while the E-components goes up (to 0.49) compared to ordinal models. In contrast to the other two schemes, however, the C-component also slightly increases when using the binary models. Turning to the estimates per group, we see that the A-component is highest for the working classes, which is in line with the findings from the Oesch scheme and to some extent with findings based on ORDC.

In general, most estimates based on full class schemes are in line with the results based on ordinal schemes and point to roughly 40 of the variability in class attainment being accounted for by genetic differences, around 10 percent by shared environments and roughly 50 percent by unshared environments or measurement error. These results are almost identical to the metric model results based on the SIOPS scale and are largely consistent across class schemes and modelling strategies. The comparatively small estimates for the role of shared environmental influences are clearly at odds with sociological theories emphasizing social origins as an important determinant of class attainment.

[FIGURE 1]

## 6. Discussion and conclusions

All sociological theories on class mobility involve a set of theoretical assumptions about what explains intergenerational persistence in class positions, and these invariably invoke explanations based on more or less purely social, economic, or cultural mechanisms related to social origins. Drawing on the sociological and behavioral genetic literatures, we argue that it is crucial to examine how much of the variation in class attainment can be explained by such mechanisms, and how much might instead be related to genetic differences.

Our results suggest that class attainment is neither purely a result of social origins, nor genetic origins. In the egalitarian context of Norway, additive genetics overall account for around 40 % of the variation in class outcomes among twins, while shared environments (including, but not limited to, social origins) account for around 10 % of this variation. The largest source of variation is related to the unshared environment, which encompasses both measurement error, and numerous factors that make identical twins different, including different experiences, random chance, individual choices, and human agency. These results are largely consistent across class schemes and modelling strategies. Despite important differences in the theoretical foundations of the class schemes, the choice of class scheme or the use of a prestige scale did not matter much. Our analyses provide a first benchmark of the heritability of class attainment that further studies can build on, and illustrates that genetic differences should be accounted for – in one way or another – when analyzing and explaining social mobility and related processes. The results could nevertheless be contextual, as social origins might matter more in less egalitarian contexts than Norway. The contextual nature of the results is also apparent from the differences across cohorts, whereby especially older cohorts have large A-estimates. Consequently, we encourage others to replicate our findings in other contexts and across different environments and social groups. However, taken at face value, our results suggest that both genetics and social origins matter for class attainment, but that genetics matter much more.

These findings are relevant for at least two important reasons. First, heritability estimates are informative about the potential explanatory power of sociological theories of intergenerational persistence. Estimates of the importance of shared environmental factors for class attainment among twins are neither representative nor completely unbiased, and they do not allow us to differentiate between different mechanisms or explanations for *why* or *what aspects* of social origins matter. But they do provide a rough idea about the potential upper-bound for the impact of social origins on class positions and provide a basis for evaluating central theories in the field by assessing *how much* social origins matter. We believe this is an important piece of the puzzle for evaluating sociological theories of intergenerational class persistence, and our results suggest that, broadly speaking, sociological theories explaining class outcomes in terms of social origins have little explanatory power. If similar results are found in other contexts, the theoretical implications of this are, in our view, that sociological theories of class reproduction should be reformulated to account for the important role of genetics in class attainment. Ignoring or downplaying the role of genetics in theorizing on class mobility and reproduction may hamper future sociological research in this field by producing misleading findings, results that are easily dismissed because they are based on erroneous assumptions, and policy recommendations that are ineffective at reducing inequalities (Freese 2008).

Second, heritability estimates do have some policy relevance, despite objections to the contrary (Goldberger 1979; Manski 2011). Our results imply that there is some room for policies to reduce the impact of social origins, as such factors may account for a small amount of variation in class outcomes. But our results also point to the importance of policies that may level the playing field by also addressing genetically rooted differences that produce social advantages and disadvantages. Such differences are likely correlated with social origins, and they may still be addressed and reduced by egalitarian social policies (Harden 2021). However, we stress that effective policy measures should be based on realistic theory about why individual outcomes differ, and solid evidence on what policies work. In this sense, policies aimed at reducing intergenerational persistence in class attainment or other socioeconomic outcomes that are based on classical sociological theoretical explanations that assume that the impact of social origins is large may prove ineffective, as they are likely to address mechanisms that are not important determinants of such outcomes.

It is important to stress that we reject any argument that because socioeconomic outcomes are shown to have a high heritability, social inequalities are somehow 'natural' or 'fair'. Regardless of whether systematic differences in class outcomes are primarily due to social or genetic origins, the vast inequalities in rewards that are seen today between different social strata, be they business owners, managers, professionals, manual workers or the unemployed, are nowhere close to egalitarian ideals of fairness (Swift 2004). Some people may be born with traits that make them particularly suited for specific types of jobs. Others may be born with traits that severely hamper their opportunities in the labor market. That does not mean that such traits necessarily must be heavily rewarded or penalized (Swift 2004; Harden 2021).

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**Tables and figures**

**Table 1: Classes used in the ordinal analyses (hierarchically ordered)**

| | EGP | ORDC | Oesch |
|---|---|---|---|
| Class 1 | **Service class**<br><br>*Upper service class*<br>*Lower service class* | **Elite**<br><br>*Cultural upper*<br>*Balanced upper*<br>*Economic upper* | **Higher grade service class**<br><br>*Large employers*<br>*Technical experts*<br>*Higher-grade managers*<br>*Socio-cultural professionals* |
| Class 2 | **Routine non-manual**<br><br>*Routine non-manual higher grade*<br>*Routine-non manual lower grade* | **Upper-middle class**<br><br>*Cultural upper-middle*<br>*Balanced upper-middle*<br>*Economic upper-middle* | **Lower grade service class**<br><br>*Technicians*<br>*Lower-grade managers*<br>*Socio-cultural semi-professionals* |
| Class 3 | **Skilled workers**<br><br>*Lower grade technicians*<br>*Skilled manual workers* | **Lower-middle class**<br><br>*Cultural lower-middle*<br>*Balanced lower-middle*<br>*Economic lower-middle* | **Skilled workers**<br><br>*Skilled craft workers*<br>*Skilled clerks*<br>*Skilled service workers* |
| Class 4 | **Low-skilled workers**<br><br>*Semi- and unskilled manual workers*<br>*Agricultural laborers* | **Working class**<br><br>*Skilled workers*<br>*Unskilled workers* | **Low-skilled workers**<br><br>*Low-skilled production workers*<br>*Low-skilled clerks*<br>*Low-skilled service workers* |

**Table 2: Estimates of A-, C- and E-components for the metric, ordinal and binary twin models**

| | A | 95% CI | C | 95% CI | E | 95% CI |
|---|---|---|---|---|---|---|
| **Metric** | | | | | | |
| SIOPS | 0.38 | [0.30-0.47] | 0.12 | [0.04-0.19] | 0.50 | [0.48-0.53] |
| **Ordinal** | | | | | | |
| Oesch (4 class) | 0.44 | [0.35-0.53] | 0.12 | [0.04-0.20] | 0.44 | [0.41-0.47] |
| ORDC (4 class) | 0.46 | [0.37-0.56] | 0.19 | [0.10-0.27] | 0.35 | [0.32-0.38] |
| EGP (4 class) | 0.51 | [0.40-0.61] | 0.09 | [0.00-0.18] | 0.40 | [0.37-0.43] |
| **Binary** | | | | | | |
| Oesch | 0.41 | - | 0.09 | - | 0.49 | - |
| ORDC | 0.38 | - | 0.10 | - | 0.52 | - |
| EGP | 0.40 | - | 0.11 | - | 0.49 | - |

**Figure 1: A-, C-, and E-component for binary models per class in the three class schemes**