



## Sibling similarity in income: A life course perspective

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### ABSTRACT

Sibling similarity in income is a measure of the omnibus effect of family and community background on income. We estimate sibling similarity in income accumulated over the life course (ages 18 to 60) to demonstrate that previous research has underestimated sibling similarity in income. Using high-quality Swedish register data, we find sibling similarity in accumulated, lifetime income to be much higher than sibling similarity in income measured over a short number of years. In addition, we test theories predicting variation in sibling similarity over the life course. We find that, contrary to predictions derived from the model of cumulative advantage, sibling similarity in accumulated income is largely stable over the life course. Sister correlations in income are lower than brother correlations but differences diminish across cohorts. We also find largely the same amount of sibling similarity in accumulated income in socioeconomically advantaged and disadvantaged families. We conclude by discussing the importance of using accumulated income for understanding trends and mechanisms underlying the omnibus effect of family and community background on income.

### 1. Introduction

The similarity of siblings is a measure of the omnibus effect of family and community background on life chances (Björklund & Jäntti, 2012, 2020; Grätz et al., 2021; Solon, Corcoran, Gordon, & Laren, 1991). Sibling correlations in income are closely related to estimates of intergenerational income mobility, which estimate the association between parental and offspring income (Jäntti & Jenkins, 2015; Torche, 2015). A high similarity of siblings in income implies a large impact of family and community background on income and a high intergenerational transmission of income. The resemblance of siblings is, however, a broader measure of the impact of family background on income than intergenerational correlations of parental and offspring income, as siblings share many observed and unobserved characteristics.<sup>2</sup>

A number of studies have estimated sibling correlations in income (Björklund & Jäntti, 2020; Björklund, Eriksson, Jäntti, Raaum, & Österbacka, 2002; Björklund & Jäntti et al., 2012; Björklund, Jäntti, &

Lindquist, 2009; Conley & Glauber, 2008; Conley, 2004, 2008; Hauser & Peter, 1985; Hauser & William, 1986; Jencks et al., 1972, 1979; Mazumder, 2008, 2011; Schnitzlein, 2014; Solon et al., 1991; Thaning & Hällsten, 2020; Wiborg & Hansen, 2018). These studies share, with the exceptions of Bingley and Cappellari (2019) and Hällsten and Thaning (2021), one shortcoming, which we address in this article: The studies measure income over a short number of years in mid-adulthood, for instance ten years (Björklund & Jäntti et al., 2012). Because of the limited number of income observations, these studies estimated what we refer to as sibling similarity in age-specific income.

We are convinced that from an equality of opportunity perspective we should be more interested in estimating sibling similarity in income accumulated over the whole working life, i.e. lifetime income, than in sibling similarity in age-specific income. Our article not only advances this theoretical idea but we also provide the first study that reports estimates of sibling similarity in accumulated, nearly lifetime income, operationalized as all income accumulated from ages 18 to 60.

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<sup>2</sup> We focus on sibling similarity in income (instead of the association between parental and offspring income) because this method allows to take into account the effects of both observed and unobserved aspects of family (and community) background on income (Björklund & Jäntti, 2020; Björklund & Jäntti et al., 2012). We nevertheless discuss and relate our study to the literature on intergenerational income mobility because both concepts are closely related (Solon, 1999). Sibling correlations can also be influenced by siblings affecting each other but, to a large part, they are due to intergenerational effects, i.e. parents affecting their offspring, as well as to neighborhood effects (Björklund & Jäntti, 2020).

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Accumulated income is all income received up to a specific age. In other words, at age 30, the accumulated income of a woman is all income she received between ages 18 and 30. We call accumulated income over a whole working life, i.e. income from age 18 to 60, lifetime income.

Different concepts of income can lead to different results (Landersø & Heckman, 2017). We compare estimates of sibling similarity in earnings and sibling similarity in disposable income. Earnings are a measure of human capital. Disposable income is a measure of consumption (and savings) possibilities, as the latter also includes capital gains.

We test theories predicting variation in the impact of family background on income over the life course. The model of cumulative advantage (DiPrete & Eirich, 2006) predicts an increasing impact of family background on income over the life course. Contrary to that, increasing influences of genes and luck on income during the career may make siblings less similar to each other over the life course. Our approach does allow us not only to investigate sibling correlations in age-specific income over the life course but also sibling similarity in accumulated income, which, as we argue, is a better measure of equality of opportunity.

In addition, we study gender and cohort differences in the effects of family background on income by looking at both brother and sister correlations. We expect sister correlations in accumulated income to be lower than brother correlations but that sister correlations increase over cohorts with increasing female participation in the labor market.

Finally, we analyze differences in sibling similarity by family socioeconomic background (Conley & Glauber, 2008; Conley, 2004, 2008; Grätz, 2018). These differences may come about if parents reinforce or compensate for differences in siblings' endowments and if these parental responses vary between socioeconomically advantaged and disadvantaged families (Behrman, Pollak, and Taubman 1982; Becker & Tomes, 1976; Conley, 2004, 2008; Griliches, 1979). Comparing sibling similarity in income across social groups allows us to assess whether these parental responses lead to differences in within-family variation in life chances for children from socioeconomically advantaged and disadvantaged families.

## 2. Background and theoretical considerations

### 2.1. Sibling similarity in income as a measure of the Omnibus effect of family background on income

Research on intergenerational income mobility relates parental to offspring income (Jäntti & Jenkins, 2015; Torche, 2015). This approach underestimates the intergenerational transmission of advantage, as other family background characteristics than parental income do also influence their children's income. For instance, Mood (2017) showed that parental education and occupation affected children's earnings alongside parental income. Many of these family background characteristics are likely to be unobserved, for instance, parental skills and parental motivation to foster the development of skills in their children.

The similarity among siblings provides a way to take into account all these factors and to obtain a more universal measure of the effect of family background on income (Björklund & Jäntti et al., 2012; Solon et al., 1991). The similarity of siblings in income is a composite measure that takes into account the effects of parental education, parental occupation, and parental income on children but also the effect of any unobserved characteristic which is shared among siblings. As siblings share many more characteristics than can be considered through observable measures of social origin, sibling correlations approximate more closely a measure of the omnibus impact of family background on income than the association between parental income and child income. Siblings grow up together, so they share most parental resources. Siblings experience nearly the same educational environment within the family. In addition, siblings grow up in the same neighborhood and often attend the same school. Sibling correlations also include factors that are

hard to measure with quantitative, in particular with administrative, data, such as parental personality, parenting styles, and parental motivation to foster children's educational careers. All aspects of family (and community) background that are constant and shared among siblings are included in the measure of the omnibus effect of family background provided by a sibling correlation. Nevertheless, the measure of sibling similarity is closely related to the measure of income mobility, i.e. the association between parental income and child income. A higher similarity between siblings entails a stronger transmission of advantage across generations and therefore less intergenerational mobility (Solon, 1999).

Even though siblings grow up together, they may experience differently some aspects of the family environment. For instance, previous research showed that birth order affected children's educational outcomes and their income (e.g., Kantarevic & Mechoulan, 2006). These sibling-specific effects are not considered by sibling correlations, which is why they may provide lower bound estimates of the omnibus effect of family and community background (Björklund, Jäntti et al., 2012). However, corrections to take into account these factors by Björklund & Jäntti et al. (2012) did not considerably change sibling correlations in several outcomes (among them earnings and education) in Sweden. Therefore, the bias introduced by omitting sibling-specific family background factors may be small.

Several concerns that are more fundamental have been raised against using sibling similarity as a measure of the omnibus effect of family background on life chances. Sibling correlations were criticized for mixing different types of effects together, including the influences of different parental resources, parenting, and influences from neighborhoods, siblings, and peers (Breen & Jonsson, 2005). On the one hand, this can be seen as an advantage of sibling correlations. It is precisely because of their summative nature that sibling correlations provide such a good measure of the omnibus effect of family (and community) background. We are interested in estimating how much the shared aspects of siblings' upbringing affect their life chances, as well as how this impact varies over the life course. We are therefore not interested in decomposing this total effect into different components. On the other hand, it certainly may be interesting to understand the contribution of the different components. This is, however, not possible to do with the framework employed in this study.

Another concern is that sibling correlations are estimated on a selective sample, as only children do not contribute to their estimation (Breen & Jonsson, 2005). The consequences of focusing on siblings to estimate the effect of family background on income are not clear. In the country and for the cohorts that we analyze, only children are quite rare so that even if our estimates of family background effects were not generalizable to only children, we would still cover by far the largest part of the population. For instance, less than seven percent of children born in 1960 had no siblings, i.e. were only children. In addition, Lindahl (2008) found no differences in intergenerational income mobility between families with one child and families with more children in Sweden.

### 2.2. Sibling similarity in income over the life course: accumulated and non-accumulated measures of income

There are both substantive and methodological reasons to study how sibling similarity in income varies over the life course. From the perspective of theories of intergenerational mobility, we should be more interested in accumulated income as a measure of socioeconomic status than in income at specific ages. This is in line with ideas expressed by economists according to which we should look at permanent rather than at current income, as people base their consumption on the former (Bhalla, 1980; Friedman, 1957; Modigliani & Brumberg, 1954). Substantively, different theoretical perspectives predict a variation in the impact of family background on income over the life course. We discuss these theories in the next section.

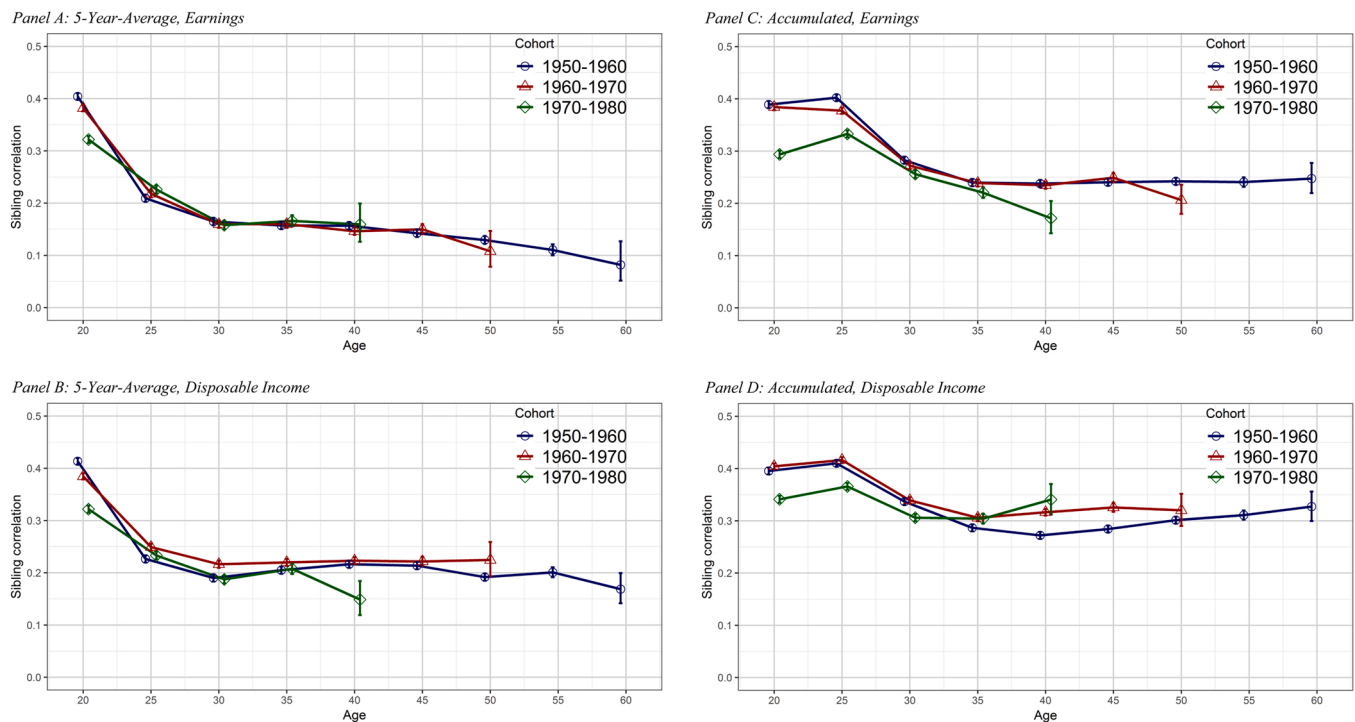


Fig. 1. Sibling correlations in earnings and disposable income, men.

There are several methodological, life course-related challenges for research estimating the effect of family background on life chances by using sibling correlations in income or by estimating the association between parental and child income. We want to highlight three aspects in which measures of accumulated income improve upon age-specific measures. First, accumulated income captures that different individuals have different income trajectories. Second, accumulated income captures that individuals can have variation in income over their life courses, for example, due to periods of unemployment or other reasons for being out of the labor market. Third, accumulated income is more robust to measurement error, as it is based on income measured over a large number of years and life course stages.

Stratification researchers and economists have been aware of these problems (Jenkins, 1987). The two standard solutions have been, first, to focus on income measured in mid-adulthood when individuals are established in the labor market and, second, to average income over several years. These solutions give, however, only partial corrections to the problems associated with assessing life course patterns from a limited age range.

The literature usually calculates “permanent income” using income measured over a number of years in mid-adulthood (Brady, Giesselmann, Kohler, & Radenacker, 2018; Gangl, 2005; Jäntti & Jenkins, 2015). Some studies have estimated whether current earnings could predict lifetime earnings (Björklund, 1993; Böhlmark & Lindquist, 2006; Haider & Solon, 2006; Mazumder, 2001). Björklund (1993) found that, at ages 30–50, the correlation between age-specific income and lifetime income was around 0.6–0.8 in Sweden. This far from perfect correspondence between mid-adulthood and lifetime income may arise because current income is a rather weak predictor of lifetime income due to measurement error and/ or because income profiles are hard to measure, as variability across years is high for some individuals. It may also be that income trajectories are not well captured by measures in mid-adulthood or that simply discarding information on income early and late in the life course has more important consequences than often realized.

There may also be differences within the population in how

predictive mid-adulthood income is for lifetime income. Different occupations have different income trajectories over the life course. Working class occupations have flatter income trajectories, while professional jobs show steeper income growth (Bhuller, Mogstad, & Salvanes, 2011; Goldthorpe & McKnight, 2006). Groups with high variability, due either to poverty and hardship or occupation-specific characteristics, also show low correspondence between mid-life and lifetime income. For these reasons, measures of accumulated income produce less attenuation bias. Our approach also takes into account income volatility and precariousness over the life course, as these life course events lower accumulated income (Jäntti & Jenkins, 2015; Kaltefleiter, 2018; Western, Bruce, Deirdre Bloome, Benjamin Sosnaud, & Laura Tach, 2012).

Researchers are aware that the issues of attenuation and life cycle bias have led research to overestimate intergenerational income mobility (Grawe, 2006; Haider & Solon, 2006; Jenkins, 1987; Nybom & Stuhler, 2016, 2017). Research on intergenerational mobility nowadays often uses averages of income over several, for instance five, years to overcome these issues (Mazumder, 2005). This averaging of income measured in several years overcomes the issue of variability in the age of measurement, but it does not capture that some individuals can have income trajectories over the entire life course that are characterized by high variability (Haider, 2001). Despite this limitation of the standard practice, most research on intergenerational income mobility and sibling similarity in income focuses on a brief age range (five to ten years) to measure income. As a result, sibling correlations in income will appear lower as the income of siblings may often be measured during a five-year period with unusually low or unusually high labor market attachment. Labor force responses to childbearing make such issues even more severe, in particular for women, as parenthood overlaps with the ages at which income is typically measured.

### 2.3. Variation of sibling similarity in income over the life course

Several theoretical approaches predict variation in sibling similarity over the life course. The cumulative advantage model argues that a

favorable starting position leads to further gains over time (DiPrete & Eirich, 2006). Family background has a positive effect on the income at the start of the labor market career. If cumulative advantage occurs, this favorable impact of family background will increase over the life course. Therefore, this theoretical perspective leads us to expect an increase in sibling similarity in income over the life course.

Other theories expect sibling similarity in income to decrease over the life course. In the early twenties of their lives, siblings often share geographical locations (Kolk, 2017), and shared experiences in childhood are proximate in time. If individual characteristics, which are unrelated to family background, become more important over the life course, sibling similarity will decrease. This includes random life events that affect income, which Jencks et al. (1972) referred to as “luck.” Genetic differences between siblings may also become more influential over the life course (Plomin, 2018). From this perspective, we therefore expect the influence of family background to decrease over the life course.

Finally, a third possibility is that sibling correlations in income remain stable over the life course. This is the case if sibling income profiles follow closely each other over the life course.

There is some previous research that tested these hypotheses estimating sibling similarity in age-specific occupation or income over the life course. Two studies found sibling similarity in occupational status to decrease over the life courses of men and women in Wisconsin (Hauser & Wong, 1989; Warren, Robert, & Sheridan, 2002). One study, using nationally representative data for the United States, found sibling similarity in income to increase over the life course (Conley, 2008). In addition, Bingley and Cappellari (2019), using data on Danish men, found a weak U-shaped variation of brother similarity in age-specific earnings over the life course. In this study, brother similarity in earnings was highest at age 25 (the first measurement point) and lowest at age 40. After age 40, sibling similarity slightly increased again up to age 55 (the last measurement point).

#### 2.4. Gender and cohort differences in sibling similarity in income

We expect sister correlations in income to be lower than brother correlations. Historically, and to a lesser extent today, women in Sweden were less attached to the labor market than men. This lower labor market attachment of women can lead to more periods of no income but also reflect fewer working hours and, therefore, lower income.

We analyze three different cohorts. We expect that across these cohorts, the similarity of sisters in income is going to increase. Across the three cohorts we look at, women became more integrated into the labor market (Stanfors & Goldscheider, 2017). We expect this change to lead to higher sister correlations in income, as in the past low female labor force participation may have led to a relatively weaker connection between family background and life course income for women than for later cohorts where women to a larger extent achieve high-status occupations. For men, we expect no change in sibling similarity in income across the three cohorts we study, in line with Björklund et al. (2009), who found no change in sibling correlations in age-specific income for the cohorts we look at.

Björklund & Jäntti et al. (2012) reported brother and sister correlations in earnings in Sweden. In line with our theoretical expectations, they found larger brother than sister correlations in earnings measured at ages 31–40. It is instructive to compare these results to our estimates, which replicate their findings for age-specific income and also estimate gender differences in sibling similarity in accumulated income.

#### 2.5. Differences in sibling similarity in income by family socioeconomic background

The traditional approach to study sibling similarity assumes that the similarity between siblings does not vary across social groups within a society. There are theories that question this assumption. According to

Becker and Tomes (1976), parents reinforce ability differences among siblings. This behavior reduces the similarity among siblings. As socioeconomically advantaged families have more resources to implement reinforcing strategies, we expect a higher similarity among siblings in socioeconomically disadvantaged than in socioeconomically advantaged families (Conley, 2008).

Behrman et al. (1982) introduced another model of parental responses to ability differences among siblings. According to their separable earnings-transfer model, parents with a high level of inequality aversion compensate for rather than reinforce ability differences among siblings. Socioeconomically advantaged families have more resources to implement compensating strategies (Griliches, 1979). Conley (2004, 2008) therefore predicted that parents with many resources compensated for ability differences between siblings, but that socioeconomically disadvantaged families, in line with Becker and Tomes (1976), reinforced ability differences. As a result, this perspective predicts higher sibling similarity in socioeconomically advantaged than in socioeconomically disadvantaged families.

Conley (2008) and Conley and Glauber (2008) found lower sibling similarity in income in socioeconomically disadvantaged families in the United States. Conley (2008) found this to be due to increasing sibling similarity in income over the life course for the offspring of socioeconomically advantaged families. We test whether we can obtain similar results using accumulated income in Sweden.

#### 2.6. The Swedish context

Sweden is an interesting case for the study of sibling similarity in income. Income inequality is lower in Sweden than in other advanced, industrialized societies. Comparative research has shown that income mobility is high and sibling similarity in income is low in Sweden compared to non-Scandinavian countries (e.g., Björklund et al., 2002; Björklund & Jäntti, 1997; Blanden, 2013; Bratberg et al., 2017; Corak, 2013; Schnitzlein, 2014; Solon, 2002). Therefore, sibling similarity in income in Sweden is likely to be lower than sibling similarity in income in many other societies. In addition, Sweden is a social-democratic welfare regime (Esping-Andersen, 1990). The redistribution policies of the Swedish welfare state may in particular result in lower sibling correlations in disposable income in Sweden than in societies with different welfare regimes.

We are aware of five previous studies that estimated sibling similarity in income in Sweden. Björklund et al. (2002) estimated a brother correlation in earnings of 0.25, using data on earnings measured four times between ages 25 and 42 for a cohort born between 1948 and 1965. Björklund et al. (2009) measured income at ages 30–38 and estimated brother correlations for cohorts born between 1932–1938 and 1962–1968. They found the brother correlation in income to be 0.49 for the 1932–1938 cohort, to be declining substantively until it reaches 0.31 in the cohort born 1947–1953. For younger birth cohorts, sibling correlations in income were increasing slightly until 1953–1959 (sibling correlation of 0.36) and were stable thereafter. Björklund & Jäntti et al. (2012) reported sibling correlations for earnings of shortly spaced sibling measured between ages 31 and 40 to be 0.22 for men and 0.15 for women, using data on a cohort of siblings born between 1951 and 1967.<sup>3</sup> Thaning and Hällsten (2020) reported a mixed-gender sibling correlation in earnings at ages 34–40 of 0.134. Hällsten and Thaning

<sup>3</sup> In these studies, Björklund and colleagues focused on closely spaced brothers, which resemble each other more than siblings born further apart. Shortly spaced siblings are drawn from a socioeconomically selected sub-population (Barclay & Kolk, 2017). Our results reported below are based on a larger and less selective population of siblings. We observe, as expected, lower sibling correlations in age-specific income than Björklund and colleagues. We also compare sibling similarity between shortly and long spaced siblings in Fig. S5 in the Online Supplement.



(2021) reported a mixed-gender sibling correlation in disposable income of 0.2027, using a sample of individuals born 1947–1976 with income measured in mid and late adulthood.<sup>4</sup>

### 3. Data and Methods

#### 3.1. Data

Our data come from Swedish administrative registers. The registers contain detailed sociodemographic information on the entire population of Sweden. For our study, we include cohorts born from 1950 to 1980. Our study population is all Swedish-born men and women of those cohorts who did not out-migrate or die before age 60 (or the last age at which we observe them). We choose three focal cohorts with birth years 1955, 1965, and 1975 and examine all siblings born five years before and after these three birth years, i.e., our sibling groups include all siblings born from 1950–1960, 1960–1970, and 1970–1980.<sup>5</sup> Siblings are connected through their parents by the Swedish multigenerational register (Statistics Sweden, 2010). We define sibling groups as full biological siblings, i.e., siblings who share the same mother and father. This excludes adopted children and children from previous partnerships from the definition of a sibling group.

Individuals are linked to yearly information from the Swedish tax authorities, starting from 1968. The registers contain all income known by the authorities, as well as other payments made by the Swedish state or municipal governments. Sweden had individual taxation throughout the period we study (though joint taxation for spouses was optional from 1968 to 1971), and all income refers to individual (not couple) income (and benefits). Income refers to the total income reported to the tax office. The registers also include capital gains and all social transfers. The last year of income measurement in our data is 2012 (this corresponds to age 62 of our first cohort and to age 32 of our youngest cohort).

Our sample sizes are large. They are lowest for the oldest cohort (1950–1960) with 566,042 men and 563,727 women. The second cohort (1960–1970) includes 647,586 men and 630,193 women. Finally, 627,052 men and 603,963 women make up the 1970–1980 cohort.

#### 3.2. Variables

We use two measures of income. First, we use *earnings*, which is a measure of all labor income before taxes. Second, we use *disposable income*, which is net of taxes and includes all social benefits and transfers paid by the government, e.g., pensions, child allowances, unemployment benefits, student financial aid, and social welfare, as well as all sources of income, such as capital gains and profit from companies.

We focus on these measures, as they have been the two reliable income variables available in Swedish registers since 1968. Disposable income is an accurate measure of the actual resources available to men and women, while earnings measures labor market engagement and success. As earnings are based on pre-tax income, it is less concentrated than disposable income, which is after taxation and includes various income protection and social welfare payments. Our income variables are inflation-adjusted (using 2000 as a reference year).

We compare sibling correlations in age-specific measures of disposable income and earnings to sibling correlations in accumulated disposable income and earnings. We examine sibling correlations using

*disposable income and earnings measured at a specific age*, averaged over the current, the two previous, and the two subsequent years, and *accumulated disposable income and earnings*. Accumulated income is the sum of all income (earnings or disposable income) measured up to that age, starting from age 18. Accumulated income at age 30 is therefore the accumulated income from age 18–30, and accumulated income at age 60 is an accurate representation of all income earned up to that age, or, put differently, nearly lifetime income.<sup>6</sup> To assess how different age measurements affect our estimates of sibling similarity in income, we do not only compare five-year averages with accumulated measures, but also compare various intermediate age ranges (e.g. age 20–40 or age 40–50) with longer age ranges (in Fig. 4). This provides researchers with an estimate of how many measures of income are necessary to approximate the measure of sibling similarity in lifetime income.

Our models compare siblings at exactly the same age (e.g. age 50 for individuals born in subsequent cohorts 1950–1959); that is, we observe earnings and disposable income of siblings up to and including different years (e.g. final year 2000–2009 in the example above). We do this to get as accurate as possible a representation of life-course patterns in sibling resemblance in income. Observations include occasionally individuals with very high income (disposable income includes capital gains, which can be very large). For this reason, we log both age-specific and accumulated measures (the first after averaging over five years and the latter after accumulating).<sup>7</sup>

Because we log all measures of earnings and disposable income, respondents with a zero on a measure do not contribute to the estimation of the specific sibling correlation.<sup>8</sup> Our approach is in this respect in line with other studies estimating sibling similarity in income (e.g., Björklund et al., 2009). This leads to a loss of observations in particular in the earliest years, i.e., at age 20 or 25. The share with no accumulated earnings or disposable income is, however, only around ten percent for income between ages 18–25 and around one percent (disposable income) when accumulating income from ages 18–40, even less at higher ages. Proportions of zeros are slightly higher for women than for men. The group with zero accumulated earnings or disposable income at age 40 or higher is likely to be highly unrepresentative and poorly captured by administrative data. Descriptive statistics, including the share of zeroes, on earnings and disposable income at different ages, are reported in Table S1 in the Online Supplement. For our full population results (those reported in Sections 4.1, 4.2, and 4.5) we report findings for both earnings and disposable income. For our sub-population analyses, we only report findings by disposable income to have a more parsimonious

<sup>6</sup> We cannot analyze income beyond age 60 with the data we have. It is true that people may have income after age 60 and that this could contribute to their lifetime income. However, some people are also going to retire after this age and we think that pension income is different in a substantive way from labor income. This would have implications for using income beyond age 60 even if we had the data available. Beyond age 60 we also need to increasingly account for mortality, and it is problematic to decide which upper age limit to use for accumulating income if one is also interested in pension income. The mean age for exit out of the labor market in Sweden was around age 62 for men and women born in 1940 (Laun and Palme 2017). We think the term accumulated, lifetime income for ages 18–60 is appropriate, as it captures nearly a complete working life.

<sup>7</sup> We did not employ ranks of income, as we were interested in the sum of accumulated income, which is a value with a meaning in absolute terms. Employing ranks would considerably change the interpretation of our estimates and arguably also the research question.

<sup>8</sup> An alternative approach to deal with the issue of missing income would be to add a value of “1” to these observations. In line with Björklund et al. (2009), we think, however, such a treatment of the missing income problem is worse than the way we deal with the issue. Adding a value of “1” would make these observations extreme outliers, which would change the whole distribution of income. We therefore did not implement this approach. We also note issues such as that recoding 0 s to 1 would change our results based on the currency we use for our dependent variable.

<sup>4</sup> It is not clear from their description in how many years they actually measured income.

<sup>5</sup> For the highest ages within each cohort, we only have information on income for the three earliest birth years in each cohort. Therefore, the rightmost data point on each line in Figs. 1 to 3 should be interpreted with caution. The smaller samples are also reflected in larger confidence intervals. See Table S1 in the Online Supplement.

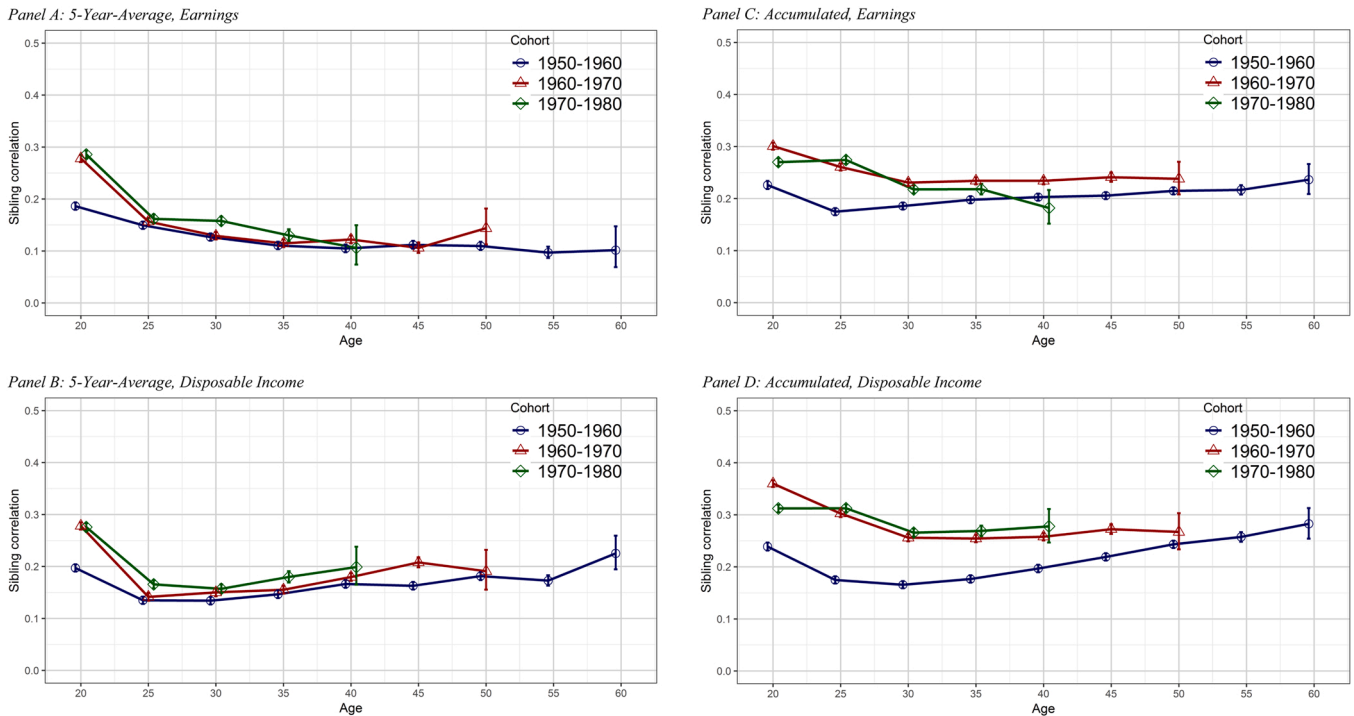


Fig. 2. Sibling correlations in earnings and disposable income, women.

presentation of our results.

### 3.3. Methods

Our analysis employs sibling correlations to measure the omnibus effect of family and community background on income. We compare these sibling correlations between accumulated and age-specific measures of earnings and disposable income across cohorts, between sisters and brothers, and between social origin groups.

We estimate sibling correlations using random effects multilevel models for individuals nested within families. We estimate these models using restricted maximum likelihood estimation (Mazumder, 2008; Schnitzlein, 2014). We measure the logarithm of accumulated and non-accumulated earnings and disposable income using the following equation:

$$E(Y) = y_{ij} = \alpha X_i + \epsilon_{ij}, \tag{1}$$

with  $y$  being our dependent variable (earnings or disposable income),  $j$  the identifier of the sibling within family  $i$ , and  $X$  a vector of control variables (dummy variables for year of birth).

The error term of Eq. (1) has a family  $a$  and an individual component  $b$ :

$$\epsilon_{ij} = a_i + b_{ij} \tag{2}$$

Under the assumption that the family variance ( $\sigma_a$ ) and the individual variance ( $\sigma_b$ ) are independent (we relax this assumption when looking at socioeconomic differences in sibling similarity), we can decompose the overall variance  $\sigma_e$  according to the following formula:

$$\sigma_e^2 = \sigma_a^2 + \sigma_b^2 \tag{3}$$

The sibling correlation is the ratio between the family-specific component of the variance  $\sigma_a^2$  and the total variance, i.e. the intra-

class correlation coefficient:

$$\rho = \sigma_a^2 / (\sigma_a^2 + \sigma_b^2) \tag{4}$$

All analyses are conducted using the mixed command in Stata 14.<sup>9</sup>

## 4. Results

### 4.1. Brother correlations

Fig. 1 shows the brother correlations in the five-year average of earnings (Panel A), the five-year average of disposable income (Panel B), accumulated earnings (Panel C), and accumulated disposable income (Panel D). It includes estimates for three cohorts with siblings born from 1950 to 1960, 1960–1970, and 1970–1980. The model coefficients used to generate Fig. 1 are reported in Table S2 in the Online Supplement.

The results for earnings and disposable income are, to a large degree, similar. Brother similarity in age-specific earnings decreases over the life course (Panel A). This decrease is very strong, as the brother correlation in income decreases from 0.3–0.4 in early adulthood to around 0.1 at age 50–60. We observe this decrease of brother similarity in earnings over the life course for all three cohorts included in our study.

The estimates for the five-year average of disposable income also show decreasing brother correlations over the life course (Panel B). The correlations are around 0.3–0.4 early in life, drop below 0.25 at age 25, and then stay largely stable around 0.20 at higher ages, and are higher than those for earnings.

For accumulated earnings (Panel C) we observe a decrease in brother similarity from ages 25 to 30 (from around 0.35 to 0.25) but see stability over the life course from ages 30 to 60. Moreover, estimates of sibling similarity in accumulated earnings are considerably higher than estimates of sibling resemblance in age-specific measures of earnings. Early in the life course, we find high brother correlations (here the accumulated and age-specific measures capture largely the same data). These

<sup>9</sup> Even though we use population data, we report 95% confidence intervals to provide some measure of uncertainty of our estimates.

high correlations may be due to brother similarity in educational timing and trajectories as well as a higher likelihood of a shared geographic location. At higher ages, brother similarity in accumulated earnings varies little over the life course. The differences between accumulated earnings and age-specific earnings (Panel A) suggest that age-specific earnings does not reflect lifetime earnings.

Brother similarity in accumulated disposable income (Panel D) varies little over the life course. If at all, we observe a slightly U-shaped pattern with a peak at age 25 at a level from 0.37 (cohort 1970–1980) to 0.41 (cohort 1950–1960), a decrease to around 0.30 up to age 35, and a further increase of brother similarity up to age 60 when the correlation is 0.33. However, the substantive size of the variation in brother similarity over the life course is small.

For men, we largely observe no change in brother similarity in income across the cohorts included in our study (though in early ages they decrease somewhat for later cohorts). This finding is in line with Björklund et al. (2009), who found decreasing brother correlations for earlier cohorts but no change for the cohorts we observe.

Brother correlations in accumulated income are constantly higher than those in income at a specific age. Therefore, using non-accumulated measures of income (e.g., by averaging over five years) leads us to underestimate brother similarity in income and to observe a different pattern of the variation in brother similarity over the life course.

#### 4.2. Sister correlations

We report the results for women in Fig. 2. We look at sister similarity over the life course using a five-year average of earnings at specific ages (Panel A), a five-year average of disposable income (Panel B), accumulated earnings (Panel C), and accumulated disposable income (Panel D). The estimates used to construct Fig. 2 are reported in Table S3 in the *Online Supplement*. We expect sister correlations in income to be lower than brother inequalities because of more spells of no employment and fewer working hours especially among the older cohorts of women. These events are likely to affect women with low and those with high income, resulting in arguably lower sibling similarity among women. However, we expect that sister similarity in income increases across cohorts because women become more strongly attached to the labor market. As a consequence, there will be less fluctuations in female income across cohorts.

For women, we observe a decrease in sister resemblance in age-specific earnings from ages 20 to 40 and stability thereafter (Panel A). For the two most recent cohorts, sister similarity in earnings decreases from above 0.25 to below 0.15. A decrease is also observed for the oldest cohort in our data, although the sister correlation at age 20 (0.19) is also rather low for this cohort. We do not find as much of a peak in correlations in early adulthood that we find for men.

Sister correlations in five-year averaged disposable income (Panel B) decrease from 0.25 to 0.15 from ages 20 to 25 (apart from the 1950–1960 cohort). After that age, sisters become more similar in their current disposable income, reaching the peak in similarity at age 60 with a sister correlation close to 0.25.

If we focus on our accumulated earnings measure (Panel C), we observe a largely stable sister correlation around 0.25 over the whole life course, in particular from ages 30 to 50. For the oldest cohort, we even observe a slight increase in sister similarity from ages 25 to 60 (from 0.17 to 0.24).

Comparing accumulated and age-specific earnings, we make the following conclusions. First, we underestimate sister similarity using age-specific instead of accumulated measures. This result is fully in line with our findings for men. Second, we observe a decrease in sister resemblance in age-specific earnings over the life course that does not hold up if we look at accumulated earnings. Third, comparing the three

cohorts, we also observe a stronger impact of family background on income for more recent cohorts of women, but differences are less pronounced for earnings than for disposable income.

Sister correlations in accumulated disposable income (Panel D) show a large difference between the 1950–1960 and the two more recent cohorts. We observe a strong increase in the resemblance of sisters in accumulated disposable income from ages 30 to 60 (from 0.17 to 0.28) for the 1950–1960 cohort. However, for more recent cohorts, sister similarity in income is stable over the life course, varying only from 0.25 to 0.30 from ages 30 to 60. The lower sibling correlations of our earliest cohort are possibly reflecting that female labor force participation is much lower for this cohort, and that individual income is less reflective of the socioeconomic status of these women, as compared to later cohorts when Sweden can more accurately be described as a true dual-earner society.

As was the case for men, sibling similarity in accumulated income for women is much higher than sibling similarity in age-specific income. Contrary to brother correlations, sister correlations increase across the three cohorts included in our study, eventually come relatively close to observed brother correlations. We do however in all periods find larger sibling correlations for men than for women for both earnings and disposable income. This result implies that increasing gender equality and female labor force participation coincided with an increasing impact of family background on income, and for similar reasons plausibly that own earnings became a more salient marker for women's own socioeconomic status over time.

#### 4.3. Robustness checks

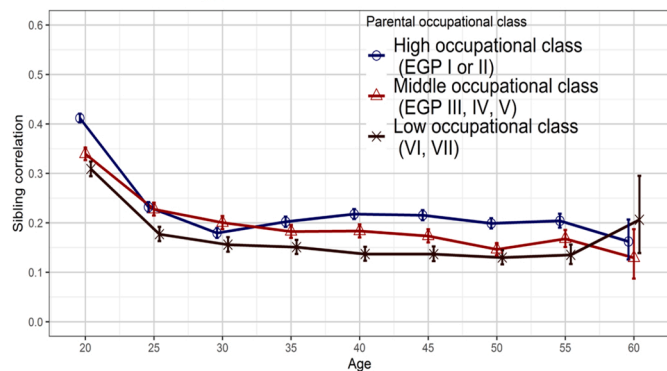
As a robustness check, we replicated our analyses using families with exactly two and four siblings to assess if family size affects our estimates. These additional models, which are reported in Fig. S4 and in Table S6 in the *Online Supplement*, lead to very similar estimates of sibling similarity in disposable income than those obtained using the full sample. We conclude that sibling similarity in disposable income does not vary by sibship size.

We also estimated the variation of sibling similarity in income by birth intervals. These models are reported in Fig. S5 and in Table S7 in the *Online Supplement*. For both men and women, we find sibling similarity in disposable income to be higher for shortly spaced than for long spaced siblings in line with our arguments developed in section “2.6. The Swedish context” above. However, at higher ages, there are hardly any differences between brother and sister similarity for shortly spaced siblings compared to the full population of families with exactly two siblings. This may partly reflect the fact that at young ages, a short interval implies that siblings live and recently went through similar educational and geographic contexts, while the impact of such shared proximate factors is less salient at older ages.

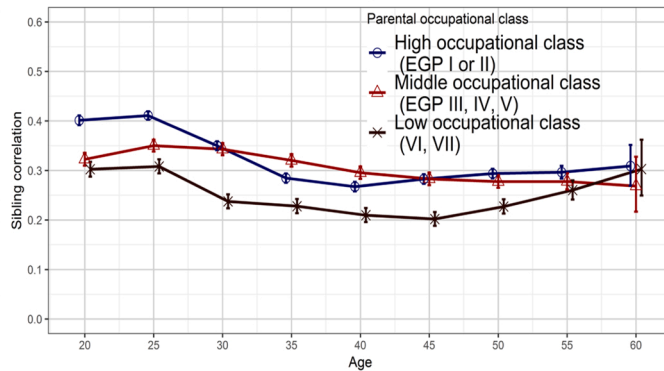
#### 4.4. Socioeconomic differences in sibling similarity in income

The estimates we presented so far assume that sibling similarity in income does not vary between social groups. We test this assumption and the theories that predict the variation of sibling similarity by family socioeconomic background in this section. We report estimates of sibling similarity in disposable income by parental occupational status in Fig. 3. To obtain three sub-groups for parental occupation, we split our observations into three samples based on the highest level of parental occupation. The high parental occupation group includes those with any parent with an occupation in classes I and II of the Erikson–Goldthorpe–Portocarero (EGP) class schema (Erikson & Goldthorpe, 1992). The intermediate group includes everyone with at least one parent with an occupation in EGP classes III, IV, and V (but not in

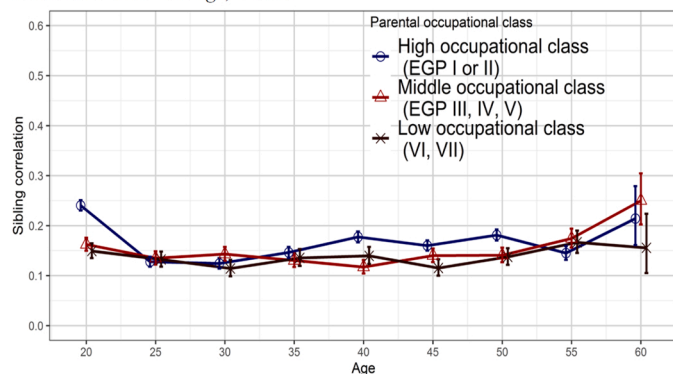
Panel A: 5-Year-Average, Men



Panel B: Accumulated, Men



Panel C: 5-Year-Average, Women



Panel D: Accumulated, Women

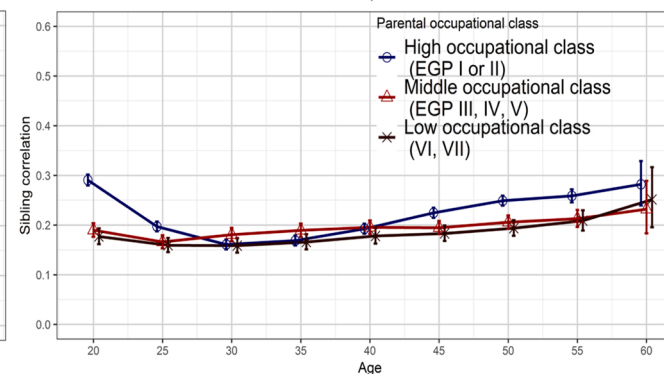


Fig. 3. Differences in sibling similarity in disposable income by parental occupational class, Cohort 1950–1960.

EGP classes I or II). Finally, the low parental occupational status group includes everyone with a parent with an occupation in EGP classes VI and VII and no parent with an occupation in EGP classes I–V. All estimates underlying Fig. 3 are reported in Table S4 in the Online Supplement.<sup>10</sup>

With respect to parental occupation, we indeed observe that socioeconomic differences in sibling similarity in income do vary over the life course, but the variation we observe is smaller in size and goes in a different direction than the one observed by Conley (2008). At young ages, for both men and women, sibling correlations are highest among siblings from families with a high parental occupational status. From age 30, siblings from families with a medium parental occupational status become as similar as siblings from families with a high parental occupational status. Brothers in families with a low parental occupational status are less similar than brothers in families with a medium and a high parental occupational status for most of their life course. However, if we look at income accumulated over the whole life course (age 55 or 60), we find no differences in brother similarity by parental occupational status. There are only small differences in sister similarity in income by parental occupational status. The comparison of brother similarity in age-specific (Panel A) and accumulated income (Panel B) does not demonstrate major differences in the variation by parental occupational

status. Similarly, sister similarity in age-specific (Panel C) and accumulated income (Panel D) show no major differences in terms of heterogeneity by parental occupational status. It therefore is likely that the differences between results in our study and Conley (2008) are due to cross-country variation, even though such a conclusion also depends on what using measures of accumulated income in the United States would reveal.<sup>11</sup>

In summary, our findings provide therefore largely no support to the claim that sibling resemblance in income is systematically higher in socioeconomically advantaged than in socioeconomically disadvantaged families. Any socioeconomic differences that we find are substantively small, do not persist until the end of the life course, and are inconsistent across different measures of family socioeconomic background.

4.5. How many years of income do we need to measure to approximate sibling similarity in life-course income?

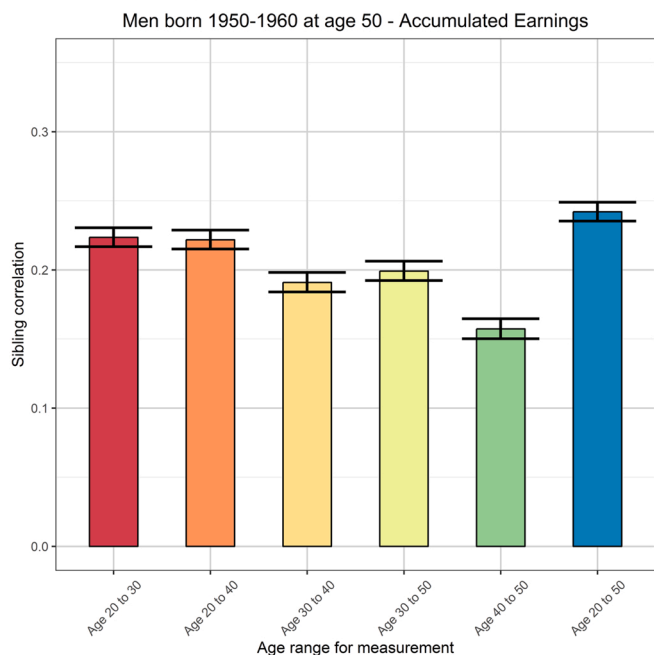
Our data allows us to have an unusually extensive coverage of income over the life courses of men and women, which allows us to estimate accumulated earnings and disposable income from age 18 and 60. Often, researchers have fewer data points available. To answer the question of how well incomplete data can approximate accumulated earnings and disposable income, we take the sibling similarity in earnings and disposable income accumulated from age 20–50 (for which we have complete information available for all men and women included in

<sup>10</sup> The comparison of sibling similarity across social groups requires the assumption of a constant within-group variance across the sub-samples. To further provide robustness to this assumption, we report in Table S4 also the within-family variance by parental occupational status. This follows a suggestion by Breen and Ermisch (2021): “If our concern is to compare the variation within families from different groups we might want to report the average within-family variance in each group as well as, or instead of, the group ICCs.” The findings comparing the within-family variances are the same as based on the sibling correlations (ICCs).

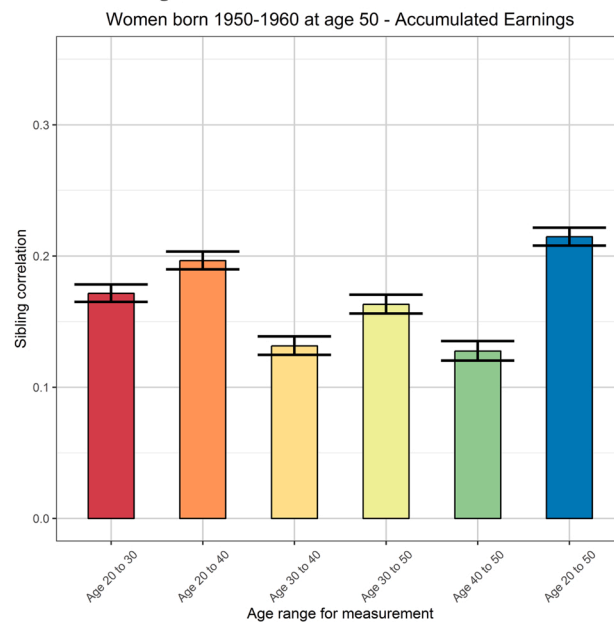
<sup>11</sup> In Fig. S2 in the Online Supplement, we report, as a robustness check, estimates of the variation in sibling similarity in income by parental education where we also compare age-specific correlations and accumulated correlations. There are a few more differences for sisters than for brothers, but all differences are substantively small.



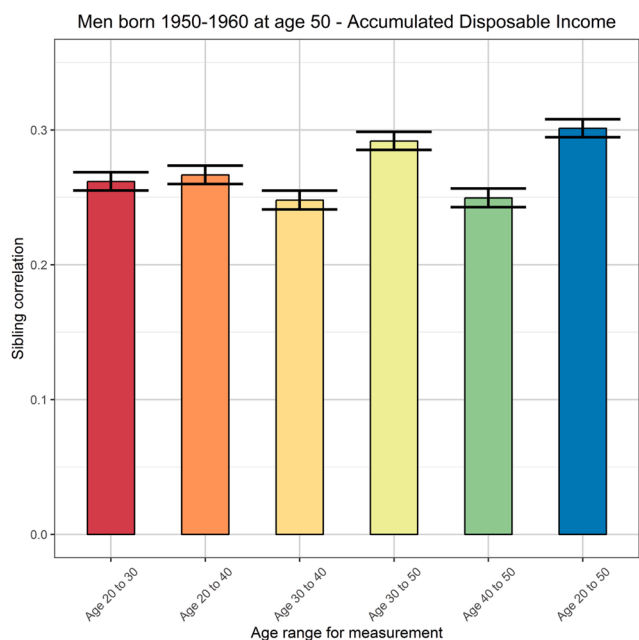
Panel A: Earnings, Men



Panel C: Earnings, Women



Panel B: Disposable Income, Men



Panel D: Disposable Income, Women

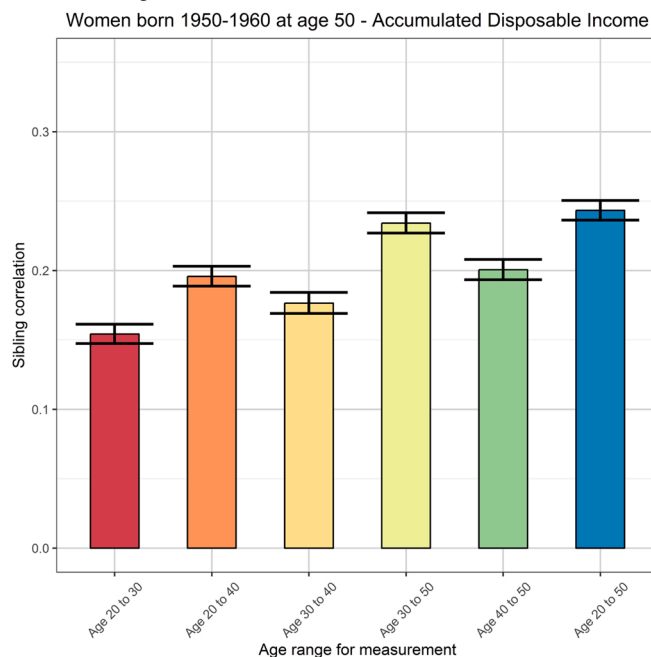


Fig. 4. Sibling correlations in income for the cohort born 1950–1960, comparisons of accumulating income over different age ranges.

the 1950–1960 cohort) as a benchmark. We compare how well we can approximate sibling similarity in earnings and disposable income with less information in Fig. 4. The estimates underlying the figure are reported in Table S5 in the Online Supplement.<sup>12</sup>

The results show no uniform picture. Observing disposable income

<sup>12</sup> We also produced estimates for different age ranges to predict sibling similarity in accumulated income between ages 20–60, but then, as explained in footnote 4, we had to rely on a smaller group of siblings born 1950–1952. These results, which are available in Fig. S3 in the Online Supplement, largely confirm what we present below of the importance of accumulating over as many years as possible.

from ages 30–50 provides quite a good approximation of disposable income from ages 20–50, but this is not true for earnings, where such measurements clearly underestimate sibling similarity as measured from age 20–50. This main result of the comparisons is true for both men and women. The sibling correlations in earnings from ages 20–30 and from ages 20–40 are nearly as high as the sibling correlations from ages 20–50. This result, which is again true for men and women, is probably rather due to the life course variation of sibling similarity than to accumulated earnings at younger ages providing a good approximation of accumulated earnings over the whole life course.

For these reasons, the comparisons reported in Fig. 4 support the main conclusion of our analysis: Sibling similarity in accumulated life

course income is higher than sibling similarity in income measured at specific ages. Data which do not allow estimation of sibling similarity in accumulated earnings and disposable income are likely to underestimate the omnibus impact of family background on earnings and disposable income. For all our measures, we find that using accumulated earnings and disposable income gives the highest sibling correlations. In particular, for earnings, we find that even taking a ten- or 20-year average from ages 30–50 substantively underestimates sibling correlations, which is also reflected in our previous results using five-year averages. The size of this bias is difficult to ascertain without having data covering the whole life course, and we find different patterns in how well age-restricted measures of income approximate our age 20–50 sibling correlations between earnings and disposable income, as well as differences by sex.

## 5. Discussion and Conclusion

Family background affects life chances, including income (Jäntti & Jenkins, 2015; Torche, 2015). Many analyses of income mobility or sibling similarity in income focus on income measured at short periods in the parental and the children's life courses. Sibling similarity in income is, however, underestimated by looking at income measured at specific ages instead of measuring sibling similarity in accumulated income. Our estimates of sibling similarity in accumulated income are considerably higher than our estimates of sibling similarity in income at specific ages. This finding is true for both earnings and disposable income. The higher estimates of sibling similarity in accumulated income imply that previous research has underestimated the omnibus impact of family and community background on income.

This finding implies that to understand the full effects of family background on income we have to take into account the whole life course. Accumulated income over the whole life course is a better measure of life chances than income at specific ages. Therefore, we believe that from an equality of opportunity perspective we should be most interested in sibling similarity in accumulated, in particular in lifetime, income. Most previous research has, however, measured sibling similarity in age-specific income and therefore overestimated equality of opportunity in contemporary societies.

Previous research has sometimes argued that sibling similarity in income is lower than sibling similarity in education or occupation (e.g., Schnitzlein, 2014; Wiborg & Hansen, 2018). Our results are partly in line with this claim. We estimate sibling similarity in disposable income to be 0.33 for male siblings and therefore smaller than estimates of sibling similarity of mixed-gender siblings in education of 0.39 (Björklund, Jäntti et al., 2012) and 0.44 (Grätz et al., 2021) in Sweden. However, our estimate of sibling similarity in income is higher than the mixed-gender sibling correlation in occupational prestige of 0.29 in Sweden (Hällsten, 2014).<sup>13</sup> One possibility is that this estimate of sibling similarity in occupational prestige itself underestimates sibling similarity, as it is based on a measure at one time point and does not take into account the variation in occupational prestige over the life course. In any case, our findings show that even with near-perfect income measurement, at least in contemporary Sweden, family background has a lower effect on income than on education. This is an important finding for theories on the intergenerational transmission of advantage, which need to be able to explain why the effect of family background on

education is stronger than the effect of family background on income.

In general, any analysis of intergenerational income mobility or sibling similarity in income assumes implicitly that income is measured reliably. For instance, analyzing the mediating role of education for income mobility (e.g., Gregg, Jonsson, Macmillan, & Mood, 2017) requires a reliable measure of income to capture the total effect of social origin on income. Another example provide studies that compare sibling correlations across outcomes (e.g., Erola, Jalonen, & Lehti, 2016, Hällsten & Thaning, 2021). The results from these analyses can potentially be biased if income is measured using information on too few years.

The second main result of our analysis is that the effect of family background on accumulated income does not vary strongly over the life course. We find a high sibling similarity in accumulated income both in the early and in the later life course. The finding of a large stability of sibling similarity in income over the life course is at odds with predictions derived from the cumulative advantage model (DiPrete & Eirich, 2006), the idea that genetic influences increase over the life course (Plomin, 2018), and the notion of a larger role of random life events, the longer an individual is in the labor market (Jencks et al., 1972). Therefore, our findings provide no empirical support to these theories. Of course, a possibility is that the mechanisms described by these theories all operate to the same strengths but in different directions and therefore cancel each other out.

Our results differ from findings for Denmark by Bingley and Cappellari (2019), who found a U-shaped variation in sibling similarity in age-specific earnings over the life course in Denmark. In our view, differences between our findings and those reported by Bingley and Cappellari (2019) are unlikely to be due to cross-country variation, as previous research found sibling similarity in income to be similar in Denmark and Sweden (Björklund et al., 2002). Rather methodological reasons seem to be responsible for these differences, in particular our focus on accumulated instead of age-specific income.

A third important finding of our analysis is that there are gender differences in sibling similarity in income even in a gender-egalitarian society such as Sweden. Gender differences diminish, however, across cohorts, and in our last cohort, the differences are not very large. Our findings suggest that increasing gender equality and female labor force participation across cohorts (Stanfors & Goldscheider, 2017) are accompanied by an increasing impact of family background on income. Even among our most recent cohort, however, the impact of family background was stronger among men than among women. For men, we found that the importance of family background did not change across the cohorts we analyze, in line with earlier results (Björklund et al., 2009).

Fourth, we tested whether there were socioeconomic differences in sibling similarity in income in Sweden. Previous research found a stronger sibling similarity in income in socioeconomically advantaged than in socioeconomically disadvantaged families in the United States (Conley & Glauber, 2008; Conley, 2008). We found sibling differences across social groups to be small in Sweden. This suggests that differences in parental investments between social groups do not affect sibling similarity in income in Sweden. One possibility is that there is cross-country variation. Another possibility is that, contrary to what we found in Sweden, sibling similarity in accumulated income differs from sibling similarity in age-specific income in the United States. Testing the latter possibility would require data to measure accumulated income in the United States. In any case, our findings suggest that theories of the intergenerational transmission of advantage in Sweden theories do not have to focus on socioeconomic differences in parental responses to child endowments within families. Even though this is a plausible mechanism underlying the intergenerational transmission of advantage,

<sup>13</sup> We estimated mixed-gender sibling correlations (Fig. S1 in the *Online Supplement*). Mixed-gender sibling correlations in income underestimate the effect of family background on income, as gender differences in income cause mixed-gender sibling similarity in income to be lower than brother or sister similarity. Nevertheless, these estimates are informative and we do indeed find lower sibling similarity than when looking at brothers and sisters separately. For instance, the mixed-gender sibling correlation in accumulated disposable income at age 50 is slightly above 0.20.

it is not of large empirical importance in Sweden.<sup>14</sup>

Fifth, we estimated how well sibling similarity in ten-to-twenty-year measures of accumulated income can approximate sibling similarity in accumulated lifetime income. We showed in general that the more years of income are accumulated over, the higher the observed effect of family background will be. The practical recommendation is therefore to use as many years to measure income as possible. At the same time, even measuring income over twenty years may underestimate the total effect of family background on income. A theoretical implication to draw from this is that social stratification is reflected over the entire life course and that the effect of family background is stronger when researchers consider the entire life course rather than when they only examine how well an individual is doing in, for example, early adulthood, or late in their careers. An advantageous family background may protect against short spells of misfortune at different life course stages. Similarly, even if people from disadvantaged backgrounds do well due to luck or merit at some part of their life course, they may still be at an above-average risk of sliding back into less well-off circumstances.

Due to the availability of data, our study is limited to Sweden. Labor market careers in Sweden are rather stable over the life course, especially after ages 30–40 (Härkönen & Bihagen, 2011). The issues we identify in our study are therefore likely to be rather more than less consequential for the study of the effect of family background on income in other societies than Sweden. Sweden can be understood as a rather conservative test case for the importance of looking at accumulated income. Our approach applied to the United States is likely to result in estimates of sibling similarity in income that would be even higher than those obtained by previous research (Mazumder, 2008, 2011; Schnitzlein, 2014; Solon et al., 1991). We have to leave it to future research to test this claim, as we do not have access to suitable data sources in these countries.

Our study is important for policy making, as we provide descriptive evidence on the importance of family background for income. Our analysis shows that family and community background are more important in influencing income than previously assumed in Sweden. This finding is also important for policy makers in other countries than Sweden, as Sweden is an example of a social democratic welfare regime with substantial income transfers (Esping-Andersen, 1990).

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<sup>14</sup> The situation could be different when comparing the top one percent to the rest of the population, which was not the focus of our analysis (cf. Björklund & Roine, 2012)

## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.rssm.2022.100688.

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