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Abstract

In this paper we estimate social mobility rates, free of measurement errors, using register data for Denmark and Sweden, 1968 to 2021. To correct for measurement error attenuation, we take ratios of the correlation of relatives at different locations in family trees, such as cousins relative to siblings. Three things emerge from these estimates. First social mobility rates in both Denmark and Sweden are much lower than conventionally estimated. Second these countries, despite their reputation for high social mobility rates, have nearly the same degree of persistence as in modern England, and also nineteenth century England or Sweden. Finally in all the cases observed marital assortment is much stronger than conventionally estimated, and this helps explain the low rates of intergenerational mobility.

JEL Codes: J62, J12, D31, I24

Keywords: intergenerational mobility, social mobility, assortative mating

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1. Introduction

Nordic countries are generally regarded as among the most socially mobile in the world.[1] Take, for example, the intergenerational correlation of years of schooling, measured as the correlation of the average years of schooling of the parents with their children. For the cohort of children born in the 1980s this was 0.19 in Denmark and 0.30 in Sweden, compared to 0.47 in the UK and 0.42 in the USA (van der Weide et al., 2024, database). Intergenerational correlations of income are also lower in Nordic countries than in most other countries. On average, the intergenerational income elasticity in the Nordic countries is 0.20, compared to 0.50 in the USA, 0.47 in the UK, and 0.41 in France (Corak, 2006).

This apparent high degree of social mobility led to the five Nordic countries being ranked the top 5 countries for social mobility in 2020 by the World Economic Forum (World Economic Forum, 2020. p. 7).[2]

The paper uses register data from Denmark and Sweden on years of education to show three surprising features of social mobility in modern Scandinavia. First intergenerational social mobility rates are much lower than conventionally estimated. Second both Denmark and Sweden have nearly the same degree of status persistence as in modern England. They also show little or no increase in mobility rates compared to nineteenth century England or Sweden. Finally in all these countries and time periods marital assortment is also much stronger than conventionally estimated. The high degree of marital assortment helps explain the low rates of intergenerational mobility.

Our approach exploits administrative records in Denmark and Sweden covering both vertical and horizontal family linkages, allowing us to calculate correlations across a wide range of kinship relations: uncle to niece, father to son-in-law, brother to sister-in-law, and so on. These observed correlations, however, as measures of the underlying correlations in educational attainment, or more general social status, are all biased downwards by

[1] Note, however, the recent article by Heckman and Landersø that disputes this general view for the case of Denmark (Heckman and Landersø, 2022).
[2] The rankings were 1. Denmark, 2. Norway, 3. Finland, 4. Sweden, 5. Iceland. The UK was ranked 21st, and USA 27th.

measurement errors. Years of schooling, for example, is a very loose measure of true educational attainment. Importantly, even for more distant relatives the attenuation of the correlations caused by measurement error occurs only once. That means that we can eliminate the measurement error in estimating intergenerational and other family correlations by dividing correlations between one set of relatives with the correlations by another, as is shown below.

2. Measuring True Social Mobility Rates

As noted, based on the parent-child correlation of years of education both Denmark and Sweden appear to be societies of high social mobility. The ability of completed years of education to index well underlying educational attainment or status will vary, however, across different types of society.

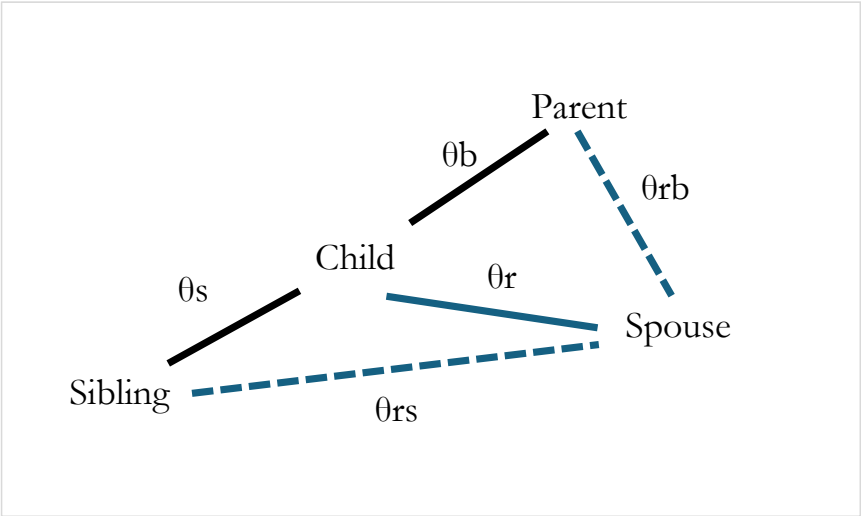
In Nordic countries, there is much greater state support for education than in most other countries. In Denmark, for example, there is no tuition payment until even the Masters degree stage, and generous support for student living expenses at age 16 and above. There is a generous supply, also, of places in degree programs. This will potentially make the correlation between years of education and actual educational attainment weaker in Denmark than in other countries, where less able students are unable to get access to tertiary education, or drop out of the educational system earlier. Thus in 2008 the completion rate for tertiary education in Denmark was 81%, compared to 56% in the USA.[3] Years of education thus potentially provide a better measure of educational attainment, or educational ability, in the USA versus Denmark, raising the observed family correlations.

Assuming all measures of social status available to researchers are imperfect indicators of underlying status, how can we get measures of social status persistence, for example, that can be compared across time in the same country, or across countries at the same time?

[3] OECD, 2009, p. 24.

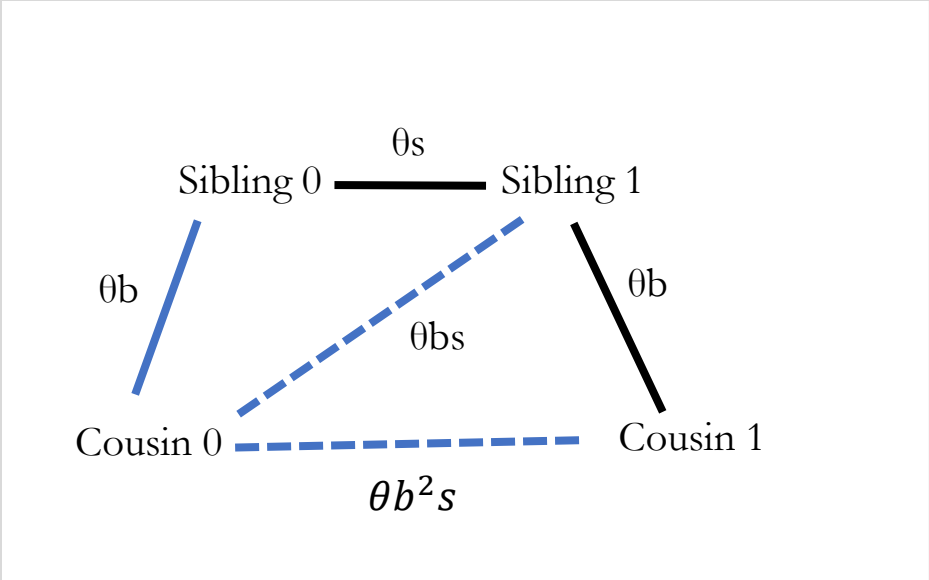
Figure 1: Observed Correlations between Relatives

A. In-Laws



Notes: Assuming the parent-child and sibling underlying correlations are independent of gender, and measurement error is independent of gender.

B. Siblings versus Cousins



Notes: Assuming the parent-child and sibling underlying correlations are independent of gender, and measurement error is independent of gender.

Figure 1 has illustrations of how such error-free estimates of the correlations that measure rates of social mobility can be obtained. In the first panel (1A) is shown the observed correlations in years of education between a child, their parent, their sibling, and their spouse. These correlations are respectively labelled $\theta b, \theta s, \theta r$, where θ is the error attenuation, and b, s, and r the underlying correlations in educational attainment between parent-child, siblings, and spouses. In figure 1 we assume for the moment that the error attenuation has the same proportionate effect irrespective of the genders of the relative pair, or their birth cohort.

Importantly we assume in figure 1A that the spousal choice is made independent of the status of the parents or siblings. In that case the correlation between parent and the child-in-law will be, as shown, θbr. Though this correlation is the product of the parent-child and spousal correlations, the error attenuation only appears once. Similarly the sibling to in-law correlation, the product of the sibling correlation times the spousal correlation, is θrs. For societies such as the modern Nordic countries the assumption that assortment in marriage is based solely on the characteristics of marital partners seems entirely plausible.

If we now take the observed correlation of parent to child-in-law (θbr), and divide that by the correlation of child to their spouse (θr), then that will be b, the true underlying parent-child correlation. Similarly if we take the observed correlation of parent to child-in-law, and divide that by the correlation of parent to child (θb), then that will be r, the true underlying spousal correlation. We can also estimate s, the true sibling correlation, by dividing the sibling-spouse correlation (θrs) by the observed spousal correlation (θr).

Panel B of figure 1 shows another set of relatives, siblings and their children. Again assuming the outcomes of their children are independent of the outcomes for their cousins, we will find that the cousin correlation will $\theta b^2 s$. The uncle/aunt-niece/nephew correlation will be similarly θbs. Taking the ratio of the cousin correlation to the uncle/aunt-niece/nephew correlation will give us an estimate of the underlying intergenerational correlation. The ratio of the cousin correlation to the sibling correlation will give an estimate of b^2.

As table 1 shows, we can derive further sets of relative correlations in years of education, that allow further estimates of the underlying mobility parameters *b*, *r*, and *s*. If, for example, we consider the relationships of a person to the spouse of their sibling in law, that would have an expected correlation of $\theta r^2 s$. The expected correlation to their aunt/uncle-in-law would be θbrs. Table 1 shows the observed correlations between 11 types of relatives using register data on completed years of education in both Sweden (from Collado et al., 2023), and from our own calculations from the population registers for Denmark. Also shown are the expected correlations for each relationship in terms of *b*, *r*, and *s*.

We assume above that the attenuation factor θ is the same for correlations across all gender combinations. Even if there is a different measurement attenuation for male-male, male-female and female-female correlations, the results will still hold. For if the attenuation factor for male-male correlations is φ, for male-female τ, and for female-female ω, then the average attenuation for all relative pairs if calculated separately by gender would now be, for all relationship pairs

$$\theta = \frac{1}{4}(\varphi + \omega + 2\tau)$$

Thus calculating true underlying correlations using ratios will see these disparate attenuation factors appear in the same way in numerator and denominator of each ratio employed.

Note that in table 1 spouses are defined as individuals who are parents of a given child. There is no implication that one or both played an active role in raising the child. Siblings includes only full siblings, children who shared a father and mother.

Table 1: Years of Education, Correlations with Relatives, Denmark and Sweden

Relationship	Expected Corr.	Sweden			Denmark		
		Obs.	Corr.	SE	Obs.	Corr.	SE
Spouse	θr	413,062	0.491	0.0012	1,869,156	0.443	0.0006
Sibling	θs	1,618,853	0.400	0.0007	2,993,118	0.374	0.0005
Parent	θb	1,595,270	0.354	0.0007	4,241,096	0.302	0.0004
Child-in-law	θbr	-	-	-	3,292,907	0.252	0.0005
Sibling in law	θrs	2,427,198	0.294	0.0006	2,545,645	0.283	0.0006
Aunt/Uncle	θbs	2,359,664	0.232	0.0006	783,564	0.232	0.0011
Cousin	$\theta b^2 s$	1,198,135	0.190	0.0009	650,723	0.191	0.0012
Sibling of Sibling in law	$\theta r s^2$	1,890,600	0.198	0.0007	1,582,569	0.192	0.0008
Spouse of Sibling in law	$\theta r^2 s$	943,108	0.231	0.0010	2,539,664	0.243	0.0006
Parent-Parent-in-law	$\theta b^2 r$	-	-	-	2,709,905	0.193	0.0006
Aunt/Uncle in law	θbrs	1,908,238	0.180	0.0007	765,909	0.183	0.0011

Sources: Danish Population Register, Collado et al., 2023, Table 3.

Note: For each relationship the table shows the number of pairs, the correlation, and the standard error of that correlation. The reported correlation is the average correlation within each relationship-type, irrespective of gender. Standard errors are computed as $SE = \frac{1-\rho^2}{\sqrt{N-1}}$.

We are also in these calculations implicitly including classical measurement errors. For status measures such as years of education, or annual earnings, this seems entirely reasonable. If we had a category variable, such as literacy, then the simple interpretation of the ratios as revealing underlying educational status will also work as long as there is an underlying normal distribution of educational attainment, where those above a certain percentile in the distribution appear as literate, and those below as illiterate. If that cutoff for literacy has an individual random component, then we would again be in the circumstance where literacy was a noisy measure of underlying educational status.

The data in table 1 in the Danish case looks at people born prior to 1985 so that they would overwhelmingly have completed their education. Since a criterion for inclusion was having both parents have an ID, those included here were the younger portion of the Danish

population, with an average birth year of 1967.[4] We thus end up including at maximum 2.3 million individuals. Years of education has been standardized to the same mean and standard deviation by birth cohort and by gender.

The Swedish data is based on an extract by Collado et al. from the Swedish Population Register. Thus in table 1, for most outcomes, despite Sweden having a population roughly double that of Denmark, we have more observations for Denmark.

3. Estimation Results

From Table 1 we derive Table 2, which shows the ratios of the correlations in table 1 that reveal the implied values of *b*, *r*, and *s*, as well as the standard error of each estimate. Table 2 also shows the implied average values of each of these correlations for Denmark and Sweden.

Several things stand out. The first is that the average implied values of *b*, *r* and *s* are very similar for Sweden as for Denmark, typically with less than 5% of a deviation. The second is the close correlation of people in parenting. The average underlying correlation of educational status for parents is 0.81 in Denmark and 0.76 in Sweden. Such close matching is consistent with both high observed sibling correlations, and high parent-child correlations. The third feature is the strong implied intergenerational correlation of 0.67-0.69. This is nearly double the observed intergeneration correlation in years of education for both Denmark and Sweden observed in table 1. Finally we also observe a strong sibling correlation of 0.64-0.70, which is again nearly double the average observed correlation of 0.39.

We also estimated the parameter values using male-only kinship types to ensure our findings are the same where we restrict the relative correlations to be only those between male relatives. Restricting our analysis to male-only kinship ties yields nearly identical results, supporting the robustness of the estimates. With all gender pairings the implied intergenerational correlation averages 0.68, while looking just at correlations between male relatives the intergenerational correlation is 0.70. Similarly the sibling correlation goes from 0.67 to 0.70, and the marital correlation from 0.79 to 0.78. So the estimates are robust to gender combinations.

[4] Since the register was introduced in 1968 only Danish residents still living in 1968 are guaranteed to be included.

Table 2: Implied Underlying Correlations, Denmark and Sweden

Relationship	Sweden			Denmark		
	b	*r*	*s*	*b*	*r*	*s*
Child-in-law	-	-	-	0.567	0.833	-
				(0.001)	(0.002)	
Aunt/Uncle	0.569	-	0.656	0.621	-	0.768
	(0.002)		(0.002)	(0.003)		(0.004)
Sibling-in-law	-	0.720	0.598	-	0.757	0.638
		(0.002)	(0.002)		(0.002)	(0.002)
Cousin	0.821	-	-	0.825	-	-
	(0.004)			(0.006)		
Sibling of Sibling-in-law	-	-	0.675	-	-	0.678
			(0.003)			(0.003)
Spouse of Sibling-in-law	-	0.799	-	-	0.859	-
		(0.004)			(0.003)	
Parent-parent-in-law	-	-	-	0.767	-	-
				(0.003)		
Aunt/Uncle-in-law	0.612	0.774	-	0.646	0.788	0.726
	(0.003)	(0.004)		(0.004)	(0.006)	(0.005)
Average	**0.67**	**0.76**	**0.64**	**0.69**	**0.81**	**0.70**

Source: Table 1.

Notes: The table shows the implied values of correlations *b*, *r*, and *s* from Table 1. Standard errors in parentheses. These are calculated using the Delta method (see Appendix).

All this implies that for educational attainment, both Denmark and Sweden show strong familiar persistence. This is occurring despite the provision in these societies of both free education up to university level, and also stipends to cover students living expenses from high school onwards.

Note also that there is an important connection between the parental status correlation and the intergenerational correlation. If both parents contribute equally to child outcomes then the correlation between a single parent and a child will be, at maximum, $(1 + r)/2$. This implies that the intergenerational correlation between a single parent and child can only be as

high as 0.8 if the parental correlation in status is at least 0.6. If the conventional measurement-attenuated correlations between parents on educational attainment, which are around 0.45, were capturing true rates of parental assortment, then intergenerational correlations would have to be much lower than observed here.

As noted above, the data on Swedish familial correlations in years of education comes from Collado et al. (2023). Collado et al., were able to identify in Sweden 141 different types of relatives in register data by linking children to each of their parents, parents to grandparents, parents to siblings, and so on through in-laws across as many as five marriages. They then estimate the correlation in years of education and income between each of these relatives. The more remote of these relatives include spouse of sibling-in-law (third degree), which involves linking seven individuals across four marriages and three sibships.

To this correlation data, Collado et al. fitted a social transmission of status model which has 20 free parameters, a combination of latent and observed status, as well as marital matching on both latent and observed status. Then using a selected set of 105 correlations, Collado et al. were able to show a strong fit of this 20-parameter model to the data for years of education.[5] That 20-parameter model, in line with the results in table 2, shows strong assortment in parenting, and strong persistence across generations. So for a wider collection of family relations there is similar evidence of strong persistence of status as relatives become more remote.

We did also estimate *r*, *b*, and *s* in the same way as in tables 1 and 2 using income as the outcome. In this case there are clear gender differences in correlations of income across relatives, so that the estimation has to be done using male relatives only. Here also a problem we run into is that even for relatives as close as cousins, the correlations in income are only 0.07 in Sweden and 0.09 in Denmark, compared to 0.19 in both countries for years of education across all cousins. This makes the estimates using the ratio of observed correlations much noisier. The average implied spousal correlation at 0.74 is similar to the education estimates. But the intergenerational and sibling correlations are estimated at only 0.55 and 0.53. These two estimates, however, are still multiple times higher than the observed intergenerational correlations of 0.19 and the observed sibling correlations of 0.20. Again there is much more persistence than the observed data would imply.

[5] The baseline model is fitted to only 105 correlations because this same model does not fit well for cousins, or for in-laws to the fourth degree or higher. (p. 1213).

4. Comparisons of Social Mobility Rates with other countries and times

For England, Clark (2023) estimates underlying rates of social mobility over the years 1650-2021, using multiple social status indicators. These indicators are literacy at marriage (weddings 1754-1889), attaining higher education, occupational status, log house value 1999-2021, index of multiple deprivation of local neighborhood, 1999-2021, and company directorships, 1999-2021. Correlations on these outcomes are reported for siblings, parent-child, sibling once removed, grandparent-child, and first to fourth cousins, as well as first to fourth cousins once removed. These correlations are derived from a large genealogical database, *Families of England*, with 423,000 observations which tracks everyone holding a set of rarer surnames from 1600 to 2025.

From these correlations it is possible to estimate the underlying intergenerational mobility rates in England, b, for all these outcomes. Thus we can estimate intergenerational mobility using literacy at marriage 1754-1889, occupational status and higher education attainment for men born 1780-1859 and 1860-1919, and house values, index of multiple deprivation, and company directorships for men and women born 1920-1995. Just using the correlations of siblings, parent-child, sibling once removed, and cousins we get estimates of the underlying intergenerational correlation, b, and sibling correlation, s.

Table 3 reports the average underlying parent-child and sibling correlation for England in the nineteenth century, and for the modern population observed 1999-2021. The estimated intergenerational correlation is 0.80 for the nineteenth century and 0.77 for modern England. The sibling correlation is 0.79 for the nineteenth century and 0.72 for modern England.

Clark (2023) also derives for the nineteenth and twentieth centuries estimates of the underlying marital correlation, r. This comes from the ratio of the correlation of occupational status between grooms to father-in-laws to the correlation of groom to father. These correlations derive from a large set of marriage records for England 1837-2021, where in these years marriage records record the occupations of grooms, fathers, and father-in-laws. As table 3 shows the marital correlation was estimated at 0.77 in nineteenth century England and 0.80 for the twentieth century.

Table 3: Comparative Underlying Social Mobility Rates, England versus Nordic

Population	Period	Marital *r*	Sibling *s*	Parent-Child *b*
England	19th c	0.77	0.79	0.80
England	Modern	0.80	0.72	0.77
Denmark	Modern	0.81	0.70	0.74
Sweden	Modern	0.77	0.67	0.75

Sources: See text, Clark, 2023.

Table 3 suggests that Denmark and Sweden have underlying social mobility rates that are similar to modern England, across all three dimensions of mobility. Marital assortment is as strong in the Nordic countries as in modern England, and intergenerational and sibling correlations are nearly as high.

Even more remarkable in table 3 is that nineteenth century England had intergenerational and sibling correlations that only modestly exceed those of modern Denmark and Sweden. In contrast to the modern Nordic societies, in nineteenth century England there was minimal public provision of education. Indeed before 1871 there was no legal requirement for parents to educate their children.

Clark et al., 2014, estimates underlying social mobility rates across a variety of countries and time periods using surname status persistence as an alternative way to control for measurement errors in status indicators. In particular, this book includes a chapter measuring Swedish social mobility rates all the way from the eighteenth century to the 2000s, by looking at the overrepresentation of elite surnames from the eighteenth century in such elites as university graduates, medical doctors, and lawyers up until the present time.

It finds, for instance, that evidence on representation of elite surnames among doctors suggests that for cohorts registered as doctors 1890-1919, 1920-49, 1950-79, and 1980-2009, implied intergenerational status persistence was 0.74 throughout (Clark et al., figure 2.13). The records of Lund university students 1700-1910 similarly suggest an intergenerational status persistence of 0.78 throughout these enrollment years (Clark et al., figure 2.13). Thus the

estimated educational status persistence rates in Sweden in the years before 1950 only very modestly exceed those suggested by the register data for the current generations.

5. Confirming Evidence of Limited Nordic Social Mobility

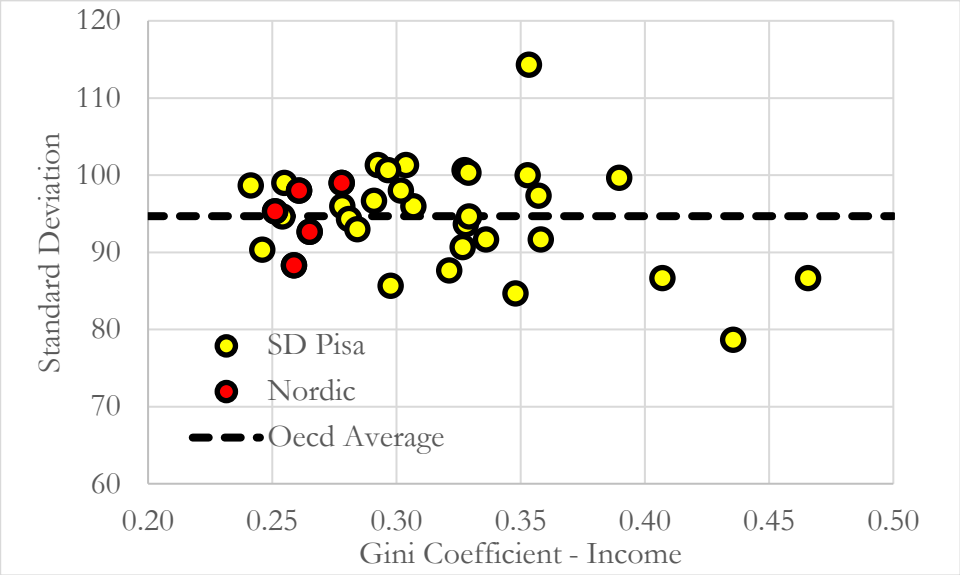
Support for the claim that societies such as Denmark and Sweden have not succeeded in increasing rates of social mobility comes if we look at the distribution of scores in the PISA (Program for International Student Assessment) measures of student reading, mathematical and science knowledge. The aim of the PISA program is to give periodic assessments of the academic achievements of a representative sample of 15-year-olds in each country.

Figure 2 shows for each OECD country in the 2018 collection of the PISA measures the average standard deviation by country of the PISA scores in Mathematics, Reading, and Science. These are graphed against average Gini coefficient for disposable income in each country for 2012-2022.

It is very clear in the figure that Nordic countries have as high a dispersion of PISA scores as the average OECD country.[6] This is despite the fact that the low Gini in these societies means much less variation in the material home environment of students than for the average OECD country. In Nordic countries, in addition, the great majority of children attend publicly subsidized pre-school ages 1-5, where standards of care and education are not dependent on parents' income. There is a substantial recent literature that emphasizes the benefits of such pre-school is particularly strong for children from the least advantaged families, if the care is of high quality (Gormley et al., 2005, Heckman and Lochner, 2000, Waldfogel, 2006). All this should compress the educational attainment differences of 15 year olds in Nordic countries. It does not. The extensive social provision of Nordic countries has not succeeded in narrowing scholastic performance gaps within each cohort.

[6] The Nordic countries are Denmark, Finland, Iceland, Norway and Sweden.

Figure 2: Standard Deviation of PISA scores 2018, by OECD country



Source: OECD, 2019, tables 1.B1.1-6, pp. 216-21.

Notes: The dashed line shows the OECD average standard deviation of 94.7. The Gini coefficient is that for disposable income, averaged for 2012-2022.

Conclusions

All measures of social status such as years of education, income, wealth, occupational status measure true, underlying status only imperfectly. Further the degree to which these measures incorporate measurement error varies across time and place. Attempts to compare societies in terms of their degree of social mobility across time and place have often failed to take any account of the problem of measurement error.

In this paper we suggest a method of correcting for measurement errors that is based on looking not at the absolute correlation of relatives in outcomes, but at their relative correlation. Applying such methods to Denmark, Sweden and England now, as well as England in the nineteenth century, we find three things.

First, actual educational intergenerational mobility rates in modern Denmark and Sweden are much lower than conventionally measured. Also the correlation of parents and of siblings in educational attainment is again much higher than conventionally measured. If educational

attainment is an index of social status in general then modern Denmark and Sweden are very immobile societies.

Second rates of educational mobility in Denmark and Sweden are only very modestly higher than social mobility rates measured through house values, neighborhood quality, or company directorships in modern England. Denmark and Sweden's more generous public support of education, and compression of household income inequalities, has not reduced the importance of families in determining child educational outcomes. This point was emphasized recently in a paper on Denmark by James Heckman and Rasmus Landersø (Heckman and Landersø, 2022).

Third, and most surprising, social mobility rates in modern Denmark and Sweden are only modestly higher than social mobility rates in nineteenth century England. Despite the absence of public educational provision in England for most of the nineteenth century, educational attainment in modern Denmark and Sweden is nearly as strongly inherited as in nineteenth century England. In Sweden, where we can measure educational status inheritance back even to the eighteenth century, the strength of inheritance now is as great as in the eighteenth and nineteenth centuries.

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Appendix: Computing standard errors using the Delta method

The reported standard errors in Table 2 are computed using the Delta method, a standard approach for approximating the variance of nonlinear functions of random variables. This method is particularly useful when estimating the standard errors of ratio-based estimators. Given two variables, *X* and *Y,* with means μ_X and μ_Y, and standard errors σ_X and σ_Y, respectively, the standard error of their ratio can be approximated using:

$$\sigma_{X/Y} = \frac{1}{\mu_Y}\sqrt{\sigma_X^2 + \frac{\mu_X^2}{\mu_Y^2}\sigma_Y^2}$$

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