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Intergenerational Income Mobility in Denmark and the United States*

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Abstract

In this paper, I conduct a novel comparison of intergenerational income mobility in Denmark and the United States, based on high-quality administrative data for both countries. The results confirm that the United States is substantially less mobile than Denmark, but they also show that the differences in mobility are smaller than previously reported. Mobility differences are larger for family income than individual income. When the individual incomes of children are considered, mobility differences are smaller for daughters than for sons. I also show that the estimated intergenerational elasticity of income for Denmark is quite robust to whether taxes or public transfers are included in the income measure.

Keywords: Comparative analysis of systems; inequality; social mobility

JEL classification: *I*28; *I*32; *J*62; *P*57

I. Introduction

In recent years, equality of opportunity has become a prominent issue for policymakers around the world. Researchers have compared measures of intergenerational mobility across countries because such measures tell us how a society is performing in terms of equality of opportunity. Comparisons of countries with different institutional arrangements are interesting because they can provide some clues about the underlying mechanisms of social mobility. The United States is often perceived as the land of opportunity: a country where one's chances of success do not depend on one's family background. Several studies, however, have documented that intergenerational income mobility is much lower in the United States than in the Scandinavian welfare states.

A problem with previous cross-country studies of intergenerational income mobility is that they have relied on different types of data, comparing results based on administrative register data from the

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Scandinavian countries with results based on US survey data. In this paper, I focus on the mobility estimates of Chetty *et al.* (2014) and Mitnik *et al.* (2015), which are based on US tax returns and other administrative data. I closely replicate their sample selection criteria, the ages at which children's income is measured, and the income concepts they use in order to compute directly comparable mobility estimates for Denmark, which are also based on administrative data. By proceeding this way, I am able to present the first comprehensive comparison of intergenerational income mobility in Denmark and the United States that is fully based on administrative data and on similar samples and income concepts for both countries.

The paper contains three separate analyses. In the first analysis, presented in Section IV, I conduct a new comparison of intergenerational income mobility in Denmark and the United States using comparable administrative data for both countries. While I consistently find that intergenerational income mobility in Denmark is substantially higher than in the United States, I also find that the results vary depending on whose income is considered: the intergenerational elasticity of income (IGE) for Denmark is roughly 40–50 percent of that in the United States when the family income of children is considered. Proportional differences based on the individual income of children are smaller and vary across genders. For sons, the Danish elasticity for individual earnings is 57 percent that of the United States, whereas this figure is 85 percent for daughters. I further show that assortative mating with respect to parental income is stronger in the United States than in Denmark, which explains why cross-country differences in intergenerational mobility are larger when they refer to children's family income rather than their individual income. Cross-country differences in mobility are smaller for daughters' earnings than for sons' earnings because of a larger gender gap in labor force participation in the United States compared with Denmark. Specifically, I show that the negative correlation between parental income and daughters' labor force participation is much stronger in the United States than in Denmark.

In the second analysis, presented in Section V, I relate the cross-country comparison in Section IV to previous comparisons in the literature. Previous studies have estimated the intergenerational elasticity of sons' earnings in Denmark to be 20–35 percent of that in the United States (see Jäntti *et al.*, 2006; Bratsberg *et al.*, 2007; Hussain *et al.*, 2009; Corak, 2013). By contrast, I estimate the intergenerational earnings elasticity of Danish sons to be 57 percent of that in the United States. I show that attenuation and selection biases have led previous studies to overstate the level of intergenerational earnings mobility in Denmark. Some of the existing mobility estimates for Denmark were also based on earnings measures that did not cover self-employment income, and I show that excluding self-employment income can result in a significant overstatement of mobility in Denmark.

Based on the earnings of fathers and sons, I estimate the Danish IGE to be 0.246, meaning that Danish sons on average earn 24.6 cents more when their father's earnings increase by one US dollar (US$). This estimate is higher than the previous comparable estimates for Denmark, which are in the range of 0.07–0.17.

In the third analysis, presented in Section VI, I show that the IGE for Denmark is quite robust to whether taxes or public transfers are included in the income measure. However, because the conventional IGE is highly sensitive to observations with close-to-zero income, researchers should pay special attention to the left tail of the income distributions when comparing IGE estimates before and after transfers.

II. Measuring Intergenerational Mobility

The literature on intergenerational income mobility encompasses a wide variety of approaches to measuring the degree to which children's social and economic opportunities depend upon the income of their parents. The canonical mobility measure, which is really a measure of intergenerational income persistence, is the elasticity of children's income with respect to their parents' income, or the IGE. A high IGE coefficient indicates a low degree of mobility (high degree of income persistence). Equation (1) estimates the IGE coefficient by regressing log child income ($\ln Y^C$) on log parent income ($\ln Y^P$):

$$\ln Y^C = \alpha + \beta^{IGE} \ln Y^P + \epsilon. \tag{1}$$

The slope coefficient β^{IGE} can also be expressed in terms of the correlation coefficient and the standard deviations of parents' and children's log incomes. Equation (2) illustrates how the IGE is affected by the marginal income distributions of each generation. If, for example, the correlation stays the same but inequality rises across generations, such that $SD(Y^C) > SD(Y^P)$, then IGE estimates will increase:

$$\beta^{IGE} = Corr(\ln Y^C, \ln Y^P)\,\frac{SD(\ln Y^C)}{SD(\ln Y^P)}. \tag{2}$$

There is a large body of literature in which different types of measurement error that lead to biased IGE estimates have been investigated. The ideal measure of income should approximate permanent or lifetime income, and should therefore be based on income observations for several years (Solon, 1992). This is especially important for the parental generation, as measurement error in an explanatory variable leads to attenuation bias. Solon (2002) and Mazumder (2005) suggest that as many as nine years (and preferably more) of parental income observations are needed to substantially reduce downward attenuation bias from transitory income shocks. Grawe (2006) and Haider and Solon (2006) show that life-cycle bias (rooted in heterogeneous age–income profiles) is best avoided when income is measured at mid-age (between the early 30s and mid-40s) for both parents and children.

Given that zero-income observations are excluded from the analysis, the use of earnings measures for children based on one or a few years of information leads to selection bias, as individuals with weaker labor force attachments are more likely to be excluded from the analysis, as emphasized by Mitnik *et al*. (2015) and Mitnik and Grusky (2020). Mitnik and Grusky (2020) propose an alternative estimand: the IGE of expected income, or IGE_E. The IGE_E has a similar interpretation to that of the conventional IGE, in that it also measures economic persistence (see the Appendix). Importantly, the IGE_E allows for the inclusion of zero-income children in the estimation sample, which eliminates the sample selection bias associated with the exclusion of zero-income children when estimating the conventional IGE. In addition, the IGE_E is much less sensitive to low-income observations in the children's generation than the conventional IGE (Chetty *et al*., 2014).

Another popular mobility measure is the rank–rank correlation, which is a measure of positional mobility. The rank–rank correlation equals the Spearman correlation between parent and child income, but one can also interpret the coefficient as the expected increase in child income rank when parental income increases by one rank unit. An advantage of the rank–rank correlation is that it allows for the inclusion of zero-income children and parents in the estimation samples. In addition, while the IGE depends on the distribution of income at different points in time, the rank–rank correlation is impervious to changes in income inequality. Small cross-country differences in rank mobility can thus translate into rather large differences in IGE estimates, due to large differences in income inequality across countries.

Mobility curves showing the relationship between child and parent log income by parental income percentile are also often considered in the literature. Several studies have found that this relationship is nonlinear, both in Denmark and in the United States (e.g., Bratsberg *et al*., 2007; Landersø and Heckman, 2017). Nonlinearity can cause single-point summary measures, such as the IGE coefficient, to be misleading. The shape of the mobility curve also casts light on the mechanisms underlying economic persistence. On the one hand, a concave mobility curve is consistent with the hypothesis that credit constraints lead low-income parents to under-invest in the human capital of their children. On the other hand, a convex mobility curve is consistent with the alternative complementarities hypothesis that low-income families live in disadvantaged neighborhoods and other social contexts that reduce the returns to investing in human capital (Mitnik *et al*., 2018). In order to adequately estimate mobility curves, large samples covering the full income distributions of parents and children are required. Such samples are provided by administrative data.

III. Data

I compare US mobility estimates from Chetty *et al*. (2014) and Mitnik *et al*. (2015), which are based on US tax returns and other administrative data, with mobility estimates based on full-population administrative register data for Denmark. The Danish register data contain information on parents, children, and their spouses and cohabiting partners. This information includes individual-level income components – such as wage income, self-employment income, capital income, and different types of public transfers, which are mainly third-party reported – and an overall measure of after-tax income. Income levels are deflated using the country-specific consumer price index, and they are made comparable with the help of a purchasing-power-parity-adjusted an exchange rate of US$100 to 776 Danish kroner (DKK). The income definitions, cohorts, and ages at which income is measured vary across analyses, as described in the following subsections.

Data Used in Section IV: Comparison with Chetty et al. (2014)

Chetty *et al*. (2014) consider children born in the period 1980–1982, and their data include as many as 9.9 million parent/child observations. They match parents and children by dependent claiming and are able to identify spouses. Chetty *et al*. (2014) measure parents' family income in the years 1996–2000, when their children are 15–20 years old, and children's income in the years 2011–2012, when they are in their late 20s and early 30s. Their main income measure is total pre-tax family income. This includes labor earnings (payroll and self-employment income), capital income, unemployment insurance, and social-security and disability benefits. It excludes non-taxable cash transfers, such as temporary assistance for needy families (TANF), supplemental security income (SSI), in-kind benefits, such as food stamps, and all refundable tax credits, such as the earned income tax credit (EITC). Chetty *et al*. (2014) also consider an individual earnings measure, which includes wage earnings and 100 percent of self-employment income.

In the Danish sample, I define parents to be the legal parents living with the child in 1996. This definition results in 30.5 percent of single parents in the Danish sample compared with 30.6 percent in the US sample. The average age of fathers in 1996 is 43.5 in the US sample and 44.0 in the Danish sample, and the average age of mothers is 41.1 for both countries. Spouses are defined by marriage, resulting in 65.5 percent single individuals in the Danish child generation in 2012 compared with only 44.3 percent in the data of Chetty *et al.* (2014).[1]

For Denmark, I measure total income as the sum of labor earnings, capital income, unemployment insurance, and retirement and disability benefits. This income measure approaches well the income measure used by Chetty *et al.* (2014). Because of differences in benefit schemes and eligibility rules between the two countries, it is not possible to perfectly align income measures across them. As a robustness check, I have also carried out the comparison using Danish income measures that include either no transfer income or all transfer income, and all results are very similar. In the Danish earnings measure, I include wage earnings and 100 percent of self-employment income. The Danish sample consists of 151,360 observations with average child and parental total pre-tax family income of at least US$10 (and 157,543 observations when zero-income children are included).[2]

Data Used in Section IV: Comparison with Mitnik et al. (2015)

Mitnik *et al.* (2015) use the Statistics of Income Mobility Panel (SOI-M), which is based on a stratified random sample of 1987 tax returns. They consider children born in the period 1972–1975. Parents' family income is measured as a nine-year average when children are 15–23 years old, and children's income is measured in 2010 (when they are 35–38 years old).[3] Parents and children are matched by dependent claiming in 1987, and the sample also includes spouses. The total income concept in Mitnik *et al.* (2015) is similar to that in Chetty *et al.* (2014), but excludes the non-taxable portion of pensions, annuities, and social security income. Mitnik *et al.* (2015) measure disposable income by subtracting out net federal taxes (including refundable tax credits such as the EITC) from total income. State taxes are not subtracted, and some non-taxable transfers (e.g., TANF) are

[1]These results are robust to also considering cohabiting partners as spouses in the Danish sample (which results in only 30.1 percent of single individuals in the children's generation).

[2]In the Danish data, interest income is reported to the tax authorities by financial institutions. This results in quite a few cases where the full income of a person is comprised of interests, and amounts to a few DKK. These observations are excluded to match the sample of Chetty *et al.* (2014), as they do not include the interest income of non-filing individuals as part of their income.

[3]Even though Mitnik *et al.* (2015) only include one year of child income, selection bias is not a concern as the IGE_E can be estimated without any problems using zero-income children in the sample (see the Appendix).

not included. Mitnik *et al*. (2015) include 100 percent of self-employment income in their definition of earnings.

For Denmark, I measure total income as the sum of labor earnings (including wages and 100 percent of self-employment income), capital income, and unemployment insurance to maximize comparability with the total income concept used by Mitnik *et al*. (2015).[4] Disposable (after-tax) income is computed in the Danish data by subtracting taxes from total pre-tax income, and individual earnings are measured as the sum of wages and 65 percent of positive self-employment income. As for the United States, the Danish family income definition includes the income of spouses. Results are robust to also including cohabiting partners in the Danish sample. The Danish parents are defined as the legal/registered parents living with the child in 1987.

Data Used in Section V: The Danish Father–Son Earnings IGE

The Danish sample includes children born in the period 1973–1975 and their fathers. Children without an observed legal father are dropped from the sample. Earnings are measured as the sum of wages and 100 percent of self-employment income. Only observations where both the child and father are observed with positive earnings for at least one year are included in the analysis.

Data Used in Section VI: Robustness to Different Income Measures

The sample replicates the Danish sample used in Table 1 of Landersø and Heckman (2017), and includes children born in the period 1973–1975. Parental income is the sum of the mother's and father's income (unless otherwise specified), which are measured when the child is 7–15 years old. Individual income for the children's generation is measured in the years 2010–2012. In order for a parent/child pair to be included in the sample, both parents are required to be observed for all nine years (i.e., when the child is 7–15 years old) and the child is required to be observed all three years (i.e., 2010–2012). Only observations with positive average income across all five income definitions considered in the analyses are included in the sample (unless otherwise specified).

Gross income including transfers is measured with the Statistics Denmark variable *PERINDKIALT*; it covers earnings (including self-employment income), transfers, capital income, and capital gains. The wage

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[4]The total income measure is similar to the Danish income definition used in the first subsection of Section IV but excludes retirement benefits and disability benefits. Results are similar when retirement benefits and disability benefits are included in the income measure.

earnings definition in Landersø and Heckman (2017) only includes salary income (Statistics Denmark variable *LOENMV*), whereas the remaining specifications also include self-employment income (Statistics Denmark variable *NETOVSKUD*). It is possible to substract total transfer income, which is observed in the Statistics Denmark variable *OVERFORSINDK*. After-tax income is measured by subtracting taxes (*SKATTOTNY*) from gross income including transfers.

IV. Comparisons Using Administrative Data for Both Countries

Previous comparisons of income mobility in the United States and Denmark (e.g., Jäntti *et al*., 2006; Hussain *et al*., 2009; Corak, 2013) compare results based on US survey data and results based on full-population administrative data from Denmark. An important concern is that differences in data sources might have affected previous cross-country comparisons. The advantage of using administrative data is that they offer much larger samples and are much less affected by attrition, non-response, and measurement error than survey data.

Recent studies based on US administrative data (Chetty *et al*., 2014; Mitnik *et al*., 2015) allow us to carry out comparisons of intergenerational income mobility in Denmark and the United States that rely on administrative data for both countries. This section presents Danish mobility estimates that are directly comparable with the mobility estimates produced by those US studies. The sample selection criteria, income definitions, and so forth used for the United States were carefully replicated in the Danish data in order to maximize the comparability of the results across countries.

Comparison with Chetty et al. (2014)

Table 1 reports US mobility estimates from Chetty *et al*. (2014), comparable estimates for Denmark, and the corresponding DK/US coefficient ratios. Rows 1–6 show that the Danish IGE and IGE_E estimates based on the family income of parents and children are approximately half the size of the US estimates, both when sons and daughters are pooled together and when they are considered separately; similar results are obtained when only parents whose income is between the 10th and 90th percentiles are included in the analysis.[5] In the latter case, the IGE and IGE_E estimates increase for both countries, indicating that intergenerational income persistence is lowest among children of parents with the lowest or highest levels of income.

[5]The IGE of expectations (IGE_E) is an alternative estimand of the intergenerational income elasticity, which is described in the Appendix.

Table 1. *Comparison with Chetty et al. (2014)*

Sample and income concept	Estimand	US	DK	DK/US
Parent and child family income	IGE	0.344	0.171	0.494
		(0.000)	(0.004)	
Parental income in P10–P90, parent and child family income	IGE	0.452	0.237	0.524
		(0.001)	(0.007)	
Sons, parent, and child family income	IGE	0.349	0.178	0.510
		(0.001)	(0.005)	
Daughters, parent, and child family income	IGE	0.342	0.163	0.477
		(0.001)	(0.005)	
Parent and child family income	IGE_E	0.335	0.175	0.522
		(0.008)	(0.005)	
Parental income in P10–P90, parent and child family income	IGE_E	0.414	0.203	0.490
		(0.004)	(0.009)	
Parent and child family income	Rank–rank	0.341	0.203	0.595
		(0.000)	(0.003)	
Sons, parent, and child family income	Rank–rank	0.336	0.215	0.640
		(0.000)	(0.003)	
Daughters, parent, and child family income	Rank–rank	0.346	0.190	0.549
		(0.000)	(0.004)	
Child individual earnings and parent family income	Rank–rank	0.282	0.223	0.791
		(0.000)	(0.003)	
Sons' individual earnings and parent family income	Rank–rank	0.313	0.228	0.728
		(0.000)	(0.004)	
Daughters' individual earnings and parent family income	Rank–rank	0.249	0.211	0.847
		(0.000)	(0.003)	

Notes: Standard errors are in parentheses. The samples include children born in the years 1980–1982. Parental income is measured in the years 1996–2000 and children's income is measured in 2011–2012. IGE estimates exclude zero-income observations in both generations, while IGE_E and rank–rank estimates only exclude zero-income observations in the parent's generation. US results are from Chetty *et al*. (2014, see their Table I and Online Appendix Figure I). Danish results are the author's own calculations based on Danish Register data.

Cross-country differences in rank–rank correlations are somewhat smaller than cross-country differences in IGEs: Table 1 shows that Danish rank–rank coefficients for family income are 60 percent of the US rank–rank coefficients (Row 7), compared to 50 percent for IGE coefficients (Row 1).[6]. One important difference between the IGE and the rank–rank coefficient is that the IGE coefficient is affected by inequality changes

[6]These results are in keeping with previous findings: Corak *et al*. (2014) also find smaller proportional differences in rank–rank correlations than in IGEs, when comparing the United States with Sweden. The Danish rank–rank correlation in family income of 0.203 is slightly higher than the Danish estimate of 0.18 mentioned in Chetty *et al*. (2014)

across generations, while the rank–rank coefficient is not.[7] Thus, a larger increase in inequality across generations in the United States than in Denmark results in larger cross-country differences in IGE estimates compared with rank–rank correlations.

Cross-country differences in rank–rank correlations are larger when based on children's family income than on their individual earnings. While Danish rank–rank coefficients in family income are equal to about 60 percent of the corresponding US rank–rank coefficients, Danish estimates based on children's individual income are equal to about 80 percent of their US counterparts. For rank–rank estimates based on children's individual earnings, the DK/US ratio is smaller for sons than for daughters.

The estimates in Table 1 are based on five years of parental income and a measure of children's income obtained relatively early (when children are in their early 30s). A relevant concern is therefore that the IGE and IGE_E estimates are being pulled down by attenuation and life-cycle biases (see Mazumder, 2015; Mitnik *et al*., 2019). In the following subsection, I present an alternative cross-country comparison based on US estimates from Mitnik *et al*. (2015), where parental income is based on nine years of information and children are measured in their late 30s, such that life-cycle biases are much less consequential.

The estimated IGE_E coefficients in Rows 1 and 2 of Table 2 (see the following subsection for a discussion of Table 2) are indeed higher than the corresponding IGE_E estimates in Row 5 of Table 1 for both countries, suggesting that the mobility estimates in the comparison with Chetty *et al*. (2014) are in fact downward biased. The estimated cross-country difference in IGE_E coefficients is also slightly larger in the comparison with Mitnik *et al*. (2015) – the DK IGE_E coefficient is 40 percent of the US coefficient – than in the comparison with Chetty *et al*. (2014), where the DK IGE_E coefficient is 50 percent of the US coefficient.

Figure 1 shows the binned scatter plots of the relationship between child and parent log income across parental income percentiles. Both countries have S-shaped mobility curves, indicating that intergenerational income persistence varies across the parental distribution, with the largest persistence (steepest slope) found among children of middle-income parents. This nonlinearity shows that comparisons of IGE coefficients alone are problematic, as the underlying assumption of linearity is violated for both countries. Region-specific estimates for the bottom and top of the parental income distributions suggest that, while there is less economic persistence in Denmark than in the United States at all levels of parental

[7]The parent/child ratio of standard deviations of log income affects the IGE coefficient (see equation (2)), but not the rank–rank coefficient.

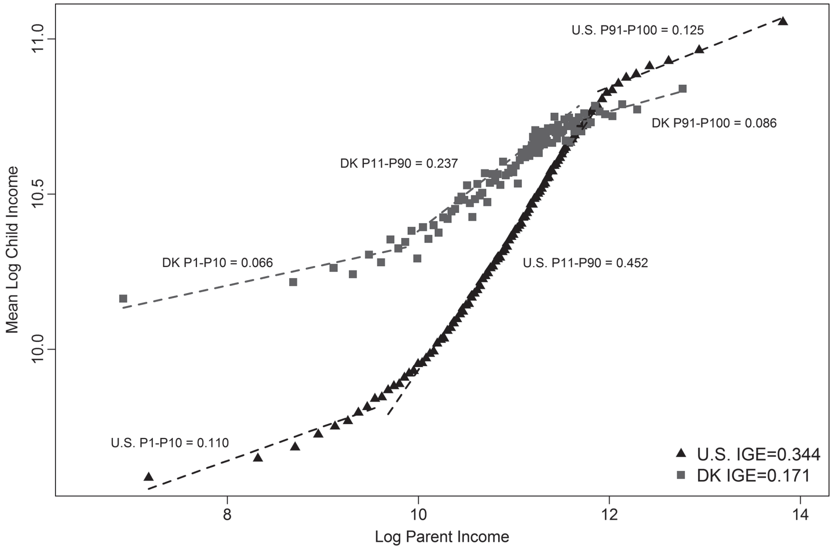


Fig. 1. Comparison with Chetty *et al.* (2014): IGE mobility curves of family income
Notes: The mean log of child family income is plotted against the mean log of parent family income at each centile bin of parental income, for the US and DK. The US results are from Figure I.B of Chetty *et al.* (2014), and the Danish results are the author's own calculations. Region-specific slopes for parental income percentiles 1–10, 11–90, and 91–100 are shown.

income, cross-country differences are largest among children of middle-income parents, where persistence in both countries is also the highest.

Figure 2 shows the expected child rank for each parental income percentile for the two countries. While the US rank–rank curve is close to linear, the Danish rank–rank curve has steeper slopes at the tails of the parental income distribution. The DK/US ratio in rank–rank coefficients is 0.60 for parental income percentiles 1–10, while it is 0.52 for parental income percentiles 11–90 and 91–100.

Comparison with Mitnik et al. (2015)

While the sample used by Mitnik *et al.* (2015) is smaller than the sample used by Chetty *et al.* (2014), it covers a broader time span and thus it allows us to better address life-cycle and attenuation biases. Mitnik *et al.* (2015) focus on the IGE of the expectation, IGE_E, which is an alternative to the conventional IGE (see the Appendix). The economic interpretation of IGE_E estimates is similar to that of conventional IGE estimates, in the sense that the former also measure economic persistence.

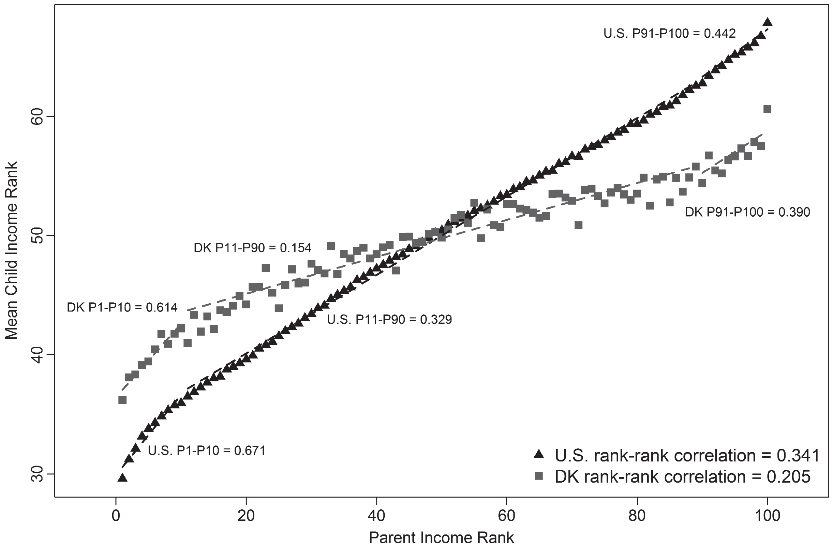


Fig. 2. Comparison with Chetty *et al.* (2014): rank–rank mobility curves of family income
Notes: For each centile bin of parental family income, the expected family income rank of children is plotted. The US results are from Figure II.A of Chetty *et al.* (2014). The Danish results are the author's own calculations. Region-specific slopes for parental income percentiles 1–10, 11–90, and 91–100 are shown.

Table 2 presents US IGE_E estimates from Mitnik *et al.* (2015) along with comparable estimates for Denmark. For each gender, the Danish IGE_E coefficient based on total family income is roughly 40 percent of the corresponding US coefficient.[8] For disposable family income, Danish estimates are 50 percent of the US estimates, while the same figure is 41 percent for daughters. The cross-country differences in IGE_E estimates based on the individual earnings of children are larger for sons than for daughters. The Danish IGE_E coefficient of sons' individual earnings is 57 percent of the US coefficient, while the Danish IGE_E coefficient of daughters' individual earnings is 81 percent of the US coefficient.

Figure 3 shows the mobility curves for the individual earnings of sons and daughters in the United States and Denmark. The mobility curves are nonlinear and have similar shapes across countries and genders; they are characterized by convexity over the bulk of the parental income distribution and then flattening at the top, as Mitnik *et al.* (2015) reported for the United

[8]A similar DK/US comparison based on US IGE_E estimates from Chetty *et al.* (2014) is shown in Row 5 of Table 1, where the Danish IGE_E coefficient in family income (pooling sons and daughters) is 52 percent of the US coefficient.

Table 2. *Comparison with Mitnik et al. (2015)*

Sample and income concept	Estimand	US	DK	DK/US
Total family income of parents and sons	IGE_E	0.48 (0.44–0.52)	0.20 (0.19–0.20)	0.42
Total family income of parents and daughters	IGE_E	0.46 (0.42–0.50)	0.17 (0.16–0.19)	0.37
Disposable family income of parents and sons	IGE_E	0.46 (0.42–0.51)	0.23 (0.22–0.24)	0.50
Disposable family income of parents and daughters	IGE_E	0.44 (0.40–0.48)	0.18 (0.17–0.19)	0.41
Sons' individual earnings and parent disposable family income	IGE_E	0.49 (0.43–0.53)	0.28 (0.27–0.28)	0.57
Daughters' individual earnings and parent disposable family income	IGE_E	0.27 (0.22–0.33)	0.22 (0.21–0.24)	0.81

Notes: 95 percent confidence intervals (bootstrapped) are in parentheses. The samples include children born in the years 1972–1975. Parental income is measured when children are aged 15–23, and childen's income is measured in 2010 when they are in their late 30s. US estimates are from Tables 6, 18 and 24 of Mitnik *et al*. (2015). The Danish results are the author's own calculations based on Danish Register data.

States. Similar to Figure 1, Figure 3 also suggests that intergenerational income persistence is highest for children of middle-income parents in both countries.[9]

The finding that the earnings mobility curves have similar shapes in Denmark and the United States is inconsistent with the findings in Bratsberg *et al*. (2007) and Landersø and Heckman (2017), who also find convex mobility curves for Denmark but not for the United States. As pointed out by Mitnik *et al*. (2015), this is likely to be because Bratsberg *et al*. (2007) and Landersø and Heckman (2017) use US survey data, which do not cover the income distribution well enough to properly asses the shape of the US mobility curve.

In the following, I replicate for Denmark the analyses that Mitnik *et al*. (2015) carried out to ascertain the roles of gender and marriage in the mobility process in the United States, and I compare the findings across the two countries. Figure 4 examines cross-country differences in marriage patterns, conditional on parental income. Figures 4(a) and (b) show that the probability of marriage and spousal earnings are both more strongly associated with parental income in the United States

[9] Mitnik *et al*. (2015) do not explain what causes the bumpy patterns in the US mobility curves. The small hump in the Danish mobility curves for children of low-income parents is caused by a shift from one- to two-parent households around the 7th parental income percentile. The downward segment is generated by the fact that children of a single parent with an average household income earn more, on average, than children with two low-income parents.

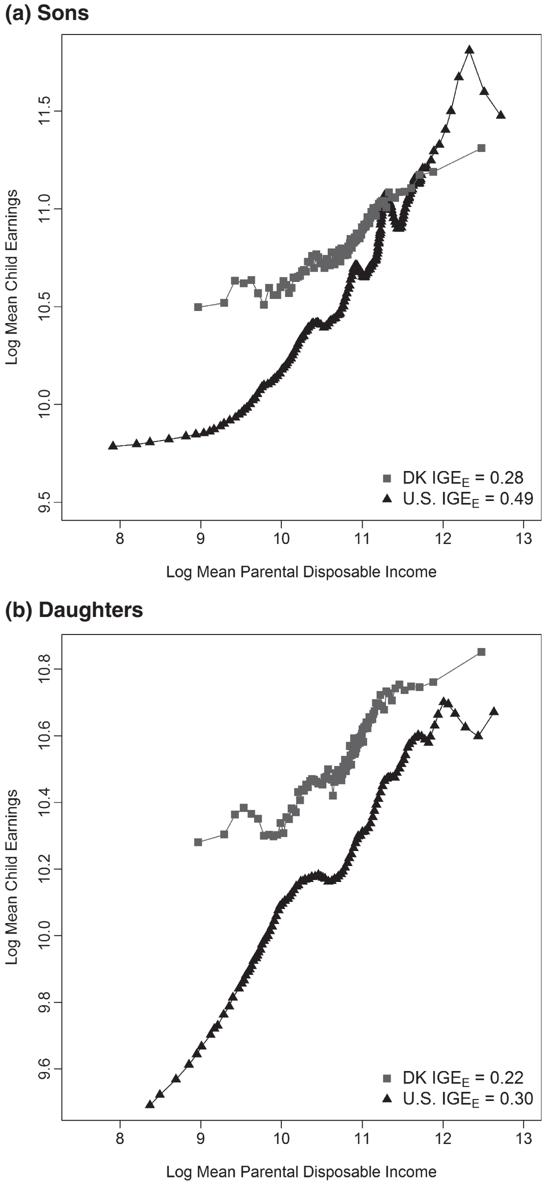
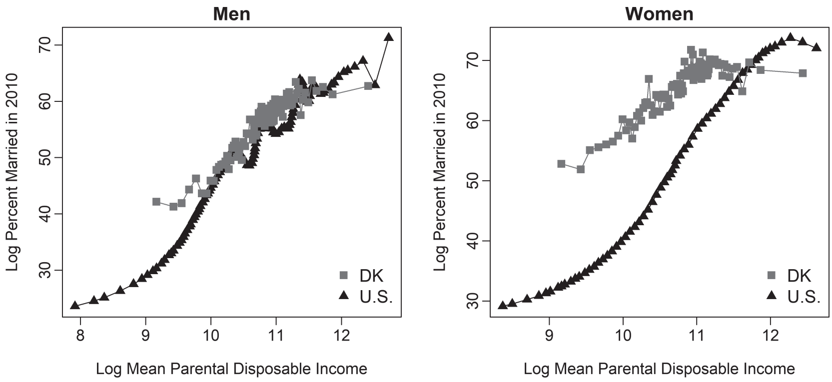
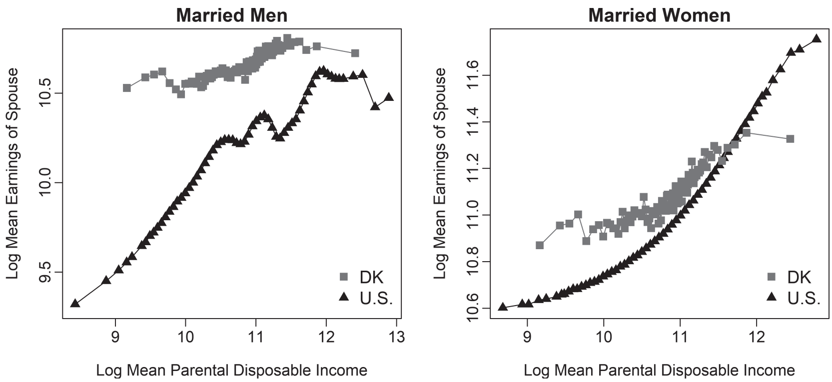


Fig. 3. Comparison with Mitnik *et al*. (2015): IGE$_E$ mobility curves of sons' and daughters' individual earnings

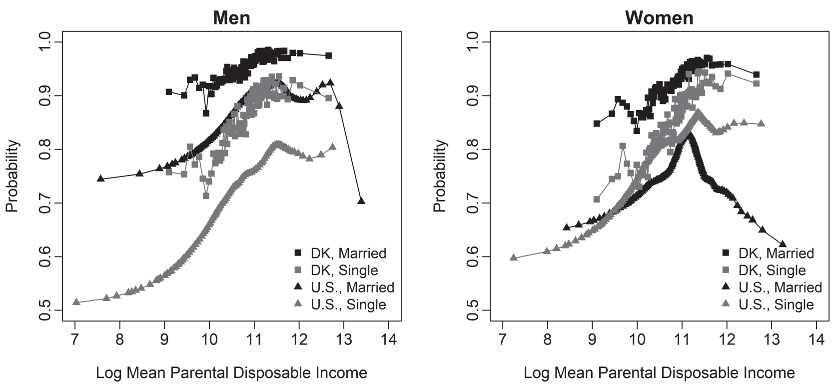
Notes: For different bins of parental disposable family income percentile, the log of the mean of sons'/daughter's individual earnings is plotted against the log of parental disposable family income. The US results are from Figure 8 of Mitnik *et al*. (2015), and the Danish results are the author's own calculations.



(a) Marriage probability



(b) Spousal earnings of married individuals



(c) Employment probability

Fig. 4. Comparison with Mitnik *et al*. (2015): marriage probability, spousal earnings, and employment probability as a function of parental income

Notes: The Danish results are the author's own calculations. The US results are from Figures 9–12 of Mitnik *et al*. (2015).

than in Denmark. When parental income increases, the child's marriage probability and expected spouse earnings increase more in the United States than in Denmark. Cross-country differences in marriage patterns thus explain why there are larger cross-country differences between mobility estimates based on the children's family income than on their individual earnings.

Figure 4(c) shows the employment probability of sons and daughters in both countries as a function of parental income, separately for married and single children. Employment probabilities are quite similar for Danish men and women, with a positive association between parental income and employment probability, and with married individuals showing the largest employment chances at each level of parental income. As Mitnik *et al*. (2015) report, however, there are large gender differences in employment probabilities in the United States. While the association between employment probability and parental income is mostly positive for US sons, the association is almost triangular for US daughters: a positive relationship for daughters of low- to middle-income parents, and a negative relationship for daughters of middle- to high-income parents.

The sharp fall in the employment probability for married US daughters of high-income parents leads to a lower earnings mobility coefficient, whereas this is not the case for Danish daughters. Cross-country differences in female employment patterns thus explain why cross-country differences in individual earnings mobility for daughters are smaller than they are for sons. This finding highlights the importance of considering sons and daughters separately for measures of individual earnings mobility, which is also the standard approach.

V. The Danish Father–Son Earnings IGE

Cross-country comparisons of intergenerational income mobility are often based on father–son earnings IGEs. Previous studies have found that the Danish father–son earnings IGE is only 20–35 percent of its US counterpart (e.g., Jäntti *et al*., 2006; Hussain *et al*., 2009; Corak, 2013). Thus, the finding that the Danish earnings IGE for sons is 57 percent of that in the United States (see Table 2) suggests that the difference in earnings mobility between the two countries is smaller than what has previously been reported in the literature.

The aim of this section is to produce the best father–son earnings IGE estimate for Denmark that is possible, and to assess the magnitudes of the life-cycle, selection, and attenuation biases that have affected previous mobility estimates for Denmark. Using Danish register data for 1980–2015, I focus on the birth cohorts 1973–1975. I measure the earnings of fathers, including self-employment income, over nine years (when their children are 6–14 years old) and the earnings of children over eight years (when they are 33–39 years old). The father–son earnings IGE estimate is 0.246, whereas the corresponding father–daughter estimate is 0.214.[10]

By contrast, Jäntti *et al.* (2006) estimate the Danish father–son earnings IGE to be as low as 0.07. However, several suboptimal measurement decisions generate a large downward bias in the estimated coefficient.[11] Indeed, Jäntti *et al.* (2006) only use one year of earnings information for fathers, which introduces attenuation bias. Fathers are also measured at relatively old ages (when their sons are 19–21 years old), which introduces a downward life-cycle bias. The sons' earnings are measured in just one year, which can be expected to result in a downward sample-selection bias, as sons with zero earnings in the considered year are excluded from the analysis.

Similar concerns apply to the IGE estimate of 0.121 produced by Bratsberg *et al.* (2007), who use two years of information for both fathers and sons, and also measure fathers' earnings at relatively old ages. Hussain *et al.* (2009) arrive at an estimate of 0.123 when they measure fathers' earnings as a five-year average (pertaining to when their sons are in their late teens), and sons' earnings for just one year in 2002 (when they are 30–40 years old). Munk *et al.* (2016) measure the earnings of both fathers and sons for five years (fathers in 1980–1984 and sons in 2004–2008), and are thereby able to reduce attenuation and selection bias to a much larger extent, reaching a higher IGE estimate of 0.171.

Table 3 quantifies the extent to which attenuation, life-cycle, and selection biases have affected the Danish estimates of father–son earnings IGEs just reviewed. In each panel, the column headings indicate the ages of the sons when their earnings are measured, whereas the row headings indicate the ages of the sons when the earnings of their fathers are measured. The upper-left cell of each panel shows the IGE estimate based on earnings measured at ages (for both fathers and sons) that approach those in the study under consideration. The IGE estimates are similar in magnitude to those produced by the previous studies, but they are not identical as they consider different cohorts and employ different sample inclusion rules and earnings definitions. The cell at the center of each panel shows the estimated IGE based on earnings of fathers and sons measured at ages when life-cycle bias is minimized (for fathers, when their sons are 10 years old, and for sons, when they are 38 years old) but

[10]In comparison, US estimates of the father–son earnings IGE are approximately 0.5 (see Corak, 2006; Mazumder, 2005, 2015).

[11]The decisions are suboptimal given the goal of obtaining the best possible estimates for Denmark (as opposed to comparing estimates for Denmark and other countries).

Table 3. *Attenuation, life-cycle, and selection biases in previous Danish father–son earnings IGEs*

Son's age when his father's earnings are measured	Son's age when his earnings are measured		
	Jäntti *et al*. (2006): IGE = 0.07, cohorts 1958–1960		
	38+40	**38**	**33–39**
20	0.109	0.103	0.111
10	0.191	0.200	0.205
6–14	0.209	0.193	0.246
	Bratsberg *et al*. (2007): IGE = 0.121, cohort 1958		
	37+39	**38**	**33–39**
19–20	0.110	0.106	0.120
10	0.185	0.192	0.203
6–14	0.211	0.193	0.246
	Hussain *et al*. (2009): IGE = 0.123, cohorts 1961–1971		
	35	**38**	**33–39**
17–21	0.109[a]	0.118	0.142
10	0.166	0.200	0.205
6–14	0.183	0.193	0.246
	Munk *et al*. (2016): IGE = 0.171, cohort 1965–1972		
	35–39	**38**	**33–39**
11–15	0.203[b]	0.175	0.214
10	0.200	0.200	0.205
6–14	0.229	0.193	0.246

Notes: Each panel shows how the Danish father–son earnings IGE changes with the ages at which the earnings of sons and their fathers are measured. All estimates pertain to sons born in 1973–1975 and their legal fathers. Earnings include wages and 100 percent of self-employment income. "38+40" indicates that ages 38 and 40 are considered, while "33–39" indicates that ages from 33 to 39 are considered. [a] 0.071 with ages used for the earliest cohort (1961) and 0.105 with ages used for the latest cohort (1971). [b] 0.168 with ages used for the earliest cohort (1965) and 0.210 with ages used for the latest cohort (1972).

where selection and attenuation biases are still present because earnings are measured in just one year. These biases are substantially reduced when the earnings of both fathers and sons are measured during more years and at optimal ages; the bottom-right cell of each panel shows the preferred IGE estimate of 0.246, where attenuation and selection biases are reduced as much as possible. The estimates shown in other cells can be interpreted similarly.

The results presented in Table 3 suggest that the IGE estimate in Jäntti *et al*. (2006) suffers from a downward bias of 56 percent. Using the Shapley decomposition, the bias can be broken down into a parental life-cycle bias of 33 percent, an attenuation bias of 7 percent, and a selection bias of approximately 15 percent. Roughly similar magnitudes of biases affect the IGE estimate in Bratsberg *et al*. (2007). The downward bias of the IGE estimate in Hussain *et al*. (2009) is also 56 percent, with a parental life-cycle bias of 28 percent, an attenuation bias of 7 percent, a child life-cycle bias of 9 percent, and a selection bias of 12 percent. A similar exercise suggests that the estimate in Munk *et al*. (2016) is downward biased by approximately 17 percent, where 4.5 percent is due to parental life-cycle bias, 7 percent is due to attenuation bias, and 4.5 percent is due to selection bias.

The previous studies also vary on how they measure earnings. Jäntti *et al*. (2006) include self-employment income as earnings whereas Hussain *et al*. (2009) do not. Bratsberg *et al*. (2007) and Munk *et al*. (2016) do not clearly specify if they count self-employment income as earnings or not. As discussed in detail in Section VI, in a recent comparison of social mobility in Denmark and the United States, Landersø and Heckman (2017) also exclude self-employment income from their measure of wage earnings in Denmark (but not in the United States).

In the income mobility literature, income is considered an index of economic status, a proxy for living standards, or as reflecting earning capacity. As income from self-employment is relevant in all three cases, I argue that it ought to be included in measures of earnings, which is also the standard approach in the income mobility literature. The preferred father–son IGE estimate drops from 0.246 to 0.091 when self-employment income is not counted as earnings. The exclusion of self-employment income is seemingly less consequential when the earnings of fathers and sons are measured over fewer years. However, this is only because self-employed individuals are then more likely to be considered as zero-earners and thereby excluded from the sample (generating sample selection bias) rather than being included but with low earnings (generating a measurement bias).

VI. Robustness to Different Income Measures

The results reported in Section IV made apparent that the magnitude of the IGE differences between Denmark and the United States varies markedly depending on whether the analysis focuses on family income or individual earnings. In a recent comparison of social mobility in Denmark and the United States, Landersø and Heckman (2017, hereafter L&H) argue that cross-country differences in income mobility also vary greatly depending on how the income measure is defined. Keeping the sample fixed, L&H provide evidence that IGE estimates can be highly sensitive to whether taxes, transfers, and/or capital income are included in the income measure or not.

While L&H discuss the variation in IGE estimates across income measures in relation to economic mechanisms, I argue that the estimated variation is driven by measurement-related issues that can be avoided. I show that the Danish IGE coefficient is in fact quite robust to the income measure used (i.e., to whether taxes and/or transfers are included in the definition of income), once self-employment income is not neglected, and once the problem of close-to-zero income observations, to which the (conventional) IGE is highly sensitive (see Chetty *et al*., 2014, Table 1; Mitnik *et al*., 2015, Tables 9 and 10), is properly addressed.

The first row of Table 4 shows L&H's IGE estimates for Denmark based on four different income measures: gross income including transfers, gross income excluding transfers, wage earnings including transfers, and wage earnings excluding transfers. The estimates range from 0.063 for wage earnings including transfers, to 0.352 for gross income excluding transfers. The wage-earnings IGE coefficients are particularly low because wage earnings do not include self-employment income. The second row of the table shows that the wage-earnings IGEs increase by a factor larger than 3 once self-employment income is counted as earnings.[12] A similar point is made by L&H, in their Web Appendix Tables A8–A12, which show the intergenerational correlations and standard deviations of all major income components for Denmark. The tables indicate that the increased ratio of standard deviations from wage earnings to gross income stems from capital income and profits from own businesses (i.e., self-employment income).

Setting self-employment income to zero implies that we underestimate the measure of economic status, living standard, or earnings capacity for observations where income consists partly of wage earnings and partly of self-employment income (e.g., for families where one parent is a wage earner and the other is self-employed, or for individuals who are wage earners during some years and self-employed during others). While L&H exclude self-employment income in their measure of wage earnings for Denmark, they include self-employment income in their measure of wage earnings for the United States, which leads to incorrect conclusions regarding the cross-country IGE comparison in their Table 1.

The second row of Table 4 shows that the IGE estimates become smaller once transfers are included in the income measure (for both parents and children). This mainly reflects the fact that the IGE is highly sensitive to close-to-zero income observations (see Chetty *et al*., 2014, Table 1; Mitnik

[12]As discussed in Section V, previous IGE estimates for Denmark have also been based on earnings measures that did not include self-employment income (e.g., Hussain *et al*., 2009).

Table 4. *Danish IGE estimates based on different income definitions and samples*

	Sample	Gross inc. excl. trans.	Gross inc. incl. trans.	Wage earnings	Wage earnings and trans.	Net-of-tax income
1	L&H	0.352	0.271	0.083	0.063	0.221
		(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
2	Repl. of L&H incl. SE income	0.351	0.270	0.327	0.252	0.231
		(0.007)	(0.004)	(0.007)	(0.004)	(0.004)
3	Same as Specification 2, income > $1,000	0.297	0.266	0.281	0.249	0.228
		(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
4	Same as Specification 2, IGE_E	0.377	0.382	0.347	0.343	0.334
		(0.013)	(0.009)	(0.007)	(0.009)	(0.013)
5	Same as Specification 2, father–son	0.260	0.247	0.224	0.216	0.221
		(0.007)	(0.005)	(0.007)	(0.005)	(0.004)

Notes: Standard errors are in parentheses. Specification 1 reproduces the results from Table 1 of Landersø and Heckman (2017). The samples in Specifications 1 and 2 only include observations where parental and child income are both positive. Specification 2 includes self-employment (SE) income (*NETOVSKUD)* in all income measures. Specification 3 excludes from the sample observations where parental or child income is not larger than $1,000. Specification 4 excludes observations where parental income is non-positive or child income is negative (so children with zero income are kept in the sample). In Specification 5, everything is as in Specification 2, but only fathers and sons are considered in the analysis.

et al., 2015, Tables 9 and 10). When the individual income of children is compared with the pooled income of their parents, there are more close-to-zero income observations among children than among parents. Recall from equation (2) that the IGE estimate increases with the standard deviation of log child income, $SD(\ln Y^C)$, and decreases with the standard deviation of log parental income, $SD(\ln Y^P)$. The fact that there are more close-to-zero income observations among children results in larger IGE coefficients. The inclusion of transfers in the income measure eliminates most close-to-zero income observations, and thereby reduces the IGE estimates.[13]

The third row of Table 4 shows that the differences between pre- and post-transfer IGE estimates are mostly driven by a few close-to-zero outlier observations. When the 1.5 percent of observations with income below $1,000 in either generation is dropped from the sample, the difference between pre- and post-transfer IGEs declines from 23 to 11 percent.

One solution to the close-to-zero sensitivity problem of the IGE is to instead estimate the IGE_E, as proposed by Mitnik *et al*. (2015) and Mitnik and Grusky (2020); see also the Appendix. The IGE_E also measures

[13] L&H indirectly address the issue of the close-to-zero-income asymmetry across generations when they note that "it is the ratio of standard deviations that drives the Danish IGE to levels above the US. When public transfers are included in gross income, the correlation and ratio increase in the US, while in Denmark the ratio decreases and the correlation is roughly unchanged" (L&H, p. 186).

economic persistence, but has the advantage of being very robust to close-to-zero income observations in the child generation. As shown in the fourth row of Table 4, the IGE_E estimates based on pre- and post-transfer income are very similar.[14]

Another solution is to focus only on fathers and sons. While the father–son specification itself is not more robust to close-to-zero income observations, its advantage is a more even distribution of the close-to-zero observations across the two generations, which leads to similar pre- and post-transfer IGE estimates, as shown in the last row of Table 4.

VII. Conclusion

In this paper, I present the first comprehensive comparison of intergenerational income mobility in Denmark and the United States that is based on administrative data for both countries. I focus on the US mobility measures estimated by Chetty *et al*. (2014) and Mitnik *et al*. (2015), and I compute directly comparable mobility estimates for Denmark.

There are three main findings in the paper. The first is that intergenerational income mobility in Denmark is substantially higher than in the United States, but it varies depending on whose income is considered. The IGE for Denmark is roughly 40–50 percent of that in the United States when the family income of children is considered. Proportional differences based on the individual incomes of children are smaller and vary across genders. For sons, the Danish elasticity for individual earnings is 57 percent of that of the United States, whereas this figure is 85 percent for daughters.

The second finding is that the estimated cross-country difference in earnings mobility is smaller than previously reported. Previous studies find that the Danish elasticity based on the individual earnings of sons is 20–35percent of that in the United States. By contrast, I estimate the intergenerational earnings elasticity of Danish sons to be relatively larger, 57 percent of that in the United States. I show that attenuation and selection biases have led previous studies to overstate the level of intergenerational earnings mobility in Denmark. Some of the existing mobility estimates for Denmark were also based on earnings measures that did not cover self-employment income, which has also led previous studies to overstate mobility in Denmark. I estimate the Danish IGE based on the earnings of

[14]The IGE_E allows for the inclusion of children with zero income in the sample. By contrast, because parental income is inversely related to the probability that a child will have zero income as an adult, omitting zero-income children from the analysis results in the downward selection bias affecting the conventional IGE estimate (Mitnik and Grusky, 2020). IGE_E estimates in Table 4 are larger than those presented in Table 2, mainly because children with only one observed parent are excluded in Table 4 but included in Table2.

fathers and sons to be 0.246; this is higher than the previous comparable estimates for Denmark, which are in the 0.07–0.17 range.

The third finding is that the income elasticity for Denmark is quite robust to whether taxes or public transfers are included in the income measure. Before- and after-tax IGE comparisons are, however, extremely sensitive towards close-to-zero income observations. As a result, researchers should pay special attention to the left tail of the considered income distributions when comparing IGE estimates before and after transfers.

Appendix: The IGE of the Expectation

The conventionally estimated IGE is

$$\beta^{IGE} = \frac{dE(\ln Y^C | Y^P = y^P)}{d \ln y^P}.$$

Mitnik and Grusky (2020) show that this is the wrong estimand. Mobility scholars have wrongly assumed they were estimating the elasticity of the *expectation* of children's income, when in fact their estimates pertained to the elasticity of the *geometric mean* of children's income. Mitnik and Grusky (2020) (and Mitnik *et al.*, 2015) advocate estimating the IGE of the expectation (IGE$_E$), which switches the order of the log and the expectation. The IGE$_E$ matches the standard interpretation of the IGE found in the literature: the percent change in a child's expected income associated to a 1 percent increase in the income of his or her parents.

$$\beta^{IGE_E} = \frac{d \ln E(Y^C | Y^P = y^P)}{d \ln y^P}.$$

An important advantage of the IGE$_E$ is that it allows the researcher to keep zero-income children in the estimation sample, thus avoiding the sample selection bias affecting the estimation of the conventional IGE. The IGE$_E$ is also very robust to the inclusion of low-income children in the analysis. In this paper, I estimate the IGE$_E$ with the Poisson pseudo-maximum likelihood estimator (Silva and Tenreyro, 2006), a semi-parametric estimator available in many statistical packages (e.g., R, SAS, Stata).

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