A Comparison of Intergenerational Mobility Curves in Germany, Norway, Sweden and the U.S.

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Abstract

We use two non-parametric measures to characterize intergenerational mobility (IGM) throughout the income distribution: Rank Mobility and Income Share Mobility. We examine IGM differences between Germany, Norway, Sweden and the United States using comparable samples. Although IGM curves are approximately linear through most of the income distribution, non-linearities are also important and in some cases alter conclusions regarding cross-country differences. However, we are less confident drawing conclusions regarding nonlinearities in Germany due to a much smaller German sample. Using ranks, we find that the U.S. is substantially less intergenerationally mobile than the three European countries which have fairly similar degrees of rank mobility. Despite the substantial heterogeneity in intergenerational rank mobility within the U.S., we show that the most mobile region of the U.S. is still less mobile than the least mobile regions of Norway and Sweden. Using a linear estimator of Income Share Mobility we find that the four countries have very similar rates of IGM. However, there are some notable cross-country differences at the bottom and the top of the income distribution for both types of mobility. One key finding is that the U.S. tends to experience lower upward mobility at the very bottom of the income distribution than Norway and Sweden according to both measures. We conclude that researchers should continue to use a variety of nuanced approaches to studying cross-country differences in intergenerational mobility given that the results may depend to some degree on the concept being used and to differences at different points of the income distribution.

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I. Introduction

Intergenerational mobility has risen to prominence among policymakers in many countries. In the U.S., President Barack Obama has described growing inequality and lack of upward mobility as the "defining challenge of our time". In the UK, intergenerational mobility is such a salient issue that the government has been tracking indicators of social mobility in recent years. The OECD is now examining social mobility as one important measure in its Measurement of Economic Performance and Social Progress program. Given the growing world-wide importance of intergenerational mobility to policy makers one would imagine that an important priority would be to document differences in rates of intergenerational mobility across countries. Establishing a sound body of descriptive facts concerning cross-country differences in intergenerational mobility may yield fruitful insights into understanding the sources of intergenerational persistence in any given society.

Thus far, however, most existing evidence on cross-country differences in intergenerational mobility has focused on one particular measure, the intergenerational elasticity or "IGE" in income.[1] For example, the oft-cited "Great Gatsby" curve plots the IGE against the Gini coefficient for a sample of countries.[2] While the IGE is a useful summary measure of relative intergenerational mobility that requires just one parameter, it has some limitations. For example, it is not informative about differences between upward and downward mobility or how mobility differs at different points in the income distribution. It also does not tell us anything about *absolute* intergenerational income mobility.

[1] An exception is Corak et al. (2014) which use measures of directional rank mobility.
[2] See Corak et al. (2014). The curve shows that countries with higher levels of inequality also have higher levels of intergenerational persistence, or lower mobility. The relationship was first shown by Corak (2006) and the expression, the Great Gatsby curve was coined by Alan Krueger.

We use a new methodological approach that addresses these concerns. Specifically we measure intergenerational mobility curves using a variant of the framework developed by Aaberge and Mogstad (2014) who analyze cross-country differences in *intra*-generational mobility. Aaberge and Mogstad measure mobility using the difference between two Lorenz curves: (1) the true Lorenz curve corresponding to the realized permanent income distribution and (2) a "reference" Lorenz curve that measures the counterfactual permanent income distribution if there had been no intra-generational income mobility. The difference between the curves describes the additional share of total income obtained at each percentile of the initial distribution due to income mobility over time. The use of the Lorenz curve unifies the study of economic mobility with the large literature on inequality and social welfare (Atkinson, 1970) and offers the possibility of making normative statements about mobility.

We use the mobility curve framework to examine intergenerational mobility in Germany, Norway, Sweden, and the United States. We focus on two general measures of intergenerational mobility, a measure of Rank Mobility and a measure of Income Share Mobility. As we discuss in greater detail below, an analogous way to create a rank mobility curve would be to measure the mean *change* in ranks between parents and children at each percentile of the parent income distribution. Similarly, we could construct a mobility curve based on the *change* in the share of income at every percentile of the income distribution. For rank mobility we decided to follow the highly influential work of Chetty et al. (2014) who estimate the mean *level* of the child's percentile at every percentile of the parent income distribution rather than the change in ranks. As we show below, this formulation contains exactly the same information about rank mobility as does a curve depicting the change in ranks, but allows us to directly compare our estimates with Chetty et al.'s and may also be more intuitively appealing.

Conceptually, Rank Mobility is purely a measure of relative positional mobility. However, it does not tell us anything about the distance between ranks in terms of economic resources which may also be of interest. Our second measure, Income Share Mobility, is a hybrid measure containing aspects of both absolute and relative mobility. Rather than using ranks, this measure utilizes the level of absolute income in each generation but scales it by the average income in each respective country in each generation. In addition to providing a different conceptual measure of mobility based on the level of economic resources it also solves the problem of how to compare absolute changes in income that are measured using different currencies.

Our methodology has at least four advantages over previous studies of cross-country differences in intergenerational mobility that have relied primarily on the IGE. First, as Aaberge and Mogstad (2014) show, mobility curves are closely linked to Lorenz curves and more clearly connect the intergenerational mobility and inequality and social welfare literatures. While we do not utilize this connection in this paper, we lay the ground work for future research to exploit these linkages and to potentially say something normative about the right level of intergenerational mobility. Second, because mobility curves are non-parametric estimators they reveal heterogeneity in intergenerational mobility across the initial income distribution. Third, rank based measures allow for subgroup analysis whereas the IGE does not. We demonstrate the usefulness of this by exploring how mobility differs across regions within a country and across men and women. Finally, our income share mobility measure captures differences in absolute mobility. Focusing solely on ranks may ignore important differences in the gaps in economic resources held be families at different points of the distribution. Measures of absolute mobility may be particularly relevant to cross-country comparisons when one wants to explicitly take into account how differences in cross-sectional inequality may affect intergenerational mobility.

With respect to Rank Mobility we highlight several results. First, if we focus on a summary measure of rank persistence that imposes a linear relationship, the "rank-rank slope", we find that Rank Mobility is quite similar between Germany, Norway and Sweden while the US is a clear outlier. In the US there is generally much greater rank persistence. The intergenerational rank association is about 0.395 in the U.S. compared to 0.245 in Germany, 0.223 in Norway, and 0.215 in Sweden. The Rank Mobility curves also demonstrate that the US and Germany are characterized by much less upward mobility from the bottom and the United States also has significantly less downward mobility from the top. For example, children whose parents were in the bottom five percentiles of the income distribution are expected to rise to about the 40th percentile of the income distribution in Norway and Sweden and the 31st percentile in Germany and the United States. However, since our German samples are small, we are less comfortable with the precision of the non-parametric estimates for Germany.

Our results also imply that although there is considerable heterogeneity in intergenerational rank mobility across the US as highlighted by Chetty et al. (2014), it is nonetheless exceptionally rare for a U.S. city to exhibit the degree of rank mobility in these other societies. We also directly examine heterogeneity in rank mobility by looking at sub-regions in each country. Comparing point estimates, we find that the most mobile region of the U.S. is still less mobile than the least mobile regions of Germany, Norway and Sweden. Moreover, relative to simply assuming linearity, we find that the use of non-parametric mobility curves is important in evaluating these cross-country differences in rank mobility. We see very little difference in mobility between the countries from around the 35th to the 60th percentiles but quite significant differences between the US and the Nordic countries at the bottom and the top of the income distribution.

Our conclusions about cross-country intergenerational mobility differences are notably different when we turn to the Income Share Mobility measure. This measure considers the expected *change* in absolute income over a generation at every percentile of the income distribution. Similar to the finding of mean reversion in ranks there is also mean reversion in absolute income. Families that start at higher percentiles in the distribution experience smaller increases in absolute income over a generation than families that start at lower percentiles. When we scale those absolute income changes by the average level of family income in each country and if we impose linearity on the relationship, we find that the rate of mean reversion is nearly identical in all four countries. We find that in all of our samples, moving up 10 percentiles in the parent income distribution is associated, on average, with a reduction in the change in income over generations equal to 10 percent of the average family income level in that country.[3] However, when we allow for non-linearities we find substantial cross-country differences at the bottom and the top of the income distribution. For example, among children who start in the bottom decile of the parent income distribution, income is expected to increase by 32 percent of average income in Germany, 40 percent of average income in the United States, 46 percent of average income in Norway, and 49 percent of average income in Sweden. Corak et al. (2014) also found lower absolute income gains among those at the bottom of the distribution who experienced upward mobility when comparing the U.S. to Sweden.

We show that the differing conclusions regarding cross-country differences in intergenerational mobility between the linear version of Rank Mobility and the linear version of

[3] For example, a family at the 30thth percentile of the parent generation distribution in our US sample would expect to experience an absolute income gain ($25,419) that would increase its ratio of income measured relative to the national average by 0.19 over a generation. A family at the 50th percentile would expect to experience an absolute income gain ($11,296) which would increase its ratio of income measured relative to the national average by 0.01. In this example, there is an 18 percentage point difference in Income Share Mobility between two families that are 20 percentiles apart in the income distribution.

Income Share Mobility reflect the difference in concepts between the two measures. Intuitively, in a country with higher inequality it will be much more difficult to change ranks since the ranks will be farther apart in dollar terms than in a country where the ranks are closer together.[4] Therefore countries can experience similar rates of absolute mobility but experience very different degrees of rank mobility. Therefore, when it comes to *interpreting* estimates of intergenerational income mobility, it is critical to choose the estimator that captures the concept of mobility that one is interested in measuring. A focus on relative mobility as measured by changes in ranks over a generation suggests that the US is significantly less intergenerationally mobile than Germany, Norway and Sweden. On the other hand, a measure of mobility based on absolute income changes scaled to average income shows little difference across the countries. We also find that for both measures there are important non-linearities and that the broad conclusions implied by the linear estimators do not hold throughout the income distribution, highlighting the importance of using non-parametric estimators when studying intergenerational mobility. This echoes a similar point first made by Jäntti et al (2006).

While our findings are nuanced and depend on the estimator used and the concept of mobility being examined, overall our results suggest that at least compared to the Nordic countries, the U.S. may be exceptional in terms of experiencing lower upward mobility from the bottom of the distribution.[5] Such a finding naturally raises questions as to what accounts for such low upward mobility. Is this due to poverty traps? Is there something about the characteristics of families, neighborhoods and schools in the US that causes greater persistence at the bottom of the income

[4] In a slightly different context, Aaberge and Mogstad (2014) argue that there is an almost mechanical relationship between cross-sectional inequality and mobility measures.

[5] We also find similarly low rates of upward mobility for Germany, however, since our samples are significantly smaller we are less confident in our ability to make too strong conclusions regarding nonlinearities for Germany.

distribution? These remain salient issues for future studies of cross-country differences in intergenerational mobility.

The rest of the paper proceeds as follows. In section II we describe our measures and outline our methodological approach. In section III we discuss our data. In section IV we present our main findings. In section V we analyze regional differences in rank mobility. In section VI we conclude.

II. Measures and Methods

Rank Mobility

Rank mobility focuses on one particular concept of mobility, namely positional mobility. Measures based on ranks are the basis for many recent non-parametric intergenerational mobility estimates (Bhattacharya and Mazumder, 2011; Corak et al., 2014; Chetty et al., 2014; Mazumder, 2014). Compared to the intergenerational elasticity (IGE) rank mobility measures have several advantages in addition to capturing a different concept of mobility. First, they can depict how mobility differs at different points of the income distribution. Second, when fixing ranks relative to the entire population, they can be used to compare the mobility of subgroups of the population (Mazumder, 2014). Third, rank mobility measures are relatively robust to measurement issues (Mazumder, 2015; Nybom and Stuhler, 2015).

We construct a measure of rank mobility throughout the entire income distribution based on the approach of Aaberge and Mogstad (2014). Aaberge and Mogstad construct a mobility curve by taking the difference between two Lorenz curves where one curve reflects a counterfactual state in which there is no mobility. In our context an analogous measure of rank mobility (RM*) is given by:

$$RM^*(p) = E[P_{1i} - P_{0i}|P_{0i} = p], p = 1,2, \dots ,100. \quad (1)$$

In this case, we would take the expected change in percentiles at every percentile in the parent distribution. In this example, the initial percentile serves as a counterfactual distribution in which there is no mobility. An alternative representation of a rank mobility curve is the conditional expectation of the child's rank. This representation, labelled RM, is simply a 45 degree rotation of RM* (i.e. just adding P_{0i} to the rank mobility measure).

$$RM(p) = E[P_{1i}|P_{0i} = p], p = 1,2, \dots ,100. \quad (2)$$

Taking the difference between RM and a 45-degree line is equivalent to the RM* measure which estimates the mean difference between the child's percentile and parent's percentile. Although the two curves contain identical information, we chose to use the RM curve rather than RM* because it is the formulation utilized by Chetty et al. (2014) in their highly influential work and will be more familiar to mobility researchers. Of course if one wants to exploit the rich framework developed by Aaberge and Mogstad (2014) to consider the links between mobility and social welfare one can easily transform the measure accordingly.

Income Share Mobility

If one is interested in the actual *magnitude of income changes* and how that differs at different points in the income distribution, then the rank mobility measure is not an appropriate measure since it treats all rank changes equally. For example, in our US data, moving from the 10th to the 11th percentile of the child income generation is associated with $1,313.64 in additional family income (measured in 2007 dollars), whereas moving from the 90th to the 91st percentile is associated with $5,575.03 in additional family income. To supplement the analysis of Rank Mobility, we also study Income Share Mobility. Income Share Mobility is defined as the difference

between a child's income relative to her generation's average income and her parents' income relative to their generation's average income:

$$ISM_i = \frac{Income_{1i}}{E[Income_{1i}]} - \frac{Income_{0i}}{E[Income_{0i}]}. \quad (3)$$

Since we use a balanced panel of families in each generation, this measure is equal to the change in a family's share of their generation's total income scaled by the population of the generation. Consequently, Income Share Mobility can be thought of as the change in the share of the total pie a family receives between the two generations.[6] Here we simply estimate the change in the real dollar value of income at each percentile of the parent income distribution. Specifically, an "Income Share Mobility" (IS) curve is given by:

$$IS(p) = E\left[\frac{Income_{1i}}{E[Income_{1i}]} - \frac{Income_{0i}}{E[Income_{0i}]}\middle| P_{0i} = p\right], p = 1,2,\ldots,100. \quad (4)$$

We estimate these mobility curves using a bin estimator. Specifically, we calculate the average of each mobility measure at each percentile of the parent income distribution.[7]

We often report slope coefficients from linear versions of mobility curves as summary measures of mobility. A linear mobility curve is given by the linear regression of either child rank or income share mobility on parent rank.[8]

[6] Although the Income Share Mobility measure uses absolute income changes, it is not a true measure of absolute mobility since we scale it relative to average income. Instead it might be viewed as a "hybrid" of both absolute and relative mobility.

[7] Note that Income Share Mobility measures changes in income shares as a function of parent rank in the income distribution, consequently a 45-degree rotation similar to the one used for Rank Mobility is not appropriate.

[8] The linear regressions are estimated using our full samples, not the bin estimates used for the non-parameteric mobility curves.

III. Data

Our analysis uses separate datasets from Germany, Norway, Sweden and the United States. We begin by explaining our sample for the United States, since the other samples were selected to be comparable to this dataset.

For the United States, we use the cross-sectional and supplemental samples[9] of the National Longitudinal Survey of Youth's 1979 (NLSY79) cohort. The NLSY79 is nationally representative of youth who were 14 to 22 years old when the survey was conducted in 1979. All youth in the sample were born between 1957 and 1964. We restrict the sample to families with all parents living in the household born between 1920 and 1950. Lastly, we restrict the sample to families for which we observe at least one year of total family income in both the adult and child generations.[10] In total, our sample includes 6,414 parent-child pairs.

Parents who were still living with their children were asked to report their total pre-tax family income from the previous year in the 1979, 1980, and 1981 parent interviews, covering years when their children were 14 to 23 years old. Therefore, parents are 28 to 60 when we measure their total family income. We subtract any earnings the youth had during this period from the total family income measure. We use the average of all of the available family income measures in this period to construct our income measure for the parent generation. For the child generation, we take the average of self-reported total pre-tax family income in 1996, 1998, 2000, 2002, 2004, 2006, and 2008 when the children were 32 to 52 years old.

For Sweden, we use a 35 percent population random sample drawn from administrative data. Mirroring the NLSY79, we restrict this sample to children born between 1957 and 1964

[9] Because we include the supplemental sample, which was designed to oversample minority and economically disadvantaged youth, we weight the estimates by the 1979 sample weights.
[10] 4,387 observations are dropped due to this restriction.

whose parents were born between 1920 and 1950. Our parent generation income measure is average pre-tax household income between 1978 and 1980. Our child generation income measure is average pre-tax household income in 1996, 1998, 2000, 2002, 2004, 2006, and 2007. In total, our Swedish sample includes 252,745 parent-child pairs.[11]

For Norway, we use Statistics Norway's full population administrative data. The sample is restricted to children born between 1957 and 1964 whose parents were born between 1920 and 1950 and were married. In total, the sample includes 328,428 parent-child pairs.[12] We measure income in the parent generation as average pre-tax family earnings in 1978, 1979, and 1980. We measure income in the child generation as average pre-tax family earnings in all years between 1996 and 2006. It should be highlighted that cohabitants are not included in the family income measure, which is a concern for the child income measure given declining marriage rates in Norway.

For Germany, we use the German Socio-economic Panel.[13] Here, unlike the other data sources, we restrict the sample to children born between 1957 and 1976 whose parents were born between 1926 and 1956. The sample includes 1,128 parent child pairs.[14] We measure income in the parent generation as average annual pre-tax total household income between 1984 and 1986 when the children were 8 to 29 years old. For the child income measure, we use average annual pre-tax total household income between 2001-2012 in years when the child was between 25 and 55 years old.[15] A key issue is that German sample size is only about a sixth of the size of the U.S.

[11] 16,165 observations are dropped due to missing or problematic data.
[12] 13,936 observations are dropped due to missing or problematic data.
[13] We use SOEPv29. For more details, see http://dx.doi.org/10.5684/soep.v29.
[14] No observations in the German sample are dropped due to missing or problematic data. However, 16.22% of observations include at least one imputed value. 3.5 % of the parent-child pairs have annual income observations in their respective averages, whose imputed subcomponents are larger than 50% of the total income observation.
[15] Due to the low number of observations in the German sample, we did not impose an additional age restriction on the children here. As a test we ran the analysis on a sample only including income observations at ages 32-54 which did not change the results presented below.

sample. This reduces the statistical precision of our estimates and so we refrain from drawing too strong conclusions regarding cross-country differences particularly when we consider nonlinearities based on on-parametric estiamtes.

Summary statistics for the four samples are shown in Table 1. We report all income measures in 2007 American Dollars.

Average family income in the parent generation ranges from $53,300 in Sweden to $68,714 in Germany. In Norway and Sweden, the average father was born in 1931 and the average mother was born in 1934. In the United States, parents are about two years younger. Since children in all three samples were born in 1961 on average, parents in the United States are about 2 years younger when they have children. Parents in our German sample are about 8 years younger than in Norway and Sweden and 6 years younger than in the United States. However, children in our German sample are also 8 years younger, on average, so parents in our German sample were about the same age as parents in our American sample when they had their children. Both our Norwegian and German samples are restricted to families with both parents present in the parent generation. In Sweden and the United States, 87 and 85 percent of households had two parents present in the parent generation.

In the child generation, average income ranges from $57,346 in Norway to $77,168 in Germany. There are slightly more men than women in all of our samples of the child generation. Our Norwegian and Swedish samples are 49 percent female, our American sample is 48 percent female, and our German sample is 44 percent female. In our American sample, 64 percent of individuals in the child generation were married at the time of 2002 survey. In Norway, 59 percent of children were married in 2002. In Germany, 53 percent of children were married in the first year

a valid income measure was reported. We do not observe marital status for children in our Swedish sample.

We present IGE estimates from a regression of log child income on log parent income for each country in order to benchmark our samples to previous estimates from the literature. These estimates are shown in Table 2. The IGE estimates vary substantially across the four countries. The IGE is 0.194 in Norway, 0.231 in Sweden, 0.314 in Germany, and 0.432 in the United States.

IV. National Mobility Curves

Rank Mobility

Figure 1 presents Rank Mobility Curves for Germany, Norway, Sweden, and the United States. Separate figures for each country are shown in the appendix. All of the mobility curves have a roughly similar shape. Rank mobility is approximately linear over most percentiles of the parent income distribution, but curves downward at the bottom of the parent income distribution and upward at the top of the parent income distribution in some of the countries. There is a slight curvature in rank mobility in the middle of the income distribution. Children whose parents were below the median have more upward rank mobility than the linear fit predicts and children whose parents were above the median tend to have more downward rank mobility than the linear fit predicts. For Norway and Sweden, the nonparametric rank mobility estimates curve sharply upward at the top of the parent income distribution. In all countries, the rank mobility curves appear to bend at least somewhat downward at the bottom of the parent income distribution. This suggests that in many instances there is relatively more persistence in ranks among the poorest and wealthiest families than the linear curves indicate.

The first row of Table 3 shows the slope of linear rank mobility curves for each country. Looking across countries, Germany, Norway, and Sweden have similar levels of rank mobility

across the parent income distribution. The slopes of linear mobility curves, which are summary measures of rank persistence, are 0.245, 0.223, and 0.215 in Germany, Norway, and Sweden, respectively.[16] This implies that each percentile increase in the parent income distribution is associated with a 0.245, 0.223, and 0.215 percentile increase in the child's rank in the income distribution in Germany, Norway, and Sweden respectively. Put another way, the *gap* in ranks between a child whose parents were in the 100th percentile of the parent income distribution and a child whose parents were at the bottom of the income distribution – a gap of 99 percentiles in the parent generation – would be expected to fall to just 21.5 percentiles in a single generation in Sweden. In contrast, the slope of the American linear mobility curve is 0.395. The gap in ranks between the two hypothetical children just discussed would be nearly twice as large if the two children were from the United States instead of Germany, Norway, or Sweden.

This cross-country disparity in rates of rank persistence can also be scaled based on the geographic mobility estimates across U.S. cities from Chetty et al. (2014). Moving from 0.25 (Germany) to 0.40 (U.S.) is the equivalent of moving from the 20th ranked American city to the 324th ranked American city.[17] Furthermore, there are only 11 out of 384 U.S. cities where the rank persistence is found to be less than 0.22. Simply put it is difficult to find the rank mobility experience of Norway or Sweden anywhere in the U.S.

One may also wonder whether these cross-country differences are due to demographic differences across countries. To address this, the second row of Table 3 shows the slope of the linear rank mobility curves for each country controlling for parents' age at birth and indicators for gender, parents' region, and for all countries except Sweden, whether or not the child is married.

[16] Boserup et al. (2013) estimate a rank persistence of 0.18 for Denmark.
[17] This calculation uses the online version of Chetty et al.'s (2014) preferred measures for commuting zones with over 100,000 people.

Including these controls has a small effect on the estimated persistence for Germany, Norway, and Sweden, but reduces the American persistence by over 25%, from 0.395 to 0.292. Since the impact of parental income on child marital status may be an important source of intergenerational persistence, one may worry that this is an inappropriate control. Without controlling for child's marital status, the United States' rank persistence is much less affected by controls, falling only 7% to 0.369. This suggests that the relationship between parental income and marital status may be an important driver of the higher rank persistence in the United States.

Table 4 further explores the role of demographics by showing separate rank persistence estimates for the subsample of married children, men, and women without additional controls using the ranks implied by the full population income distribution. Across countries, marital status and gender have an ambiguous association with intergenerational mobility. Compared to the full sample, rank persistence is higher among married children in Norway (0.260 versus 0.223), the same in Germany (0.245) for both groups, and lower in the United States (0.344 versus 0.395). Persistence is lower for men than for women in Germany, is roughly the same for both genders in the United States, but slightly higher for men than for women in Norway and Sweden.

Importantly, focusing instead on the nonparametric mobility curves allows for a richer and more nuanced comparison of mobility at different points in the parent income distribution. Children whose parents were at the bottom percentile were expected to be in the 24th percentile in Germany, 35th percentile in the United States, and about the 37th percentile in Norway and Sweden. As is evident in Figure 1, the nonparametric estimates at any given percentile of the rank mobility curves are imprecisely estimated for the U.S. and especially for Germany. Averaging over several percentiles will improve precision somewhat for these countries but we may still be wary about drawing too strong conclusions, particularly for Germany. Nevertheless, we find that for children

whose parents were in the bottom five percentiles of the income distribution, they are expected to rise to about the 40th percentile of the income distribution in Norway and Sweden, and the 31st percentile in Germany and the United States. In contrast, children whose parents were in the top five percentiles of the income distribution are expected to fall to the 66th percentile in Germany, Norway, and Sweden, and the 70th percentile in the United States. Therefore, the gap in ranks between children of the wealthiest and poorest families is expected to fall to 29 percentiles in Norway and Sweden, 35 percentiles in Germany, and 39 percentiles in the United States.

At other points of the parent income distribution, there are only small differences in rank mobility. Children whose parents were in the 5th decile of the income distribution are expected to be in the 49th percentile in all four countries. Children whose parents were in the 6th decile are expected to be in the 50th percentile in Sweden and the United States, the 51st percentile in Norway, and the 57th percentile in Germany.

Income Share Mobility

Income Share Mobility considers changes in income normalized by the average income in the economy.[18] Figure 2 shows Income Share Mobility curves for the four countries in our analysis. Since we are now plotting *changes* in income share on the y-axis in Figure 2, we expect a *downward* sloping curve if there is regression towards the mean. Figure 1 was upward sloping since we presented the conditional expectation of the child's rank rather than the *difference* between the child and his or her parent's rank in order to make our analysis comparable to that of Chetty et al. (2014).

What is immediately evident is that the nonparametric Income Share Mobility curves are approximately linear over most of the income distribution as was the case with Rank Mobility.

[18] Footnote 3 provides a concrete example.

The slopes of all four linear Income Share Mobility Curves are approximately -0.01. More precisely, the slopes are -0.009 in Germany and Norway and -0.010 in Sweden and the United States. This indicates that in all countries moving up 10 percentiles in the parent income distribution is associated, on average, with a reduction in the change in income over the next generation equal to about 10 percent of average income. Put another way, the income of two children whose parents were at the top and bottom of the income distribution, respectively, will converge by 100 percent of the average income in a single generation, on average.

How is it possible that large cross-country differences in Rank Mobility can be consistent with small differences in Income Share Mobility? This can be reconciled by considering the differences across countries in the levels of cross-sectional inequality. Consider two countries with equal levels of average income but where one country has significantly higher income inequality in the parent generation. A given change in absolute income over a generation would lead to higher change in ranks in the country with smaller cross-sectional inequality than an identical change in absolute income in a country characterized by a high degree of inequality, where surpassing the next rank requires a greater income change.[19] The identical absolute income change, however, would lead to an identical level of Income Share Mobility.

We illustrate that this is exactly the case when we compare the U.S. to our other samples. Figures 3a and 3b show the cross-sectional income distributions in the parent and child generations of each of our samples. Incomes are measured as shares of average income in each generation within a country. In both generations, the poor in the United States have relatively lower incomes and the rich have relatively higher incomes. A child whose parents were in the bottom decile of Norway's income distribution is expected to be in the 42nd percentile of the child generation

[19] As Aaberge and Mogstad (2014) emphasized, this creates an almost mechanical relationship between cross-sectional inequality and rank mobility measures.

family income distribution. This is associated with an increase in earnings equal to 46 percent of the generation's average earnings. In contrast, a similar child in the United States is only expected to be in the 30th percentile of her generation's family income distribution which is associated with an earnings increase equal to 40 percent of the average income. Although the child from Norway is expected to move up nearly twice as many percentiles as the child from the United States, this higher rank mobility is only associated with a 15 percent larger increase in income.

In contrast to the rank mobility curves, the Income Share Mobility curves bend sharply downwards at the top of the income distribution. This suggests that, although children whose parents are born at the top of the income distribution persistently stay in the highest ranks of the income distribution, the small rank changes are associated with relatively large declines in their income.

The nonparametric income share mobility curves indicate some notable differences at the top and the bottom of the income distribution, though again we should be cautious among drawing too strong conclusions for Germany where our samples are especially small. The income of children whose parents were in the bottom decile of the parent income distribution is expected to increase by 32 percent of average income in Germany, 40 percent of average income in the United States, 46 percent of average income in Norway, and 49 percent of average income in Sweden. At the other end of the distribution, the income of children whose parents were in the top decile are expected to fall by 51 percent of average income in Norway, 62 percent of average income in Sweden, 69 percent of average income in Germany, and 84 percent of average income in the United States.

There is even more downward mobility among the very top of the distribution. Children whose parents were in the top five percentiles can expect their income to fall by 65 percent of

average income relative to their parents in Norway, by 84 percent of average income in Sweden, by 92 percent of average income in Germany, and by 120 percent in the United States.

These results are in some respects similar to the findings of Corak et al. (2014) who find significant cross-country differences between Canada, Sweden and the U.S.in absolute income changes at the very bottom and top of the income distributions. For example they find that the U.S. experiences lower absolute upward income mobility at the very bottom and greater absolute downward mobility than Canada and Sweden from the very top. However, Corak et al. condition their estimates on having either upward or downward mobility and do not scale these income changes relative to average income.

V. Regional Results

An important question is whether Germany, Norway, Sweden, and the U.S. are reasonably comparable. The U.S. is much larger than the other countries in terms of its population and geographic area. The United States' population is nearly four times the population of Germany and more than thirty and sixty times the populations of Sweden and Norway, respectively. Similarly, the area of the U.S. is over twenty times larger than the area of Germany, Norway, or Sweden. Chetty et al. (2014) have shown that the overall level of rank mobility in the U.S. conceals a considerable degree of heterogeneity across smaller geographic areas. While we have already shown that it is rare to find a city in the U.S. with the same degree of intergenerational rank mobility as the entire nation of Norway or Sweden, it may also be useful to look at heterogeneity within all of our sample countries. Perhaps, comparing the most mobile region of the U.S. to the most mobile regions of Germany, Norway and Sweden is more sensible.[20]

[20] We thank Magne Mogstad for suggesting that we make this comparison.

To address this issue, we examine intergenerational mobility separately for regional subdivisions of each country. For this analysis, we treat regions as if they are separate countries. We generate separate income distributions for each region and restrict the sample to children who lived in the region as children and adults. This restriction is meant to mirror the fact that the national analysis is implicitly conditional on not emigrating, since emigrants will generally not be observed in both generations and will therefore be excluded. For simplicity, we focus on summary measures of rank persistence instead of the nonparametric mobility curves.

Table 5 shows rank persistence measures for each country and for regional subdivisions of each country. Only one region of the U.S., the West, has comparable rank persistence as Germany, Norway, and Sweden. The slope of the linear rank mobility curve for the American West is 0.261. For comparison, the lowest rank mobility regions in Germany, Norway, and Sweden have a rank persistence of 0.236, 0.250, and 0.233, respectively. Therefore, the point estimate for the highest mobility region of the United States still has higher rank persistence than the lowest mobility regions of the three Northern European countries. If we compare the U.S. West to the most mobile regions of Norway and Sweden then there is a fairly substantial gap as the Western region of Norway and the Northern region of Sweden exhibit rank persistence below 0.180.

The other three regions of the United States have much higher rank persistence than the U.S. West or any of the other regions in the other three countries. The North Central region's rank persistence is 0.396, the Southern region's rank persistence is 0.439, and the Northeastern region's rank persistence is 0.455. Figures 4a and 4b show that the regional income distributions are similar in both the parent and child generations. In other words, regional differences in cross-sectional inequality do not appear to explain the differences in rank mobility within the United States.

Overall, we find that there is a notable striking difference in rank mobility between the U.S. and the Northern European countries that remains even when comparing the most mobile region of the U.S., the West to the least mobile regions of the Northern European countries. The other regions of the U.S. are substantially less mobile than any other region in Germany, Norway or Sweden.

VI. Conclusion

We use comparable intergenerational samples from Germany, Norway, Sweden and the U.S. to construct estimates of intergenerational mobility curves for each country. Using our first measure, Rank Mobility, we find that the U.S. is an outlier compared to the other three countries when we assume a linear relationship. The U.S. has much greater intergenerational rank persistence with roughly comparable levels in the other three countries. Compared to the Nordic countries, the U.S. exhibits both less upward mobility from the bottom of the distribution and less downward mobility at the top of the distribution. We also find that even the most mobile region of the U.S. is less mobile than the least mobile regions of the Nordic countries. Germany also appears to experience lower upward mobility from the bottom of the distribution than the Nordic countries but the estimates for Germany are less precise owing to smaller sample sizes. Non-parametric estimates which relax linearity are important as the rank mobility differences are not constant at all points of the income distribution and the countries are fairly similar in the middle of the parent income distribution.

In contrast, when we examine our second measure, Income Share Mobility and impose linearity, we find that rates of intergenerational mobility are very similar across countries. The difference between these results and those using Rank Mobility is explained by the fact that the

U.S. has much higher cross-sectional inequality than the other countries so any given change in income is associated with a smaller change in ranks.

Taken together our findings highlight several important points. First, the cross-country differences in rank mobility are consistent with many previous studies of intergenerational mobility that focused on a different measure of relative mobility, the intergenerational elasticity.[21] Second, although there is considerable heterogeneity in rank mobility within the U.S. as documented by Chetty et al. (2014), it is clear that the cross-country differences in rank mobility are robust to spatial heterogeneity in the four countries. Third, there are important non-linearities with respect to cross-country differences in rank mobility. We find that there are relatively small differences in rank mobility if we compare those who start in the middle of each country's respective income distributions. Fourth, our results with respect to income share mobility suggest that once we move to a measure of mobility that is closer to a measure of absolute mobility and impose linearity, the countries are quite similar in their rates of intergenerational mobility. Fifth, we also find evidence of important non-linearities in income share mobility at the very bottom and top of the income distributions that can significantly affect cross-country comparisons.

Overall, we find that one must take care in drawing firm conclusions regarding cross-country differences in intergenerational mobility. The differences depend to some degree on what portion of the income distribution one is examining and conceptually, whether one is interested in looking at relative or absolute outcomes. Nevertheless, there is fairly consistent evidence that the U.S. has lower rates of upward mobility from the bottom of the income distribution compared to

[21] See for example Corak (2006) and Jantti et al. (2006). Schnitzlein (2015) argues that the relative ordering in mobility between the U.S. and Germany based on the intergenerational elasticity is somewhat sensitive to the choice of how income is measured.

the Nordic countries. We also find suggestive evidence of lower upward mobility from the bottom in Germany but the data is much noisier so we are hesitant to make too strong conclusions.

Future research should continue to consider these kinds of nuanced approaches to studying intergenerational mobility and ultimately try to better understand the causes and consequences of mobility differences across countries.

References

Atkinson, A. (1970), On the Measurement of Inequality, *Journal of Economic Theory*, 2, 244-263.

Aaberge, R. and Mogstad, M. (2014), Income Mobility as an Equalizer of Permanent Income, Discussion Papers 769, Statistics Norway, Research Department.

Bhattacharya, D. and Mazumder, B. (2011), A Nonparametric Analysis of Black-White Differences in Intergenerational Income Mobility in the United States, *Quantitative Economics*, 2: 335-379.

Boserup, S., Kopczuk, W. and Kreiner, C. (2013), Intergenerational Wealth Mobility: Evidence from Danish Wealth Records of Three Generations, Univ. of Copenhagen mimeo.

Chetty, R., Hendren, N., Kline, P. and Saez, E. (2014), Where is the land of Opportunity? The Geography of Intergenerational Mobility in the United States, *Quarterly Journal of Economics*, 129(4): 1553-1623.

Corak, M. (2006), Do Poor Children Become Poor Adults? Lessons for Public Policy from a Cross-Country Comparison of Generational Earnings Mobility, Research on Economic Inequality, Vol. 13: Dynamics of Inequality and Poverty, edited by John Creedy and Guyonne Kalb, 143–88. The Netherlands: Elsevier Press.

Corak, M., Lindquist, M.J. and Mazumder, B. (2014), A Comparison of Upward and Downward Intergenerational Mobility in Canada, Sweden and the United States, *Labour Economics*, 30:185-200.

Jäntti, M., Bratsberg, B., Røed, K., Raaum, O., Naylor, R., Österbacka, E., Björklund, A. and Eriksson, T. (2006), American Exceptionalism in a New Light: A Comparison of Intergenerational Earnings Mobility in the Nordic Countries, the United Kingdom and the United States. IZA Discussion Paper 1938, Institute for the Study of Labor (IZA).

Mazumder, B. (2014), Black-White Differences in Intergenerational Economic Mobility in the United States, *Economic Perspectives,* 38(1).

Mazumder, B. (2015), Estimating the Intergenerational Elasticity and Rank Association in the US: Overcoming the Limitations of Tax Data, Working Paper Series WP-2015-4, Federal Reserve Bank of Chicago.

Nybom, M. and Stuhler, J. (2015), Biases in Standard Measures of Intergenerational Dependence, IFAU Working Paper 2015:13.

Schnitzlein, D.D. (2015), A New Look at Intergenerational Mobility in Germany Compared to the US, forthcoming, *Review of Income and Wealth (early view: DOI: 10.1111/roiw.12191)*

Table 1. Summary Statistics

	Germany	Norway	Sweden	United States
Observations	1,128	324,870	252,745	6,414
Parent Generation				
Family Income (2007$)	68,714	67,590	53,300	65,141
Father Birth Year	1939	1931	1931	1933
Mother Birth Year	1942	1934	1934	1936
Two Parents	1.00	1.00	0.87	0.85
Child Generation				
Family Income (2007$)	77,168	57,346	72,129	76,877
Child Birth Year	1969	1961	1961	1961
Female	0.44	0.49	0.49	0.48
Married	0.53	0.59	-	0.64

Notes. All currencies are reported in 2007$. Currencies were converted to 2007 units using GDP deflators reported by the World Bank or by their national CPI and converted to American Dollars using the average 2007 exchange rate reported by the OANDA Corporation.

Table 2. IGE Estimates

	Germany	Norway	Sweden	United States
IGE	0.314	0.194	0.231	0.432
	(0.036)	(0.002)	(0.002)	(0.014)
N	1,128	324,870	251,288	6,298

Table 3. Rank Persistence by Country

	Germany	Norway	Sweden	USA
National	0.245	0.223	0.215	0.395
	(0.029)	(0.002)	(0.002)	(0.011)
w/ Controls	0.232	0.223	0.204	0.292
	(0.029)	(0.002)	(0.002)	(0.011)
	1,128	324,870	252,745	6,414

Notes. Ranks are determined using national income distributions in each generation. Controls include parents' age at birth and indicators for gender, parents' region, and for all countries except Sweden, whether the child is married.

Table 4. Rank Persistence by Subgroup

	Germany	Norway	Sweden	USA
Married Children	0.245	0.260	-	0.344
	(0.037)	(0.002)		(0.014)
	595	186,025		3,202
Men	0.198	0.229	0.234	0.395
	(0.039)	(0.002)	(0.003)	(0.160)
	627	165,947	129,027	3,301
Women	0.293	0.220	0.196	0.396
	(0.043)	(0.002)	(0.003)	(0.016)
	501	158,923	122,575	3,113

Notes. Ranks are determined using national income distributions in each generation.

Table 5. Rank Persistence by Region

	Germany	Norway	Sweden	USA
Region 1	0.223	0.179	0.175	0.261
	(0.043)	(0.003)	(0.006)	(0.031)
	510	95,061	30,189	972
Region 2	0.236	0.189	0.183	0.396
	(0.040)	(0.006)	(0.006)	(0.025)
	584	24,674	32,142	1249
Region 3	-	0.191	0.197	0.439
		(0.006)	(0.003)	(0.020)
		29,778	109,326	2027
Region 4	-	0.250	0.233	0.455
		(0.003)	(0.005)	(0.031)
		137,675	44,014	866

Notes. Ranks are determined using regional income distributions in each generation. Sample is restricted to individuals who stayed in the region of their parents.

Figure 1. Rank Mobility Curves

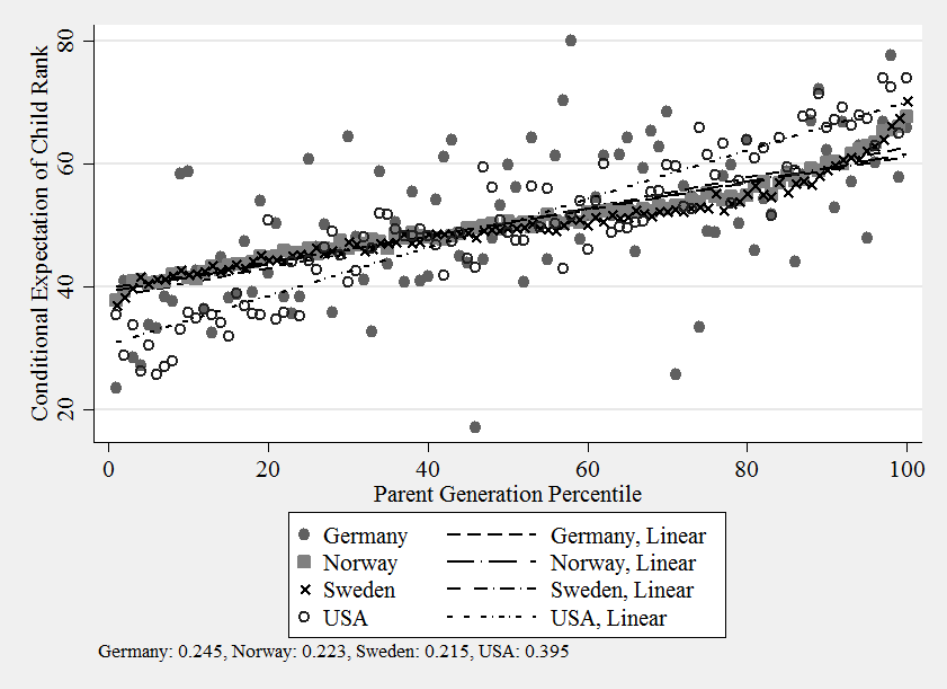


Figure 2. Income Share Mobility Curves

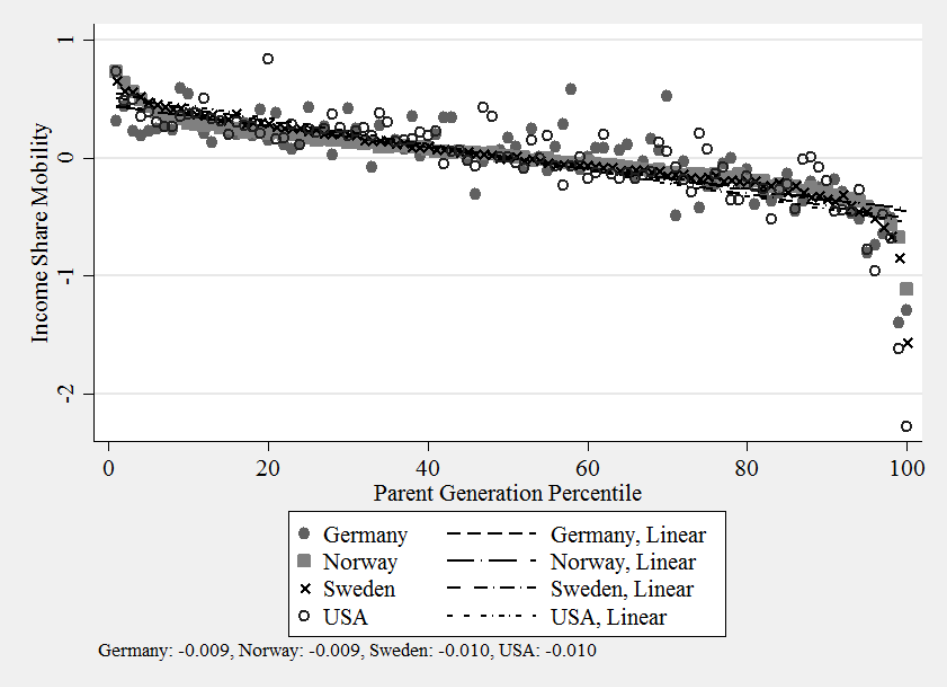


Figure 3a. Parent Generation Income Distributions

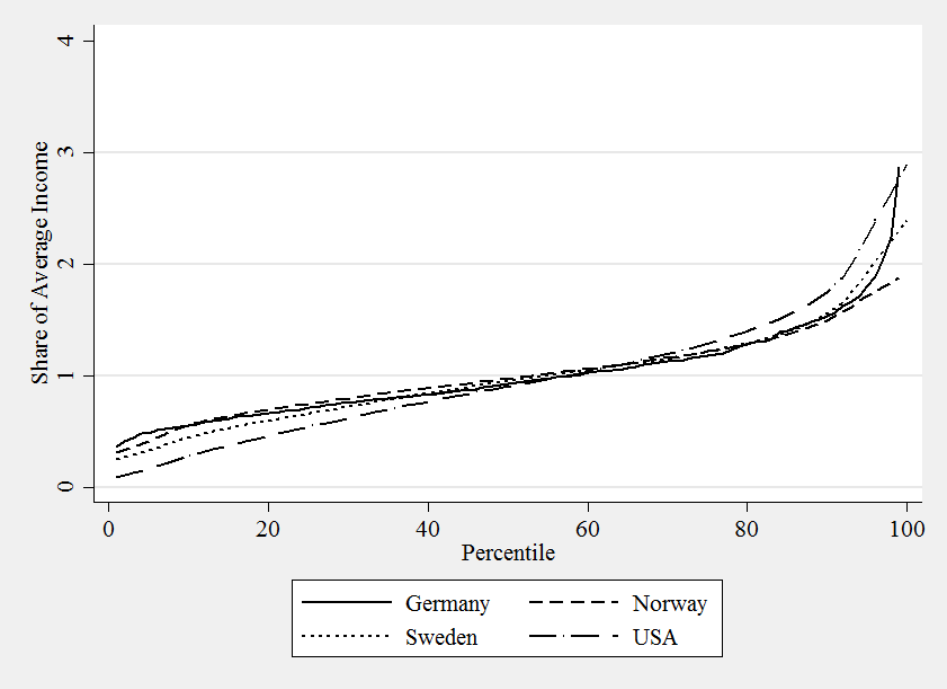


Figure 3b. Child Generation Income Distributions

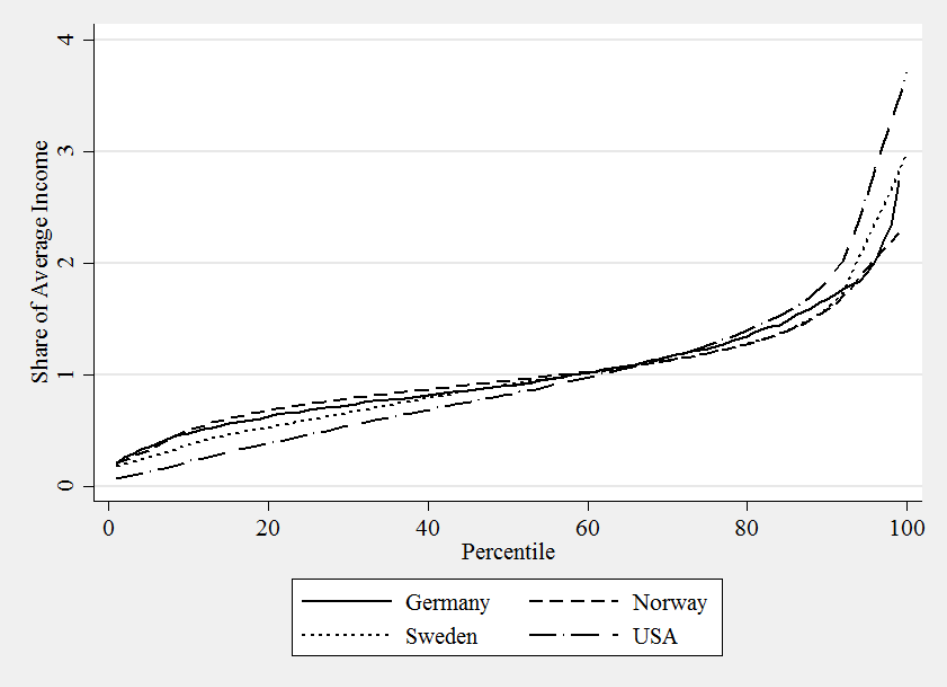


Figure 4a. Parent Generation Income Distributions, USA Regions

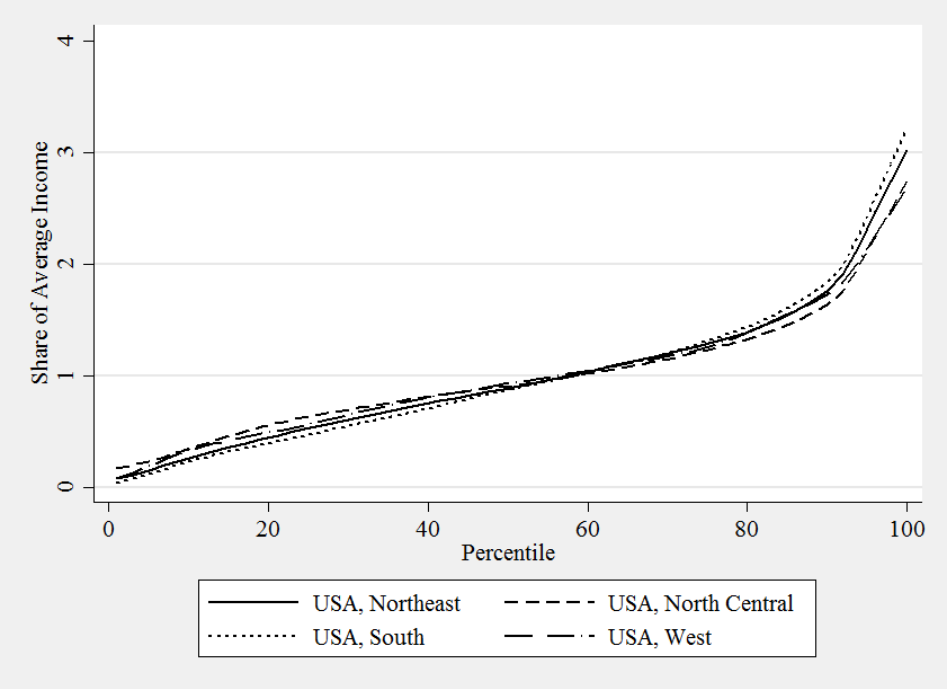
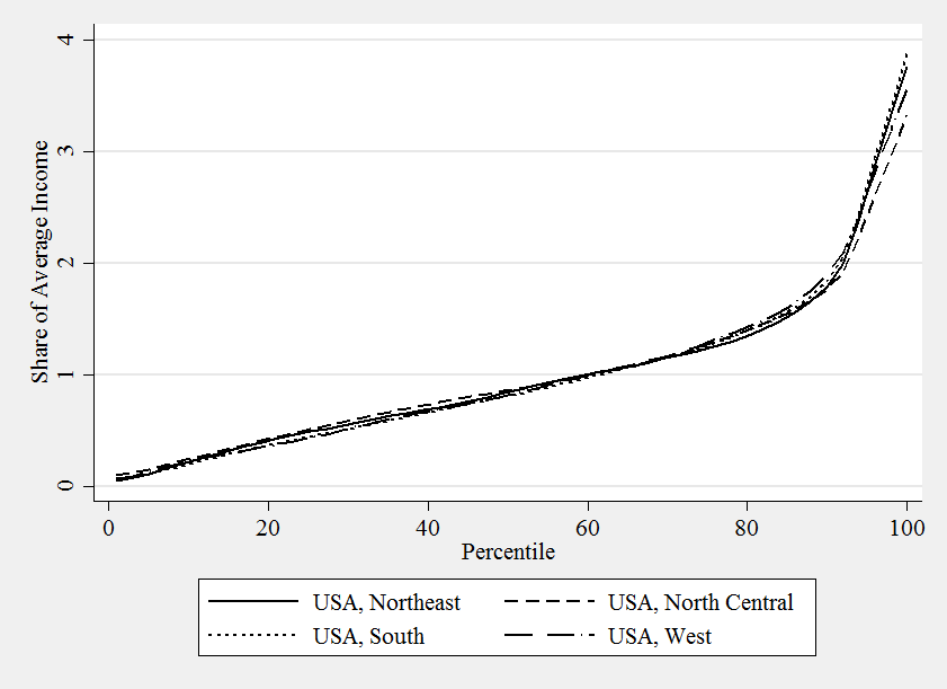


Figure 4b. Child Generation Income Distributions, USA Regions



Appendix I. Country Specific Figures

Figure A1. Rank Mobility Curve, Germany

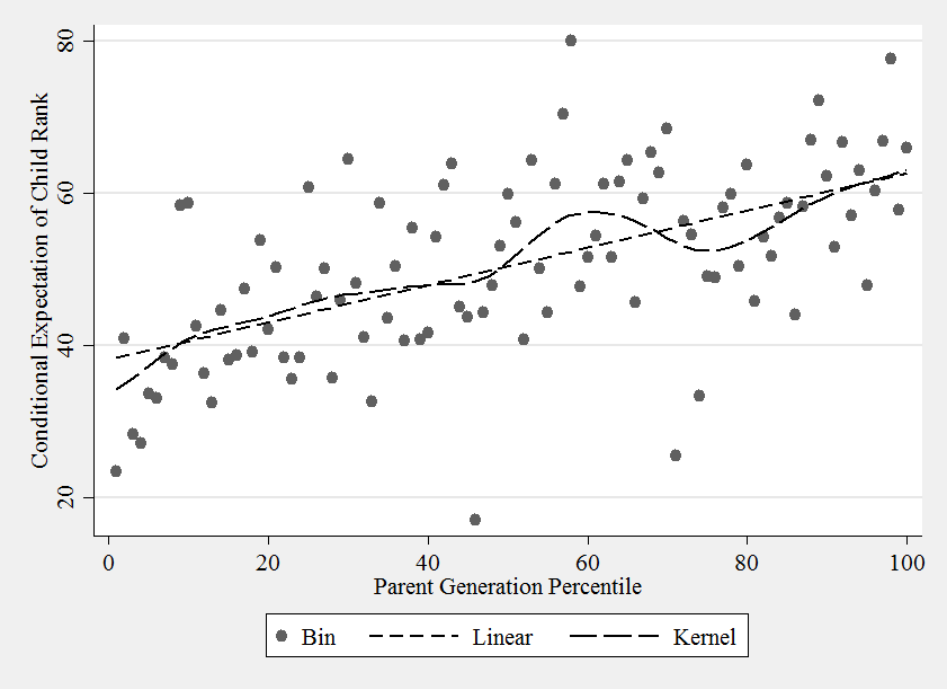


Figure A2. Rank Mobility Curve, Norway

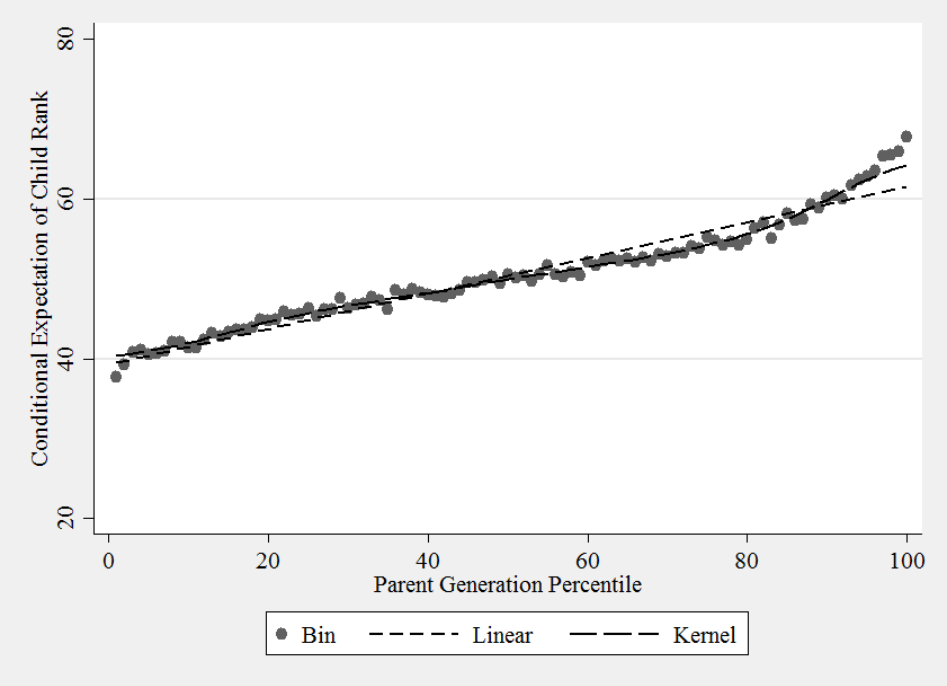


Figure A3. Rank Mobility Curve, Sweden

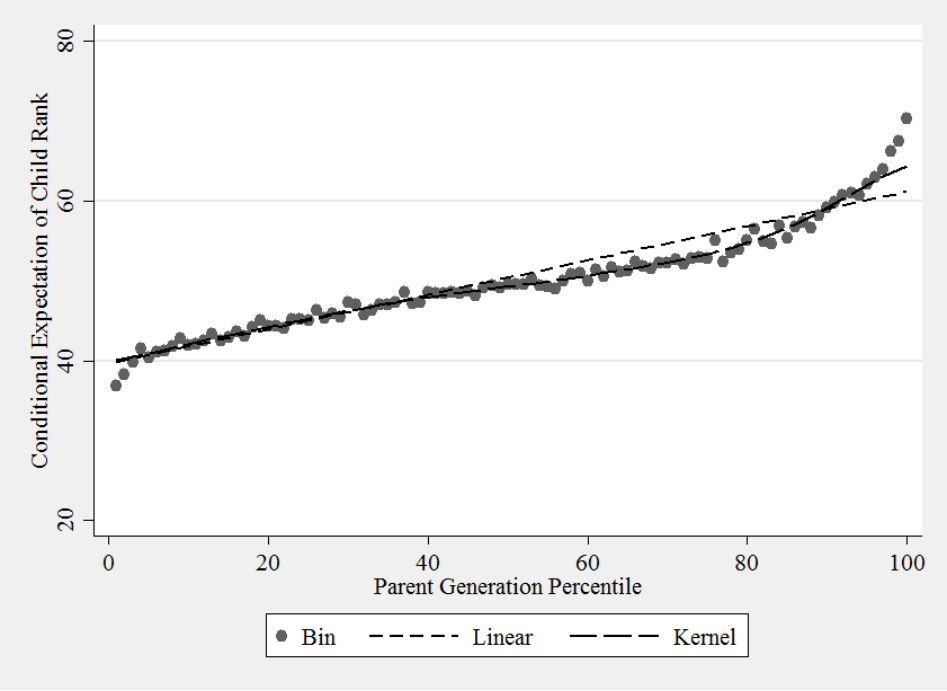


Figure A4. Rank Mobility Curve, USA

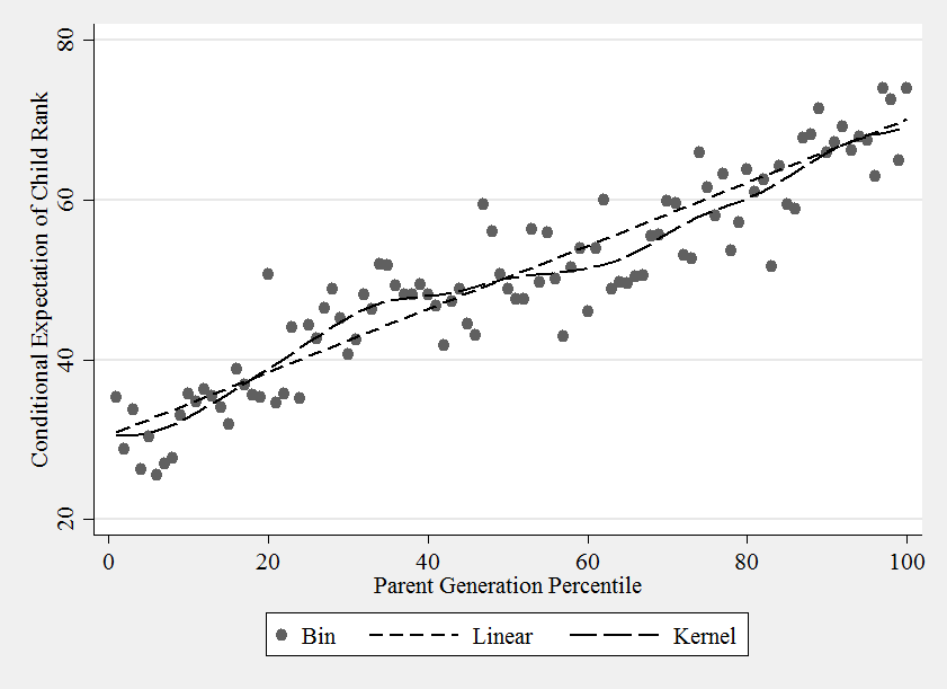


Figure A5. Income Share Mobility Curve, Germany

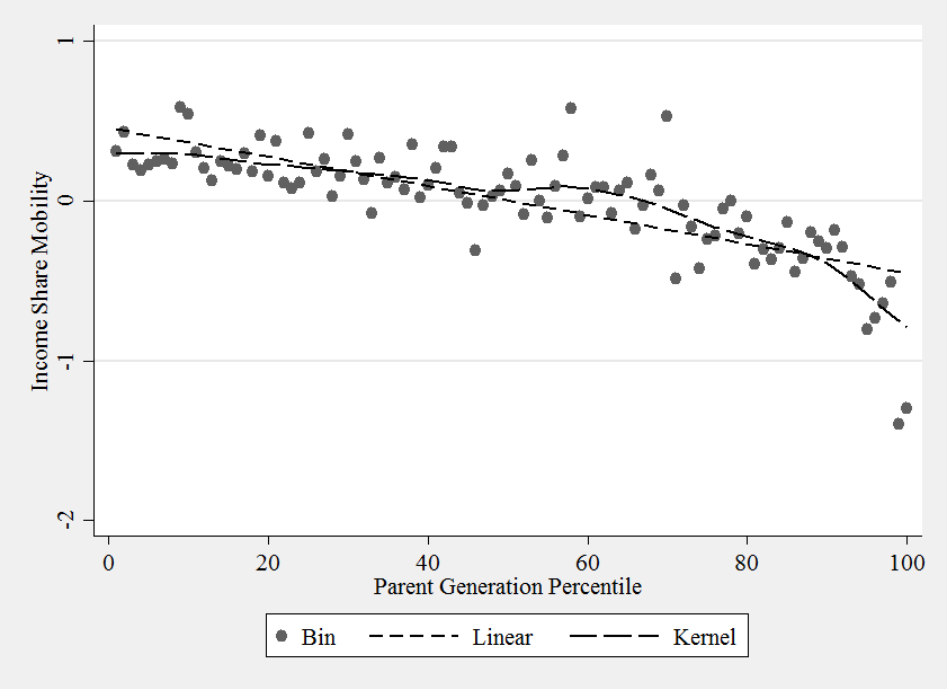


Figure A6. Income Share Mobility Curve, Norway

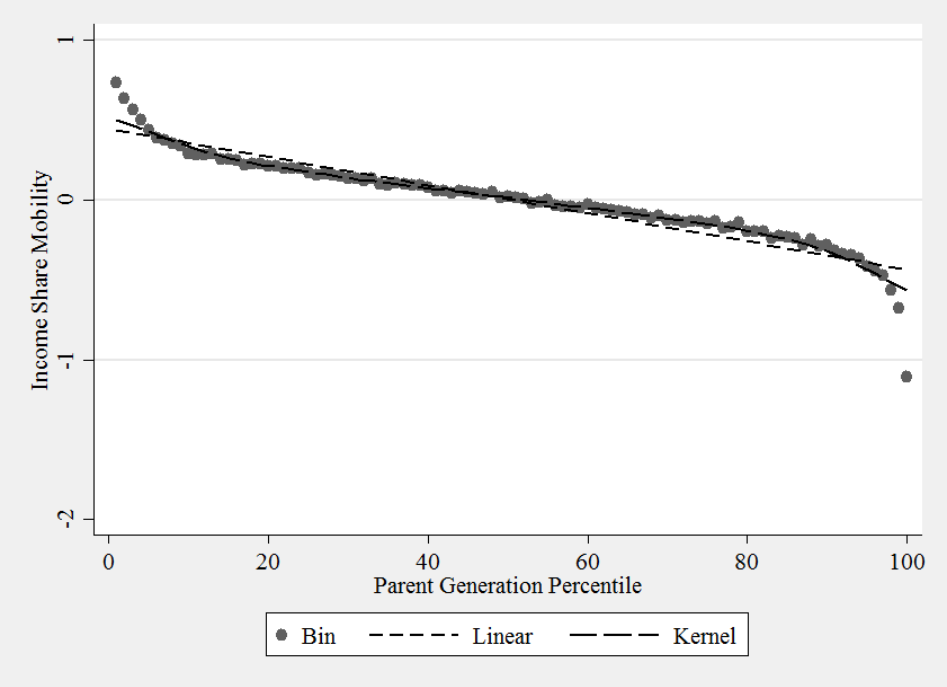


Figure A7. Income Share Mobility Curve, Sweden

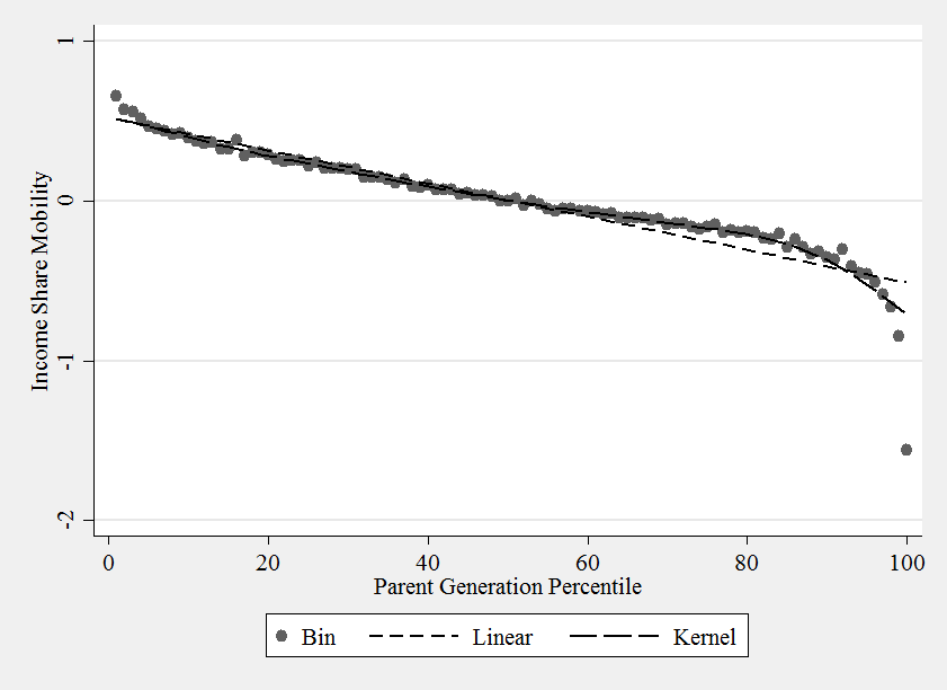


Figure A8. Income Share Mobility Curve, United States

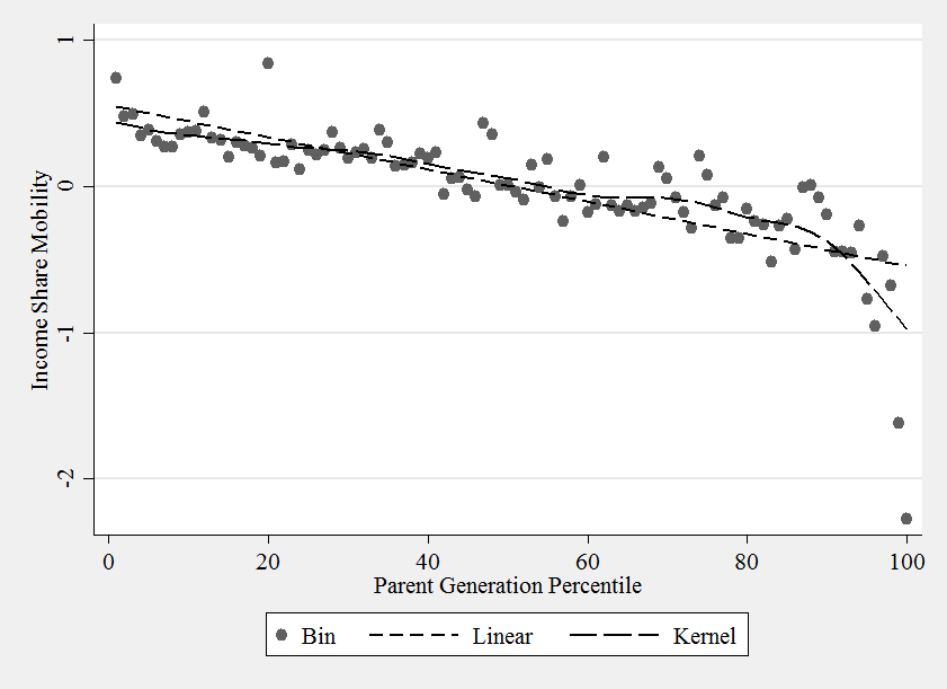


Figure A9. Germany Income Distributions

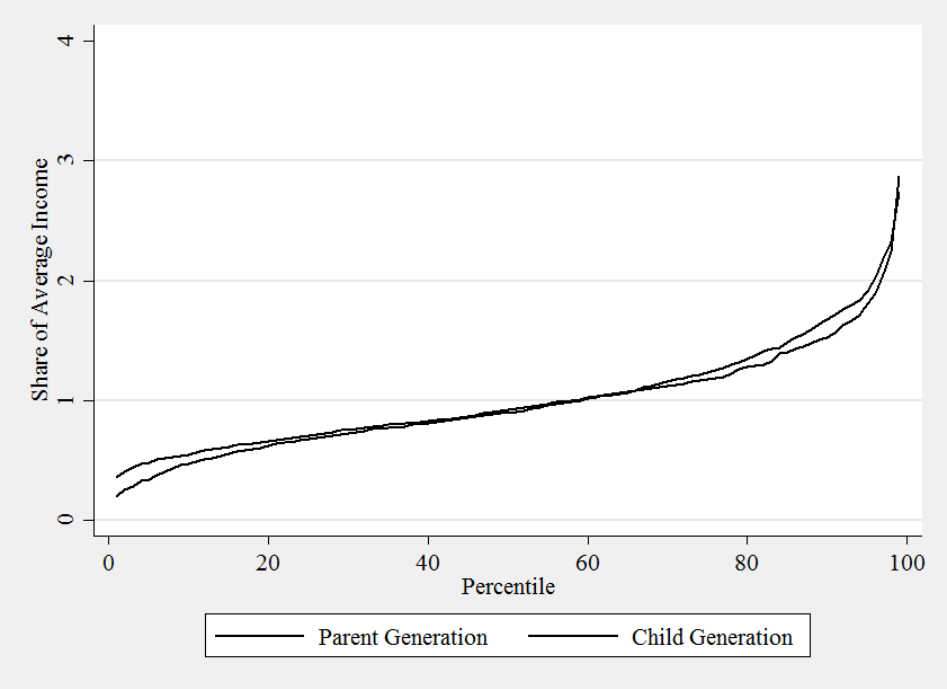


Figure A10. Norway Income Distributions

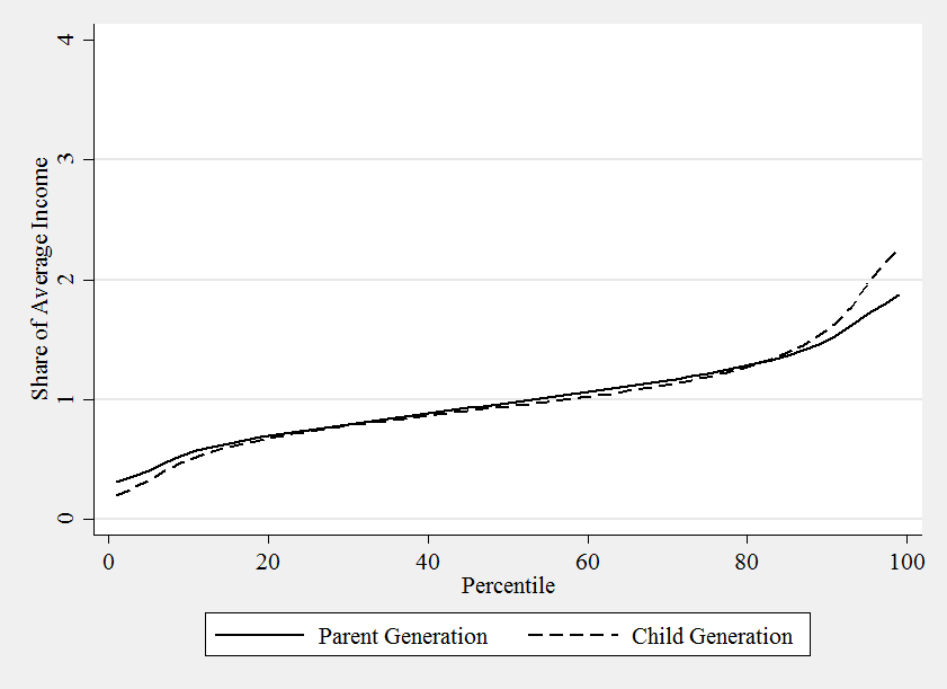


Figure A11. Sweden Income Distributions

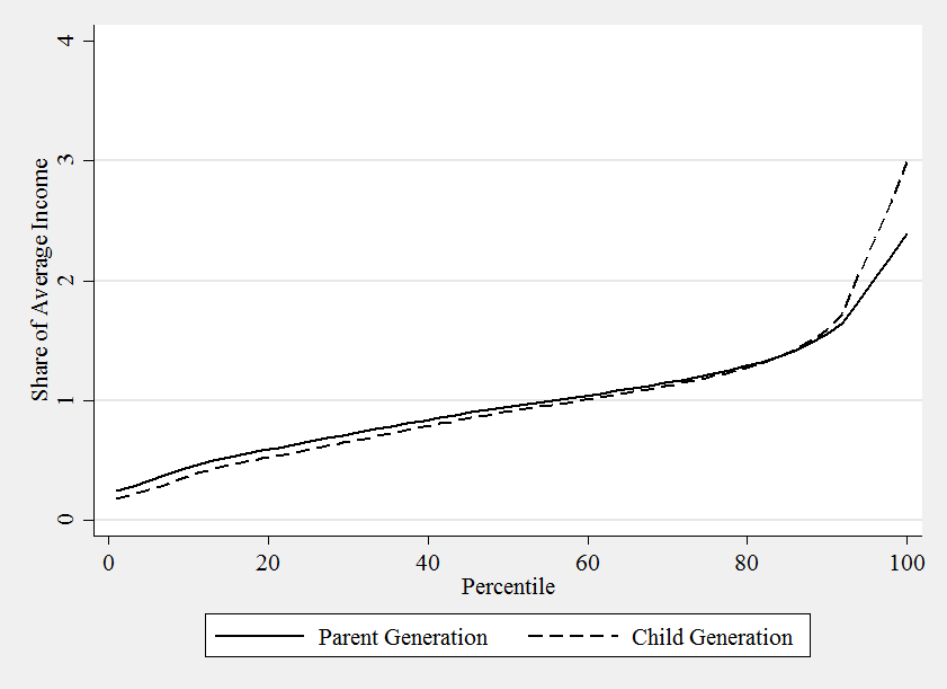


Figure A12. USA Income Distributions