

# The Socio-Economic Gradient in Children's Test-Scores – A Comparison Between the U.S. and Denmark

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*First version: August 22, 2016*

*This version: September 5, 2017*

*Abstract: This paper contributes to the debate on intergenerational mobility in the U.S. and Denmark by linking parental resources to differentials in cognitive development in primary school. Using U.S. survey data and Danish register data, we observe a socio-economic gradient along the entire test score distribution in both countries, but the gradient is always largest in the U.S. Our findings show that a substantial socio-economic test-score gradient is present even in a Scandinavian welfare state. However, in light of the recent debate on similarities in intergenerational mobility between Denmark and the U.S., it is important to note that this socio-economic gradient is smaller in Denmark than the U.S.*

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Keywords: Test scores, intergenerational mobility, inequality, test score gap

JEL codes: I24, I28 & J24

## 1. Introduction

Despite considerable differences in the institutional setting between Denmark and the U.S., recent debates (Thompson, 2016; O'Brien, 2016) have questioned

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whether the relationship between parents' resources and children's outcomes differ substantially between the two countries. With comprehensive redistributive policies in place in Denmark, as well as social protection schemes and close to universal pre-school programs, it may seem counter-intuitive for social mobility to remain the same as in the U.S. Nonetheless, intergenerational mobility in gross wages, wealth, and educational attainment have of late been shown to be similar, with the latter possibly reflecting lower incentives to pursue higher education (Landersø and Heckman, 2017).

Whether social mobility in terms of educational attainment is in fact similar in the two countries is controversial. Tom Hertz and colleagues argue that studies of changes in the intergenerational transmission of educational inequality (IGTEI) are very sensitive to the measure used to capture this transmission (Hertz et al., 2007). In particular, they show that the past 50 years have seen a marked decrease in IGTEI globally if explored by comparing the magnitude of coefficients from a regression of children's educational attainment on parental educational attainment, but has been strikingly static if explored through correlation coefficients between parents' and children's educational attainment. Whether or not the relative variance of parents' and children's education is taken into account is equally important for comparing IGTEI between countries. In the case of the U.S. and Denmark, regression coefficients have the IGTEI to be slightly higher in Denmark compared with the U.S. while it is much lower in Denmark if gauged by correlation coefficients.

Educational attainment as an outcome summarizes a broad set of factors and processes that determine a young person's educational career. The socio-economic situation of the home environment may play a decisive role in determining which opportunities children will find open to them within the educational system and in shaping their educational choices. Within the Sociology of Education, a useful distinction is made between the *primary effects* of parents' economic and educational resources that translate into differentials in educational achievement and cognitive development for the child, and the *secondary effects* which are expressed through differentials in choices (see Jackson et al., 2007). A rich literature has for many years explored the mechanics of these effects, highlighting the role of teachers' perceptions of pupils (Alexander et al., 1987; Papageorge et al., 2016), the efficacy of investments in children's cognitive development before and outside of the educational system (Heckman, 2006), the role of aspirations and expectations of children and their significant others (Eriksson and Jonsson, 1996), and the differing degrees of direct influence that parents exert on the day-to-day operations at the school level (Booth and Dunn, 1996), among other themes.

While arguing that the IGTEI is similar in Denmark and the U.S., Landersø and Heckman (2017) also note that there are notable differences in PISA test-score distributions across these two countries. The lowest proficiency level covers a

considerably larger share of the population in the U.S. compared with Denmark. Esping-Andersen (2004) has shown a similar difference for the adult population using data from the International Adult Literacy Survey (IALS). Such results suggest that those children most at risk of falling out of the educational system stand a better chance in the institutional setup in Denmark. At the same time, differences in children's cognitive development and academic achievement remain to be linked to parental resources in each country such that a clearer picture of how the primary effects coincide or differ might be painted. As the justification of active social policies tends to build on a notion of fairness as equality of opportunity, the primary effects of parental resources stand out as a key aspect of IGTEI by which to judge their efficacy.

The objective of this paper is to explore the link between academic achievement<sup>3</sup> and parental resources more carefully in the U.S. and Denmark. Using data from the Early Childhood Longitudinal Study (ECLS-K) for the U.S. and administrative register data from Denmark, we provide three sets of comparative findings: first, we find that the above-below median household income difference in reading test scores is 17 (14) percentile rank scores in the U.S. (Denmark) at school entry, and 22 (15) in grade eight. The pattern for the test score gap with respect to college/no-college educated parents is very similar. Second, we provide percentile-percentile plots that show a socio-economic gradient along the entire test score distribution. The gradient is always largest in the U.S. The median test score among the low income children corresponds to the 18th percentile among the high income children in the U.S. and the 25th percentile in Denmark. Third, we show that the parental income and child test score relationship is considerably steeper in the US than in Denmark. The test score difference between the highest and lowest income groups at school entry is about 50 percent larger in the U.S. than in Denmark. To evaluate whether our findings are driven by differences in the tests used in the two countries, we use data from the PISA 2012 that provides assessments that are designed to be directly comparable across countries and replicate some of our main findings.

This paper contributes to the literature on international comparisons of socio-economic gradients in test scores (see e.g., Bradbury et al., 2015) by focusing on differences along both the test score and parental income distributions, from school entry to around age 14. Moreover, we are, to the best of our knowledge, the first to provide a comparison between the U.S. and Denmark; two countries that have been used as contrasting examples and caused the debate on the »Scandinavian Fantasy« (Landersø and Heckman, 2017; Thompson, 2016; O'Brien, 2016). The studies most similar to ours are Jerrim (2012), Beuchert and Nandrup

3. Throughout this paper we treat cognitive skills as interchangeable with academic achievement as expressed in standardized test scores.

(2018), and Bradbury et al. (2015).<sup>4</sup> Jerrim (2012) assesses the socio-economic gradient along the test score distribution for six countries (including the U.S. but not including Denmark) using PISA data. Bradbury et al. (2015) use the same data for the U.S. as we do, the ECLS-K survey, to show the mean test score gap by parental background for the U.S. and Beuchert and Nandrup (2018) use the same data for Denmark, as we do, data from the National Tests, to show the mean test score gap in Denmark. While both Beuchert and Nandrup (2018) and Bradbury et al. (2015) also consider the socio-economic test score gap from school entry to age 14, they both focus on mean comparisons. Jerrim (2012) on the other hand looks at the gap along the test score distribution, but using only outcomes at age 15 (and not including Denmark). In contrast, the objective of this paper is to assess the socio-economic gradient throughout grade school along both the income and test score distributions in a comparison between Denmark and the U.S.

In the next section, we briefly describe the data sources and empirical strategy. In section three, we show the three sets of results: the mean test-score gap in Denmark and the U.S; the test-score gap along the test distribution; and the test-score gradient along the parental income distribution. In section four, we conclude with a brief discussion.

## 2. Data and Empirical Strategy

### 2.1. Data

As the objective of this paper is to assess how the development of cognitive skills in primary school relate to parental background in the U.S. and Denmark, we need data from both countries that satisfy two conditions: one, the datasets should include assessments of children's cognitive abilities at several points in childhood. Two, the datasets should contain information on parental background. For the U.S. we use data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K). For Denmark we use test score data from the Danish Ministry of Education linked to administrative registers on parental background from Statistics Denmark. We briefly describe these two datasets in the following two sections. For both countries, we use measures of cognitive ability in reading and mathematics. For the U.S., we have test scores in both subjects in kindergarten, grade 1, grade 3, grade 5, and grade 8. For Denmark, we have math test scores in grades 3 and 6, and reading test scores in grades 2, 4, 6, and 8.<sup>5</sup>

4. There is a rich literature both within sociology and economics about intergenerational mobility. For a review of this literature see e.g. Black and Devereux (2011).
5. For the development of the mean test score difference, we therefore focus on reading test scores as the math test scores are only measured twice. We have also ran the analyses using

### 2.1.1. US: ECLS-K

The ECLS-K is a longitudinal survey conducted by the U.S. National Center for Education Statistics (NCES). The gross survey consists of almost 20,000 children who began kindergarten in the fall of 1998 (i.e. born around 1993). The children were surveyed in kindergarten, grade one, three, five, and eight. While the survey consists of a wide range of detailed information about the children, their families and the schools, we here focus on the children's reading and mathematics test scores and the parents' educational background and the household income. Both parental education and household income was measured when the children were in grade one (i.e. about six to seven years old). For education, we focus on the college/no-college gradient, and for income we both evaluate the median split and the gradient by the provided income groups (-5,000 USD, 5,001-10,000 USD, and so on, in total 13 groups). It is worth noting that the panel is not balanced. While almost 15 thousand children completed the reading assessment in grade 1, less than nine thousand children completed the assessment in grade eight. As our analyses are cross-sectional, we apply the ECLS-K cross-sectional weights to make the sample representative for the cohort of children starting kindergarten 1998-99 (results are not sensitive to the choice of weights). As Appendix Table A.1 reveals, the final sample consists of between 8,727 and 15,425 children for each grade level.

### 2.1.2. DK: Administrative Register Data

For Denmark, our point of departure is the Danish National Test in reading (Danish) and mathematics, which are mandatory assessments in Danish public schools. The reading tests are taken in grades 2, 4, 6, and 8, while mathematics tests are taken in grades 3 and 6. The tests were introduced in 2010 which implies that children in our sample are born around 2000. We link the test data to administrative registers to obtain information about parental background. The parents' educational background and income was measured when the children were six years old. To make the dataset comparable to the U.S. data, we focus on the college/no-college gradient as well as the median household income split. We also create 13 income groups that are designed to have the same distribution as the U.S. group (i.e. 3 percent of the population is in the first group in both populations, and so on). The final sample consists of approx. 250,000 children for each grade level (see Appendix Table A.1).

### 2.1.3. Data caveats

For the U.S. we apply a large scale survey and for Denmark we use administrative registers. It is important to mention several caveats that pertain to this data.

mathematics test scores and the results are qualitatively similar. These results are available on request.

First, the selection into the datasets is potentially very different in the two countries. While the U.S. data suffers from the usual attrition issues of survey data, the Danish data is based on mandatory tests that only cover public schools (approximately 80% of a cohort). In Appendix Figure A.1 we assess the importance of this sample selection in Denmark. As we have information on the ninth grade GPA for the entire cohort, we can compare the distribution of GPA for children in our sample to the distribution for children not included. In all analyses we therefore weight the observations based on the relative representation (compared to the birth cohort) within each cell, where the cells are defined by parental income percentile and education (college/no college).

Secondly, the Danish data is considerably newer than the U.S. sample. While the children in the ECLS-K are on average born in 1993, the children in the Danish data are on average born in the year 2000. To assess the stability of the gaps over time, Appendix Figure A.2 shows the gap in the ninth grade GPA for children born 1986 to 1996. We do not observe signs of notable changes over time.

Thirdly, as we use test-scores from different tests in the two countries, differences in the socio-economic gradient could stem from differences in the tests. To assess this issue we replicate the main findings using PISA data in section 3.3.

Finally, while the U.S. data is longitudinal the Danish data consists of several birth cohorts measured at several points in time between 2010 and 2014. In the Danish data we are able to follow the same birth cohorts from 2<sup>nd</sup> through 6<sup>th</sup> grade or from 4<sup>th</sup> through 8<sup>th</sup> grade. Figures based on this subset of the data are consistent with results using the full dataset.

#### 2.1.4. PISA data

In light of the data caveats mentioned above, we assess the robustness of our results using data from The Programme for International Student Assessment (PISA). The PISA is a worldwide survey among 15 year old school children conducted by the Organisation for Economic Co-operation and Development (OECD). The PISA data includes an assessment of competencies that is designed to be comparable across countries. In contrast to the ECLS-K and the Danish National Data, the PISA data only contains an assessment at the end of compulsory schooling. Moreover, for Denmark and the U.S. the information on parental background is relatively limited in the publicly available PISA data. Given the advantages (comparability across countries) and the disadvantages (no assessment at young ages and limited parental background information), the PISA constitutes a good supplement to the main data.

We use the publicly available version of the PISA 2012 (children born around 1997) and focus on the reading and mathematics tests. We are only able to divide the children into groups by educational background, as information on parental income is not available. We weight each observation with the student weight provided in the PISA 2012 survey data. For both mathematics and reading we use

one set of plausible values for the performance in the assessments (imputed values). Results are not sensitive to the choice of plausible values.

## **2.2. Empirical Strategy**

Comparing test scores across tests and countries is challenging because the underlying test distributions may differ. The distance between test scores in one test may vary considerably from distances using a different test. To assume cardinal comparability may therefore be unfeasible. Instead, we focus on ordinal differences by comparing percentile ranks.<sup>6</sup> Percentile ranks are computed for each subject at each test time separately for each country. In this way, rather than indicating a specific test result, the percentile scores indicate a location in the distribution of test achievements at a particular point in time.

We use these percentile ranks in three ways. First, we show how the mean percentile ranks differ in the U.S. and in Denmark between children conditional on parental income and education in grades 0 through 8. This provides an intuitive measure of the mean inequality. Second, to explore the distributions behind these means we compute percentile-percentile plots (see also Nielsen, 2015). For a given percentile rank in the group of children of non-college educated parents (below median income households) we calculate the share of children of college educated parents (above median income households), who obtain the same or a lower raw test score. For example, given that the 20<sup>th</sup> percentile in the non-college group achieved a test score of  $y$ , what fraction in the college group scored at most  $y$ ? If the test performance is unrelated to whether the parents' have a college degree (above median income), we would expect the fractions to be the same and the relationship to be a 45 degree line. These plots mimic the intuition of a Lorenz-curve and by calculating pseudo-gini coefficients we achieve a measure of the inequality over the full distribution. Third, we split the parental income into thirteen income groups and calculate the mean percentile rank within each income group in each country to compare the income gradient.

## **3. Results**

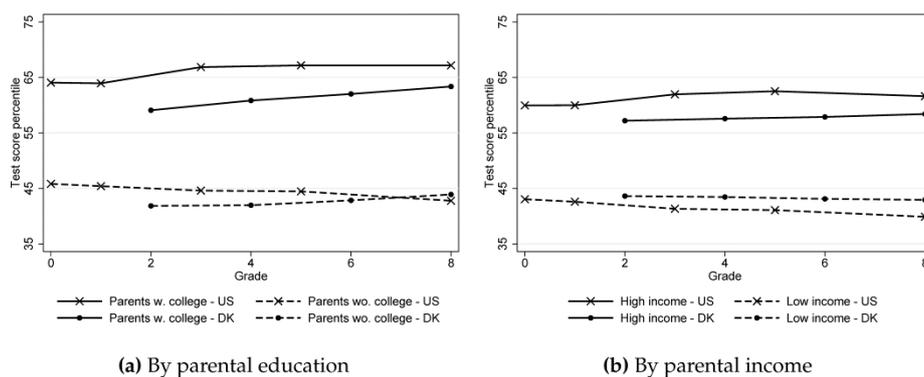
### **3.1. The development of the test score gap**

We first replicate the findings by Beuchert and Nandrup (2018) and Bradbury et al. (2015) by showing differences in test score means across groups. In Figure 1a, we show the mean test score for both children of college-educated parents and

6. Note that focusing on ordinal ranking does not completely solve the issue of non-comparability across tests. It may still be that differences in ranks across socio-economic groups arise because the tests measure different abilities with differing social gradients. We address this issue by replicating our main findings using the PISA 2012 data.

children of parents with at most a high school degree. In the U.S. (Denmark) the gap between these two groups of children is 18 (17) percentile ranks in grade zero (two). While the gap widens in the U.S. towards grade eight (to 24 percentile ranks), the increase in the gap is much smaller in Denmark (to 19 percentile ranks). Throughout all grades, the gap in means is largest in the U.S.

If we split the sample by household income as shown in Figure 1b, the gap in reading test scores is 17 (14) percentile ranks in the U.S. (Denmark) at school entry (i.e. grade zero and grade two, respectively), and 22 (15) percentile ranks in grade eight. The finding of a slightly widening test score gap are in line with the findings of Bradbury et al. (2015) for the U.S. and Beuchert and Nandrup (2018) for Denmark.<sup>7</sup>



**Figure 1:** The reading test score gap in the US and Denmark

Notes: The test score is computed into a percentile rank in both countries. The high/low income split corresponds to above/below median income. For the U.S. income is household income, for Denmark income is the sum of father and mother's net income.

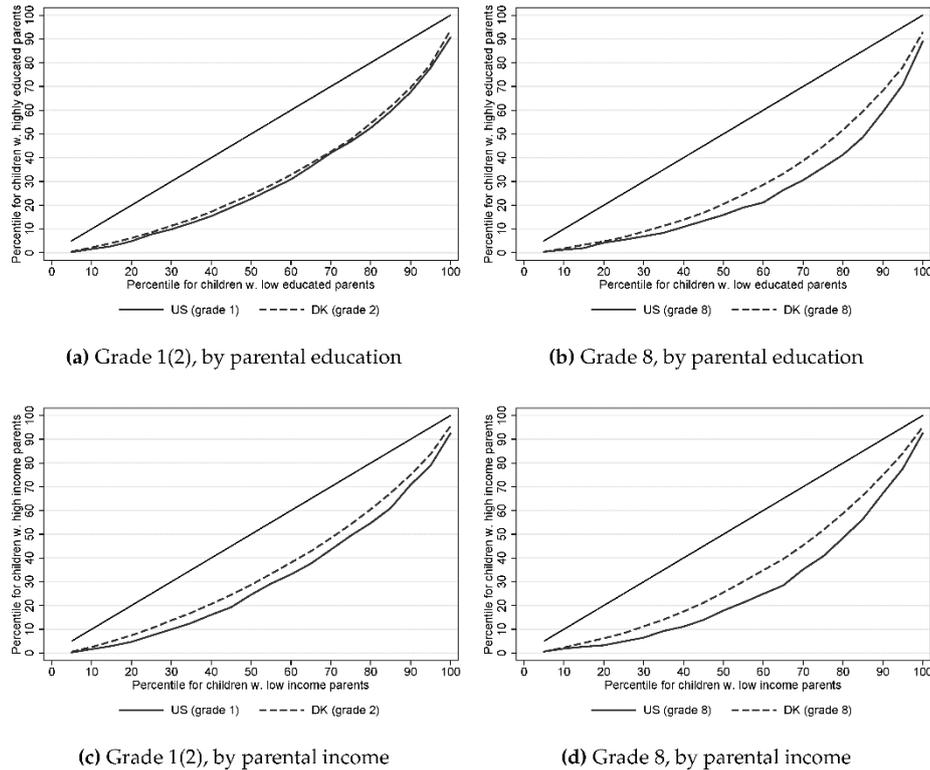
### 3.2. Percentile-percentile plots

The mean comparisons provide a useful first overview of the differences between the two countries and clearly link this paper to previous studies. Meanwhile, mean differences may be caused by specific parts of the test score distribution. It could for example be the case that all differences in mean test scores are driven by the lower tail of the test score distribution, i.e. that we observe many more students from the low resource group in the lower tail of the test score distribution in the U.S., while we observe equally many students from both groups in the other end of the distribution.

Figure 2 shows percentile-percentile plots for reading in both countries by parental income and education. The test score of the tenth percentile in the no-

7. Note however that both Bradbury et al. (2015) and Beuchert and Nandrup (2018) apply slightly different educational groupings.

college group in the U.S. (Denmark) corresponds to the first (second) percentile test score in the collegeeducated group in grade one (two), as shown in Figure 2a. Focusing on the below vs. above median household income gap, Figure 2d shows that the median test score among the low income children corresponds to the 18<sup>th</sup> percentile among the high income children in the U.S. and the 25<sup>th</sup> percentile in Denmark (in grade 8). Across grades and parental characteristics, we observe that the dashed line is closer to the 45 degree line along the entire distribution, suggesting that the socio-economic gradient is always smaller in Denmark compared with the U.S.



**Figure 2: Percentile-Percentile Plots for Reading**

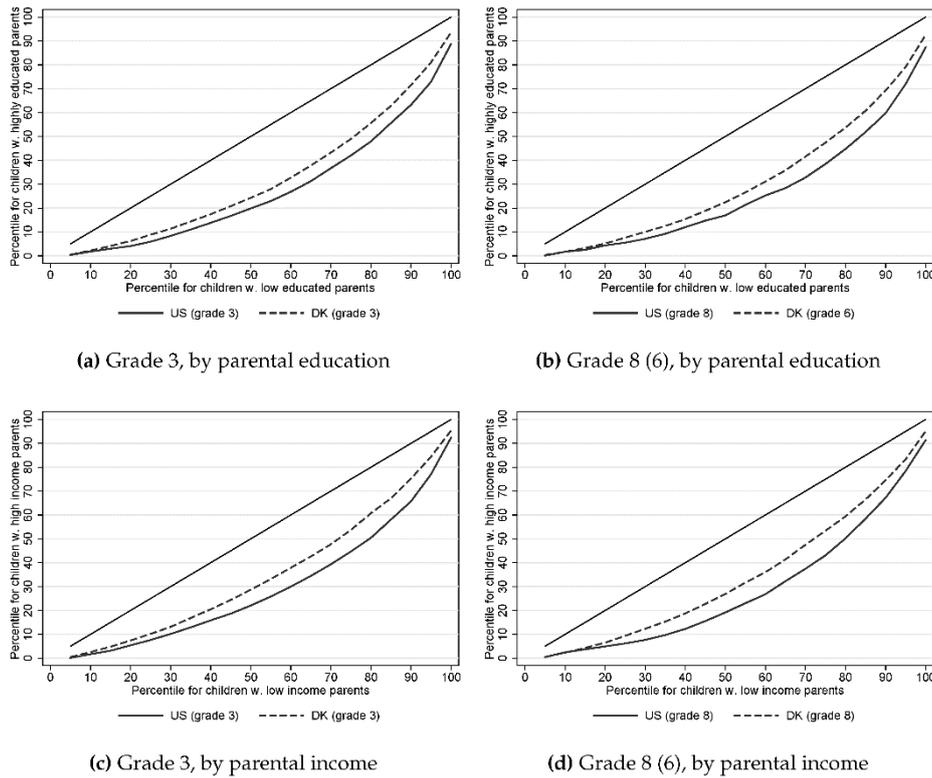
Notes: The high/low income split corresponds to above/below median income. For the U.S. income is household income, for Denmark income is the sum of father and mother's net income. For both countries the percentile-percentile plots are calculated on ten percentile rank intervals. For both countries the percentile-percentile plots are calculated on five percentile rank points. For the U.S. the reading test score is from grades 1 and 8. For Denmark, is the reading test score is from grades 2 and 8.

The differences between the two countries are slightly clearer when focusing on the socio-economic gradient along the test score in mathematics. Figure 3a shows that the median test score among the low income group corresponds to the test

score of the 20<sup>th</sup> (29<sup>th</sup>) test score in the high income group in the U.S. (Denmark), in grade 3. These percentile-percentile plots confirm that the socio-economic gradient in test scores is observed in both tails: At the lower end of the test score distribution in grade 3, the test score of the 10<sup>th</sup> percentile for children of parents with an income below the median, corresponds to the test score of the 1.6<sup>th</sup> (2.4<sup>th</sup>) percentile among children of parents with an income above the median in the U.S. (Denmark). At the other end of the test score distribution in grade 3, we observe that the low-income group's 90<sup>th</sup> percentile test score corresponds to the test score of the 68<sup>th</sup> (75<sup>th</sup>) percentile in the high income group in the U.S. (Denmark).

As the 45 degree lines in Figures 2a to 2d and Figures 3a to 3d correspond to perfect equality in test scores across parental income and education groups, we can quantify the degree of inequality by calculating the share of the area between the 45 degree lines and the graphs relative to the full area below the 45 degree line, i.e. pseudo Gini coefficients, where a lower coefficient indicates a greater degree of equality and 0 indicates perfect equality. The main purpose of these pseudo Gini coefficients is to provide a single measure of the inequality in test scores across socio-economic background.<sup>8</sup> We calculate the size of the area by a linear approximation for each five percentile point interval on the x-axis. The coefficients are shown in Table 1. As expected based on the visual inspection, the inequality is larger in the U.S. than in Denmark. As the graph suggests, the difference is especially pronounced when we split the groups by parental income. Focusing on parental education, we find that the pseudo Gini coefficient is 20 (31) percent larger in reading (mathematics) in the U.S. than in Denmark in grade 8/6.<sup>9</sup>

8. The pseudo Gini coefficients have a slightly different interpretation than the traditional income Gini coefficients. The latter refers to the distribution of a limited stock of resources, while our pseudo Gini coefficients refer to the distribution of test performances. For example, an income Gini coefficient of one would suggest that one individual has all the income in the economy. In the context of test scores, it is not possible that one person has »all the test scores«.
9. It is important to bear in mind that the differences in reading and mathematics are not strictly comparable. While reading comparisons are between Danish 2<sup>nd</sup> and 8<sup>th</sup> graders and U.S. 1<sup>st</sup> and 8<sup>th</sup> graders, mathematics comparisons are between Danish 3<sup>rd</sup> and 6<sup>th</sup> graders and U.S. 3<sup>rd</sup> and 8<sup>th</sup> graders.



**Figure 3: Percentile-Percentile Plots for mathematics**

Notes: The high/low income split corresponds to above/below median income. For the U.S. income is household income, for Denmark income is the sum of father and mother's net income. For the U.S. the mathematics test score is from grades 3 and 8. For Denmark the mathematics test scores are from grades 3 and 6.

### 3.3. Percentile-percentile plots based on PISA 2012

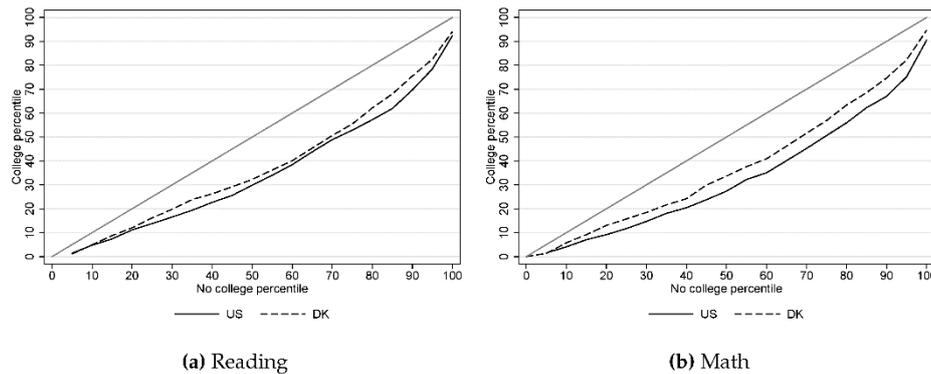
We now turn to the PISA 2012 data, which provides assessments of reading and mathematics skills that are comparable across countries. The ECLS-K and the Danish administrative data might suffer from different measurement errors. While we have no reason to believe that these measurement errors are systematic, it may be the case that the ECLS-K survey data has larger measurement errors for the variables capturing parental background. The survey questions related to household income did for example not specify whether income was measured net or gross. If the measurement error is larger in the U.S. data, the difference in the socio-economic gradient between the two countries might actually be larger than our results suggest. A second advantage of the PISA 2012 data is therefore that it reduces the issue of differences in measurement errors across countries. Compared with the main data, the socio-economic gradient along the test score distri-

bution is slightly smaller when using the PISA data, but especially in mathematics, the difference between the U.S. and Denmark is similar, as Figure 4 shows.

**Table 1. Pseudo Gini coefficients**

	--- US ---		--- DK ---	
	Edu	Inc	Edu	Inc
<i>A. Reading</i>				
Grade 1 (2)	0.42	0.40	0.39	0.32
Grade 8	0.53	0.48	0.44	0.36
<i>B. Mathematics</i>				
Grade 3	0.47	0.45	0.38	0.32
Grade 8 (6)	0.51	0.46	.039	0.32

Table 2 presents the pseudo Gini coefficients based on PISA 2012 data. As the graphical inspection indicated, the test score inequality is somewhat smaller in the PISA data. However, the relative difference between the U.S. and Denmark is actually slightly larger with the PISA data compared to the main data. The pseudo Gini coefficient is 24 (34) percent larger in reading (mathematics) in the U.S. compared with Denmark, when using the PISA data.



**Figure 4:** Percentile-Percentile Plots for the US and Denmark based on PISA data

Notes: Data is from the public use PISA files. For the reading score we use the variable PV1READ and for mathematics we use the variable PV1MATH. Parental education is defined by the variable hisced, where the no-college group covers values 0-5 (ISCED 1-5B) and the college group is defined by value 6 (ISCED 6 and 5A). All observations are weighted using the variable W\_FSTUWT.

**Table 2. Pseudo Gini coefficients**

	US	DK
Reading	0.32	0.26
Mathematics	0.35	0.26

Notes: Data is from the public use PISA files (see description above).

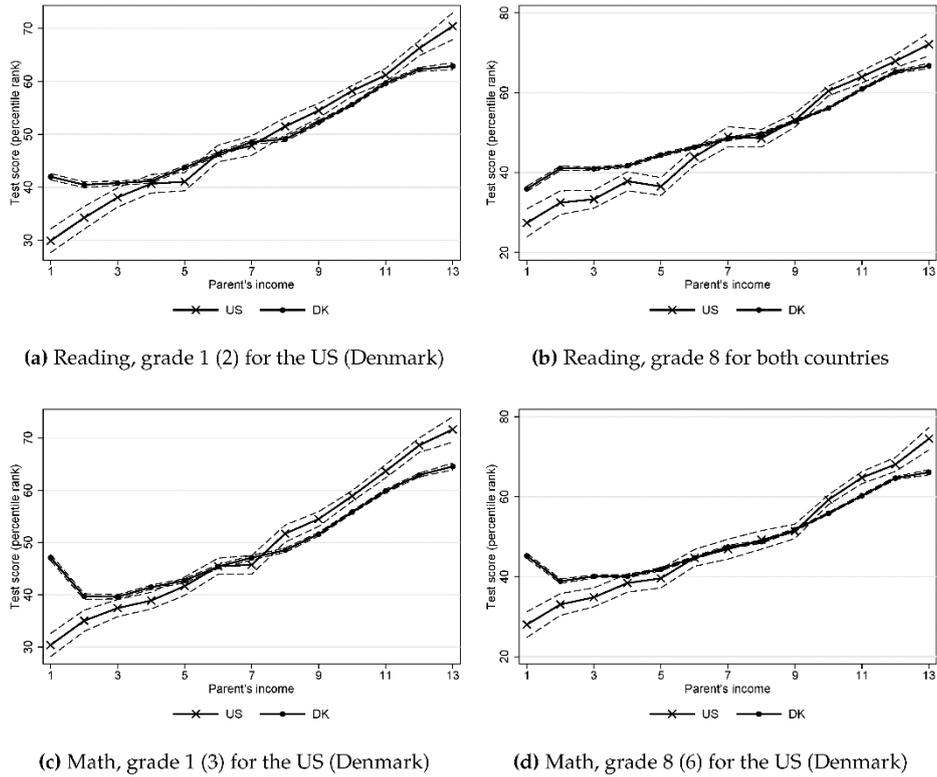
To sum up, using the PISA 2012 data we find differences between countries in test score inequality that are qualitatively similar to the differences we find using the ECLSK survey data (for the U.S.) and the Danish National Test data (for Denmark). The PISA 2012 data also allows us to compare test scores across countries. In Appendix Figure A.13, we present percentile-percentile plots comparing the U.S. with Denmark. Denmark has a higher average math score than the U.S., and the figure shows that this difference is driven by almost the entire distribution. Both at the 10<sup>th</sup> and the 80<sup>th</sup> percentile the dashed line is above the 45degree line. The median mathematics test score in Denmark almost corresponds to the 65th percentile in the U.S. The average reading test score is, in contrast, somewhat lower in Denmark compared with the U.S. Appendix Figure A.13 shows that this difference is driven by the upper part of the test score distribution.

### **3.4. The income gradient**

So far we have focused on two groupings, parents with college vs. without college and above vs. below median household income. To explore the gradient along the distribution of parental resources, we present the mean test score by household income group in Figure 5. Both at school entry (grade one and two, respectively) and in grade 8 we observe that the income gradient is considerably steeper in the U.S. than in Denmark. In other words, moving from one income bin to the next is associated with a greater difference in test scores in the U.S. than in Denmark. Especially in the lower and the higher bins the difference between the two countries is striking. The children in the lowest income groups do considerably worse in the U.S. than in Denmark, and vice versa at the high income group. The test score difference between the highest and lowest income groups at school entry is about 50 percent larger in the U.S. compared with Denmark.

## **4. Discussion**

In this paper we provided a comparison of the socio-economic gap in test-scores at grades zero to eight for the U.S. and Denmark. For both countries we observe a considerable gap at school entry, but the gap is much wider in the U.S. than in Denmark. Further, the gap seems to widen considerably more through grade school in the U.S. than in Denmark. Assessing the gap along the test score distribution confirms the mean comparisons. Children's test score attainment is much closer related to parental income and education in the U.S. than in Denmark. The difference is especially pronounced when focusing on parental income. When looking across the income distribution, the income gradient in the U.S. stands out as somewhat steeper than in Denmark. The test score difference between the highest and lowest income groups at school entry is about 50 percent larger in the U.S. than in Denmark.



**Figure 5:** Parental income and children's test score in reading and mathematics

Notes: The test score is the percentile rank in both countries. The x-axis shows the 13 income groups given by the ECLS-K data. The first group covers the first 3.09 percent of the population. The following groups cover respectively 4.12, 7.27, 7.78, 7.27, 9.12, 5.80, 7.40, 9.41, 18.30, 9.78, 8.33 and 2.33 percent of the distribution. The median split is at group eight.

As a comparative analysis, the study involves a number of limitations. First, the socio-economic significance of a college degree may vary between the two countries.

As a measure of parental resources, it may not indicate a difference in the same way. Second, in ECLS-K the reported household income does not specify whether it is gross or net income. In the Danish data we have access to both gross and net income and the results are qualitatively unchanged by choice of income definition. Third, the two data sources present each their set of potential selection issues. In the Danish data, only children enrolled in public schools are selected while the U.S. data suffers from the typical survey challenges, non-response and attrition. However, using data from the PISA 2012 that provides assessments that are comparable across countries, we find a qualitatively similar difference in the test score inequality between the U.S. and Denmark.

Our findings show that school test performance is clearly related to parental resources in both Denmark and the U.S., but less so in the former. In other words,

inequalities in opportunities in terms of differences in cognitive abilities are smaller in Denmark than in the U.S. This does not necessarily translate into a greater degree of social mobility for several reasons. First, children's test scores are only one measure of opportunity, which might differ substantially from actual opportunities as perceived by children themselves. Second, the child's choices and the institutional setting in post compulsory schooling might affect how these opportunities are realized. As (Landersø and Heckman, 2017) suggest, one mechanism that could reduce educational mobility in Denmark is that economic incentives to pursue higher education is lower in Denmark compared with the U.S. due to the much larger redistribution on income. Whether educational mobility is in fact similar in the two countries, and the reasons behind this, is not the business of this analysis. Nonetheless, equality of opportunities in terms of school performance may very well be an important social aim in itself.

Many factors affect test scores and it is well beyond the scope of this paper to provide a clear answer to why we observe a smaller socio-economic gradient in Denmark compared with the U.S. One way ahead is to elaborate on the within country differences that we have identified. While the socio-economic gradient is considerably larger for mathematics in the U.S. compared with reading, the gradient is very similar across subjects in Denmark. Differences in when and how children are taught in these subjects could potentially explain some of the differences across countries. Another way forward is to analyze subgroup differences. In the Appendix we provide results by child gender. While we find some patterns by gender, these differences are in general very small compared to the overall differences across countries. Future research might be able to clarify some of the key factors beyond the differences we identify in this paper.

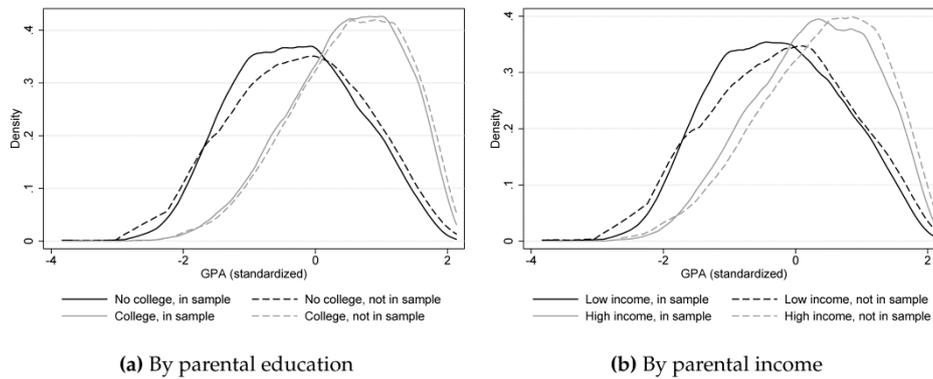
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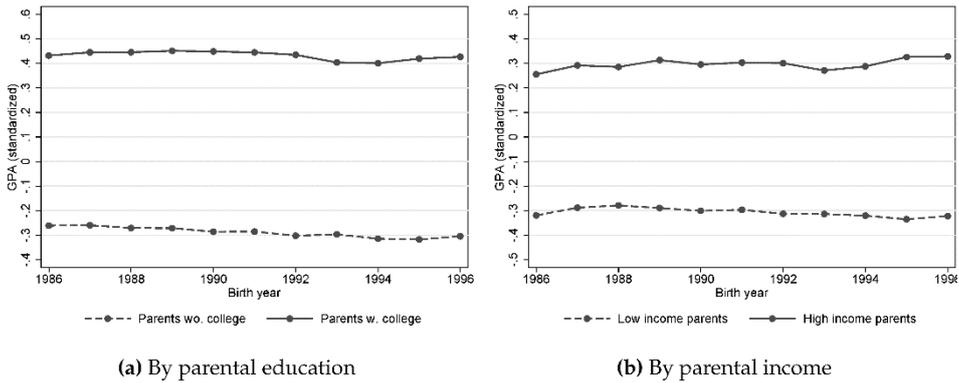
## Appendices

**Table A 1. Pseudo Gini coefficients**

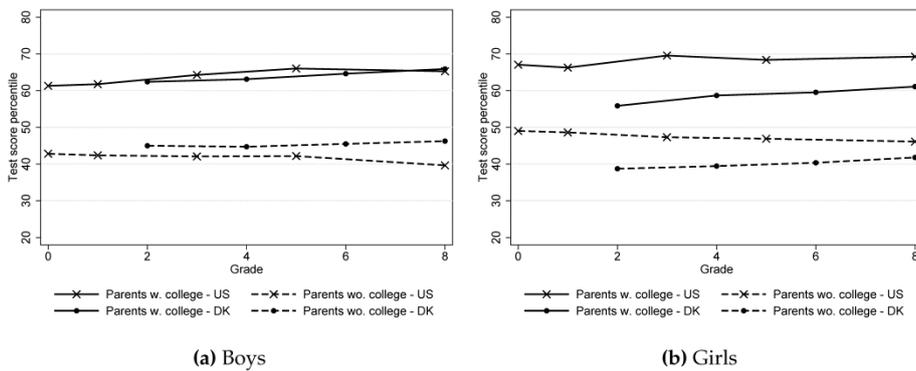
	US	DK
	N	N
Testscore (reading), grade 0	14,888	
Testscore (reading), grade 1	14,977	
Testscore (reading), grade 2		266,933
Testscore (reading), grade 3	13,074	
Testscore (reading), grade 4		267,074
Testscore (reading), grade 5	10,408	
Testscore (reading), grade 6		267,874
Testscore (reading), grade 8	8,727	249,088
Testscore (math), grade 0	15,425	
Testscore (math), grade 1	15,250	
Testscore (math), grade 3	13,156	268,182
Testscore (math), grade 5	10,416	
Testscore (math), grade 6		267,467
Testscore (math), grade 8	8,872	



**Figure A.1:** Selection, Danish sample

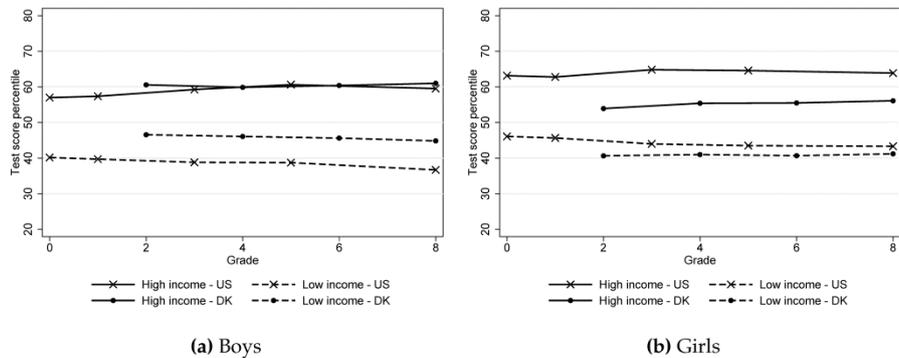


**Figure A.2:** Test score GAP, 9<sup>th</sup> grade GPA by birth year



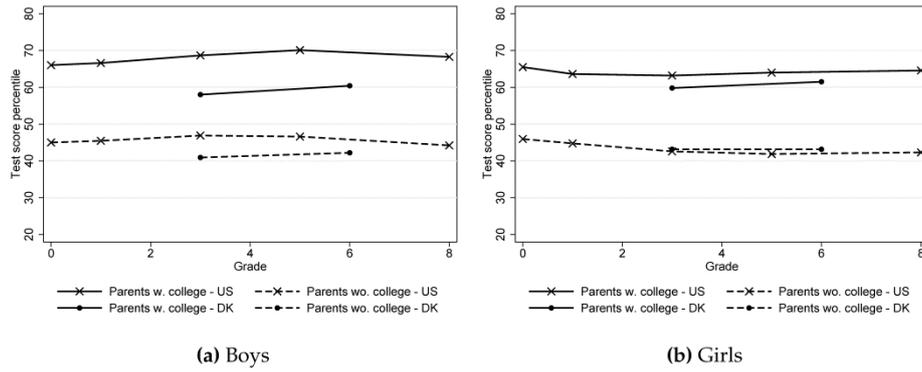
**Figure A.3:** The reading test score gap by parental education

Notes: The test score is computed into a percentile rank in both countries.



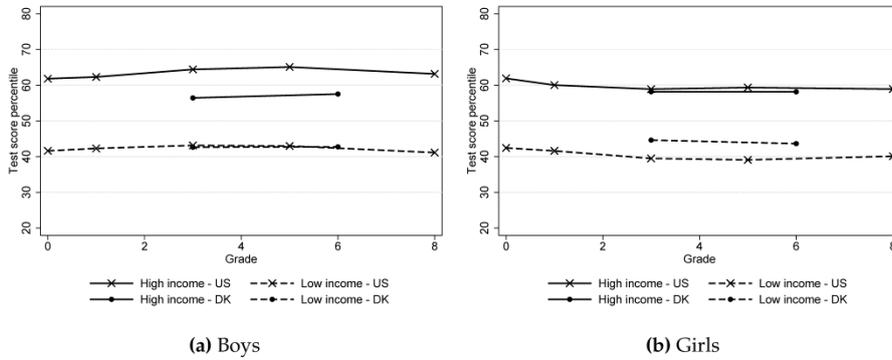
**Figure A.4:** The reading test score gap by parental income

Notes: The test score is computed into a percentile rank in both countries. The high/low income split corresponds to above/below median income. For the U.S. income is household income, for Denmark income is the sum of father and mother's net income.



**Figure A.5:** The math test score gap by parental education

Notes: The test score is computed into a percentile rank in both countries.



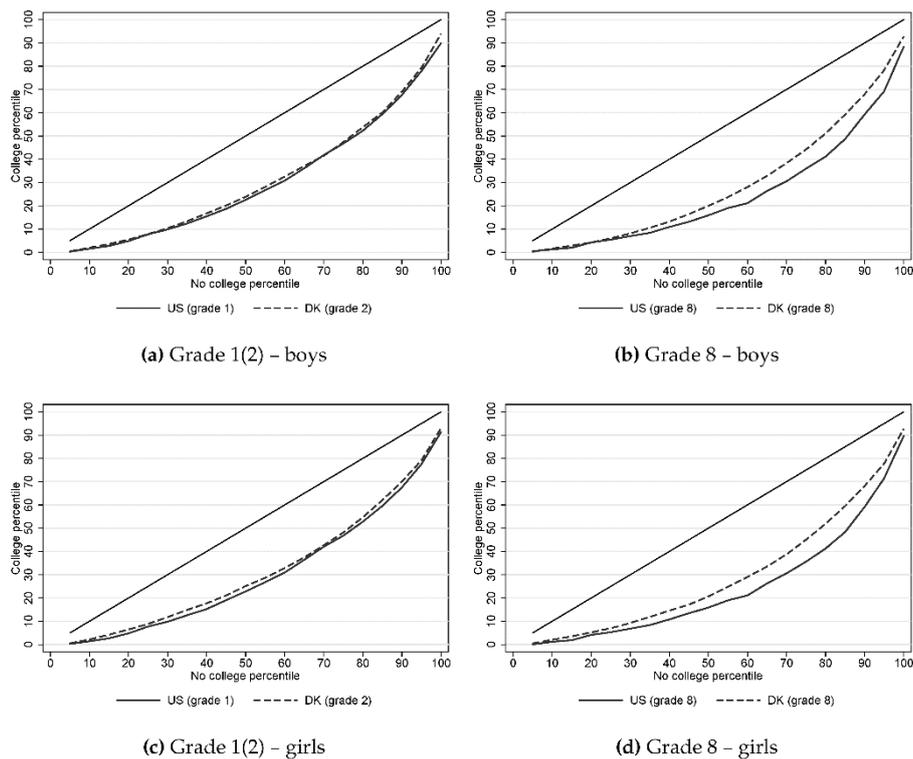
**Figure A.6:** The math test score gap by parental income

Notes: The test score is computed into a percentile rank in both countries. The high/low income split corresponds to above/below median income. For the U.S. income is household income, for Denmark income is the sum of father and mother's net income.

**Table A 2. Pseudo Gini coefficients by sex**

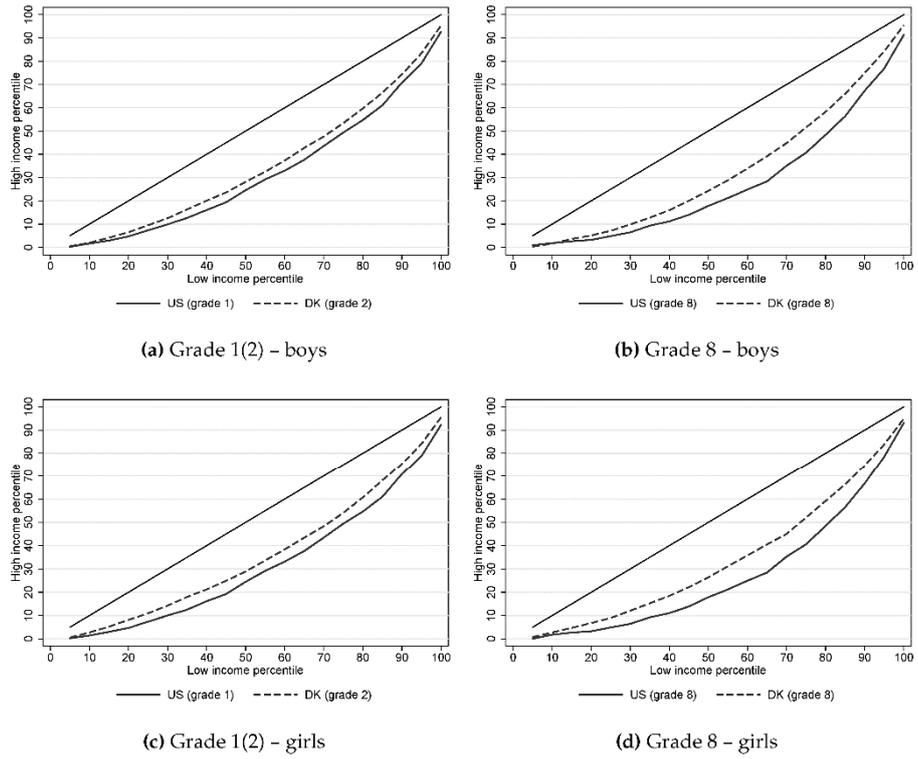
	Boys				Girls			
	US		DK		US		DK	
	Edu	Inc	Edu	Inc	Edu	Inc	Edu	Inc
<i>A. Reading</i>								
Grade 1 (2)	0.42	0.40	0.40	0.33	0.42	0.40	0.39	0.31
Grade 8	0.54	0.45	0.45	0.37	0.53	0.48	0.43	0.35
<i>B. Mathematics</i>								
Grade 3	0.47	0.45	0.39	0.33	0.47	0.45	0.37	0.31
Grade 8 (6)	0.51	0.46	0.39	0.32	0.51	0.46	0.39	0.32

Edu refers to the difference between children of college educated parents and children of parents with no college degree. Inc refers to the difference between above/below median income.



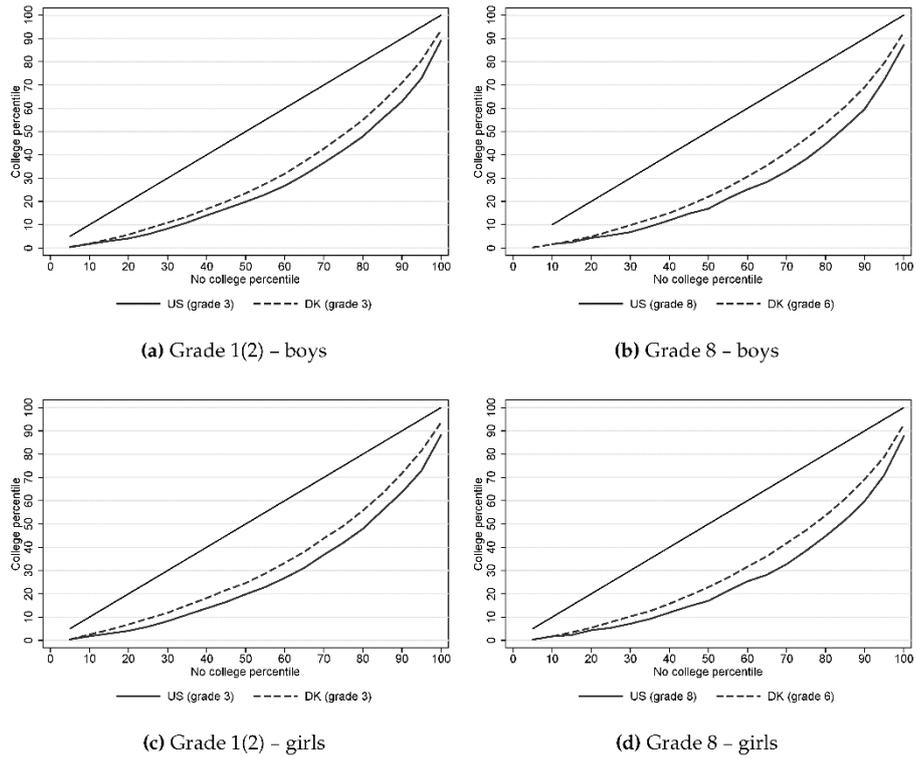
**Figure A.7:** Percentile-Percentile Plots for Reading by parents education

Notes: For both countries the percentile-percentile plots are calculated on five percentile rank intervals. For the U.S. the reading test score is from grades 1 and 8. For Denmark is the reading test score is from grades 2 and 8.



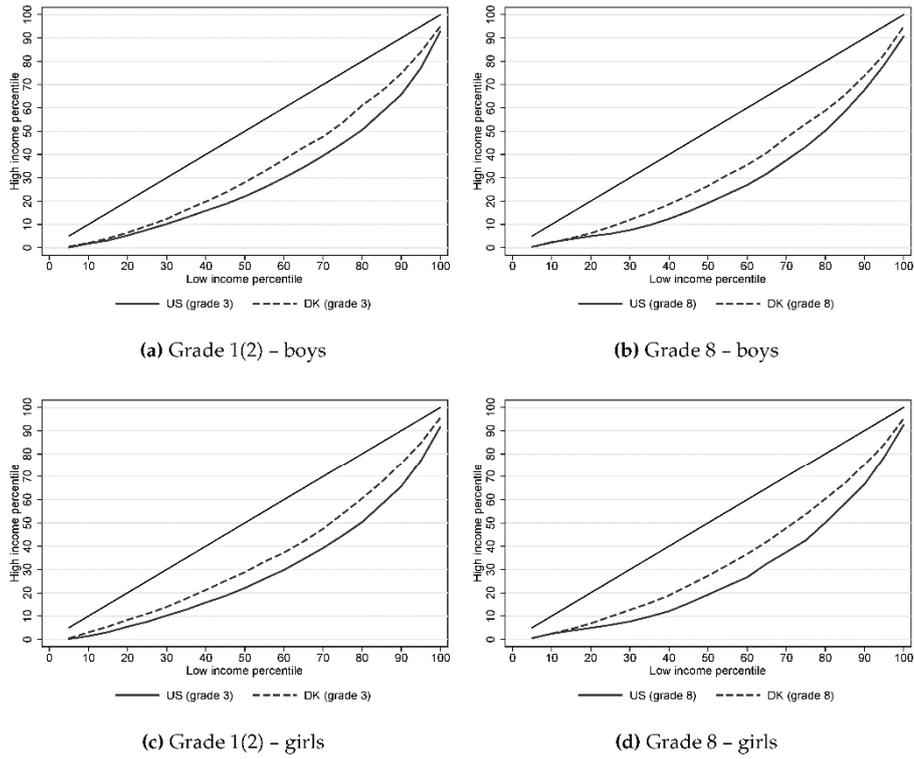
**Figure A.8:** Percentile-Percentile Plots for Reading by parents income

Notes: The high/low income split corresponds to above/below median income. For the U.S. income is household income, for Denmark income is the sum of father and mother's net income. For both countries the percentile-percentile plots are calculated on five percentile rank intervals. For the U.S. the reading test score is from grades 1 and 8. For Denmark is the reading test score is from grades 2 and 8.



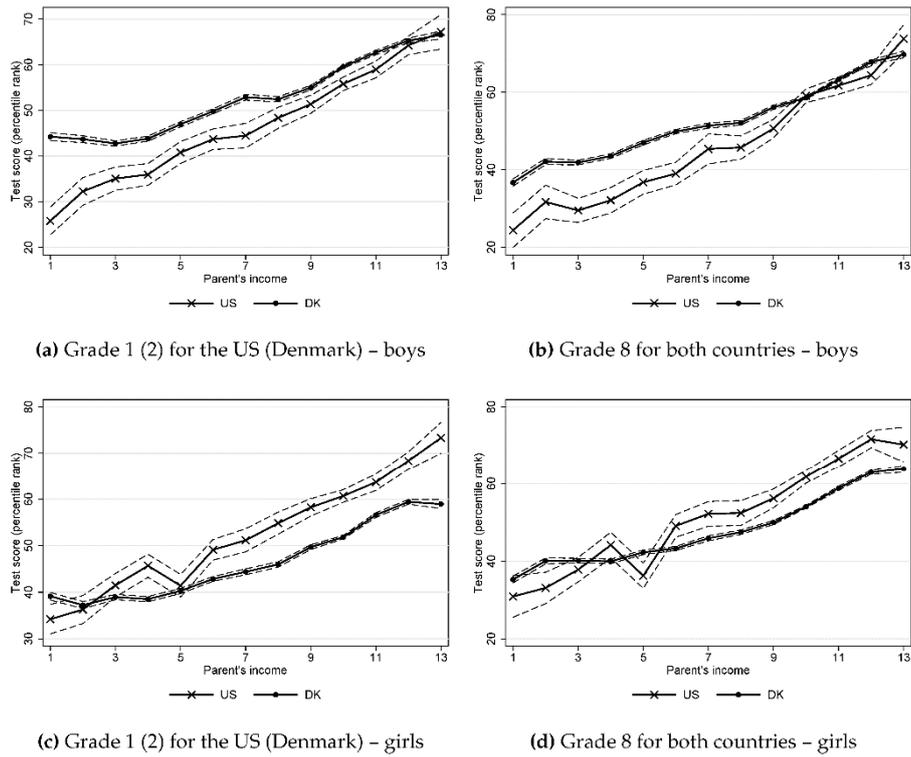
**Figure A.9:** Percentile-Percentile Plots for math by parents education

Notes: For both countries the percentile-percentile plots are calculated on five percentile rank intervals. For the U.S. the math test score is from grades 1 and 8. For Denmark is the math test score is from grades 3 and 6.



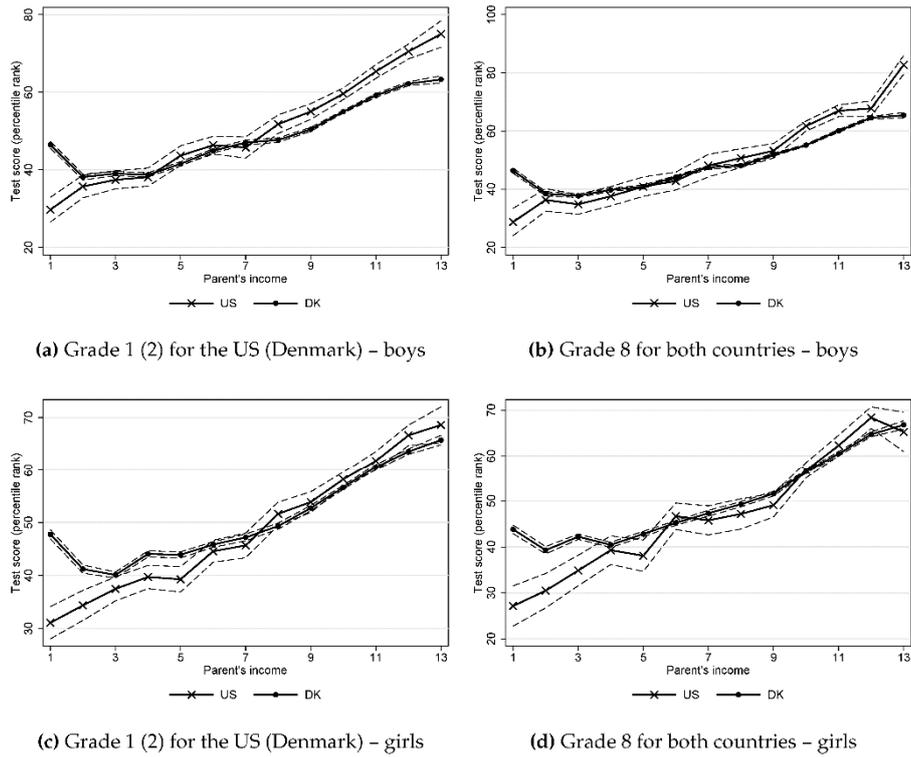
**Figure A.10:** Percentile-Percentile Plots for math by parents income

Notes: The high/low income split corresponds to above/below median income. For the U.S. income is household income, for Denmark income is the sum of father and mother's net income. For both countries the percentile-percentile plots are calculated on five percentile rank intervals. For the U.S. the math test score is from grades 1 and 8. For Denmark is the math test score is from grades 3 and 6.



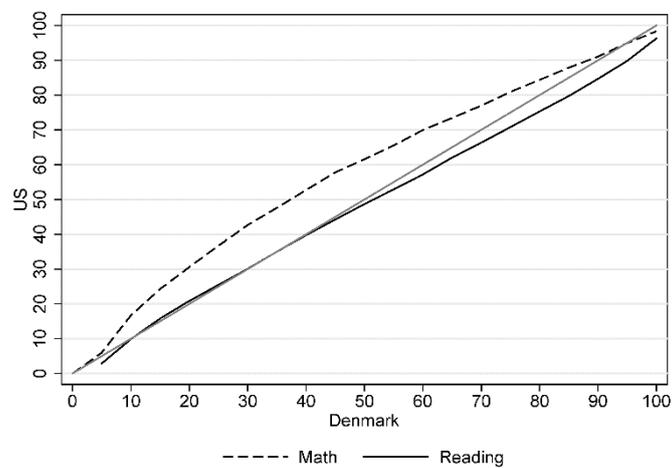
**Figure A.11:** Parental income and children's test score in reading

Notes: The test score is the percentile rank in both countries. The x-axis shows the 13 income groups given by the ECLS-K data. The first group covers the first 3.09 percent of the population. The following groups cover respectively 4.12, 7.27, 7.78, 7.27, 9.12, 5.80, 7.40, 9.41, 18.30, 9.78, 8.33 and 2.33 percent of the distribution. The median split is at group eight.



**Figure A.12:** Parental income and children’s test score in math

Notes: The test score is the percentile rank in both countries. The x-axis shows the 13 income groups given by the ECLS-K data. The first group covers the first 3.09 percent of the population. The following groups cover respectively 4.12, 7.27, 7.78, 7.27, 9.12, 5.80, 7.40, 9.41, 18.30, 9.78, 8.33 and 2.33 percent of the distribution. The median split is at group eight.



**Figure A.13:** Percentile-Percentile Plots comparing the US to Denmark using PISA data.