WEB APPENDIX

Lessons for Americans from Denmark about Inequality and Social Mobility

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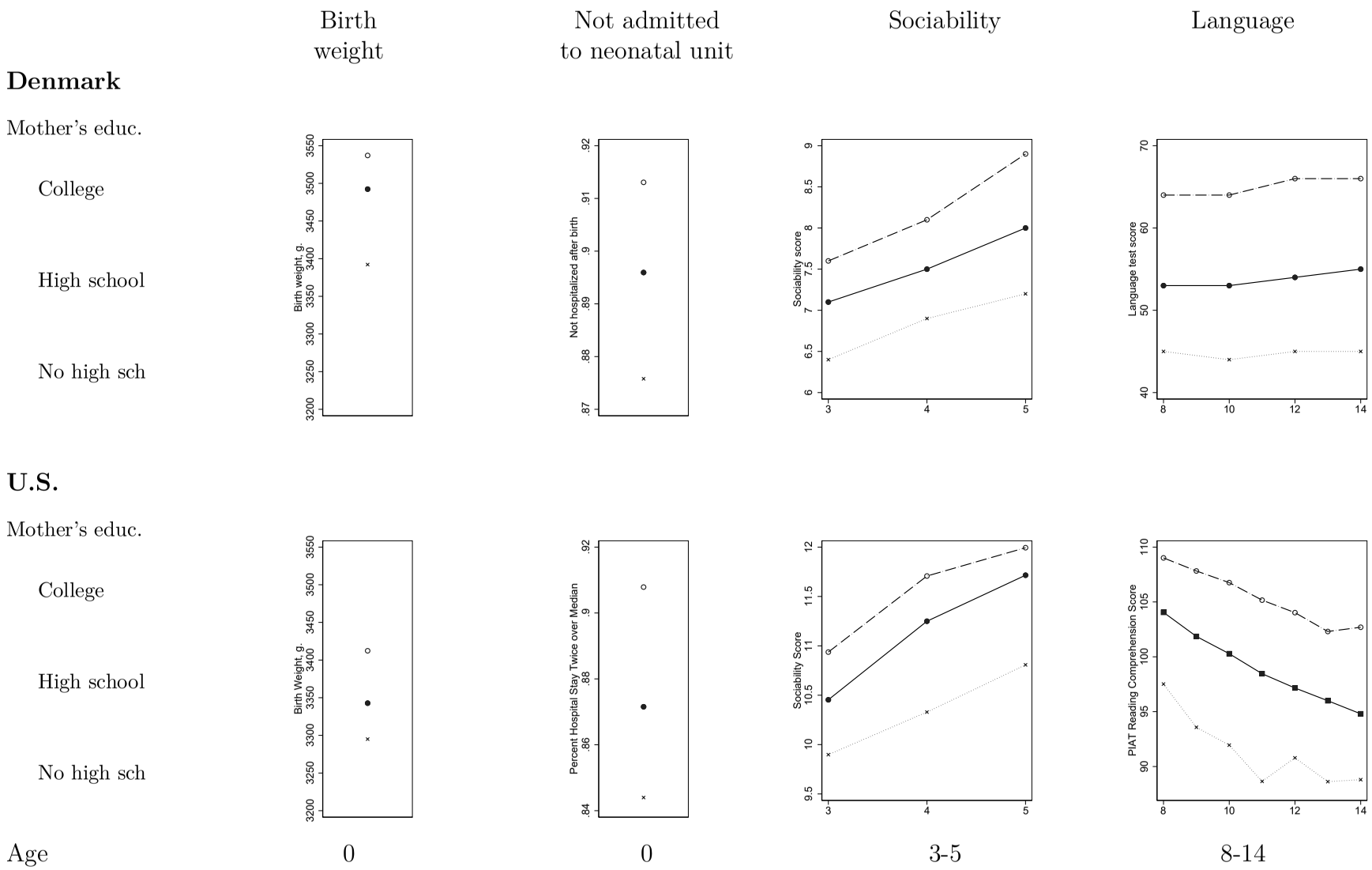
A Additional results

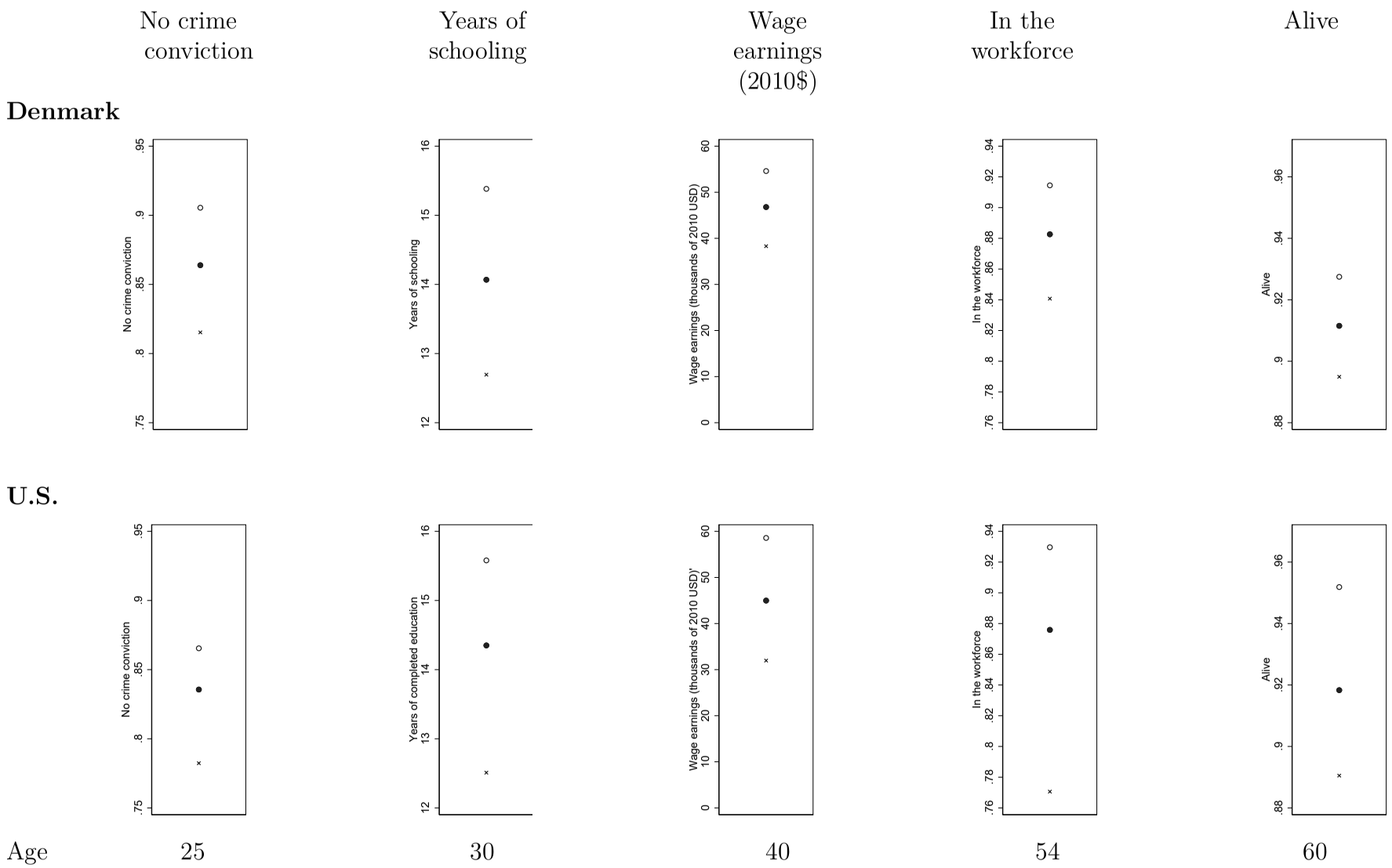
A.1 Results from Section 1 in the main text

Figure A.1: Life cycle figures



Note: The figure shows children's life course outcomes by their mother's education for Denmark and the U.S. Scale differences for some dimensions impair full comparability across countries. However, the overall pattern with differences in all outcomes across the life persist in both countries. Birth weight is the same scale and outcome – levels are lower in the US but gaps top-bottom are the same in the two countries. Data on admission to neonatal units differ in definition and can thus not be compared 1:1. Test scores are also not the same, so we can only compare patterns. The data are described in Web Appendix C.

Figure A.1: Life cycle figures, cont.

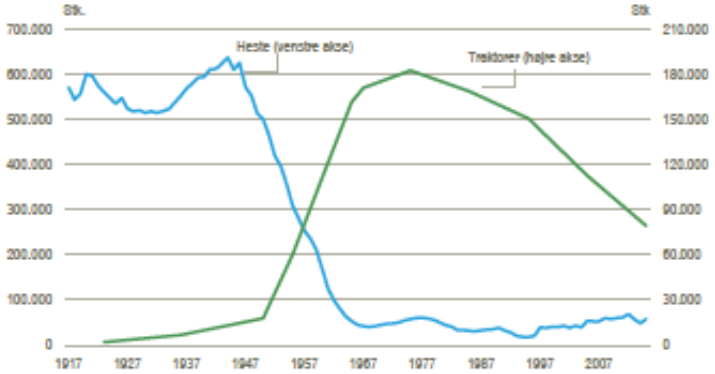


Note: The figure shows children's life course outcomes by their mother's education for Denmark and the U.S. Scale differences for some dimensions impair full comparability across countries. However, the overall pattern with differences in all outcomes across the life persist in both countries. Both crime and education are measured on the same scale and by the same definition. The gaps in crime and education are similar in the two countries. Wage earnings are also defined similarly, but gaps are larger in the U.S. (as wage earnings are more compressed in Denmark). Workforce participation is defined similarly, but levels may differ from the more geneorous social security net in Denmark. Mortality data is subject to measurement error in the U.S. The data are described in Web Appendix C.

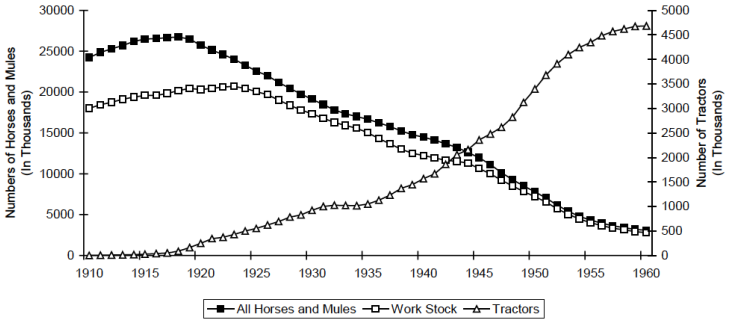
A.2 Results from Section 2 in the main text

Figure A.2: Number of workhorses and tractors in agriculture, Denmark and the U.S.

a) Denmark



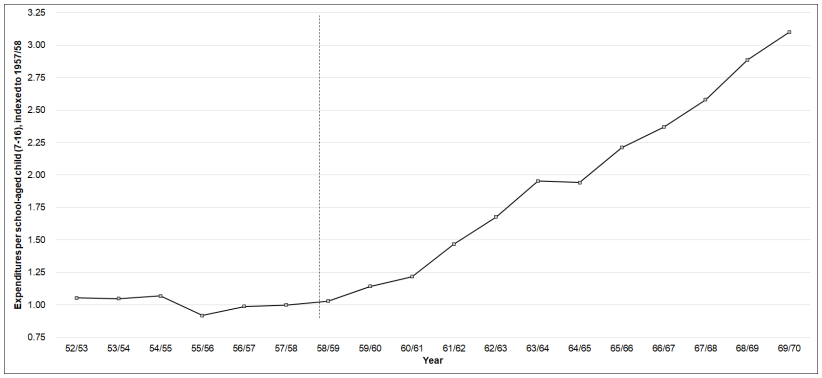
b) U.S.



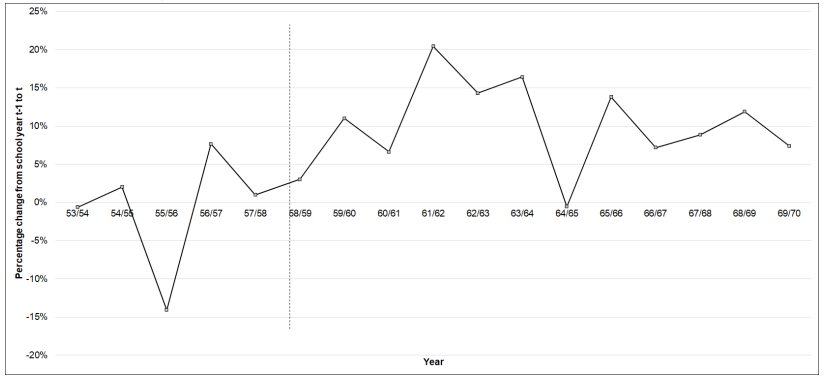
Source: Denmark: Statistics Denmark (2017). Source U.S.: Olmstead and Rhode (2000)

Figure A.3: Impact of the 1958 reform on school expenditures and number of teachers

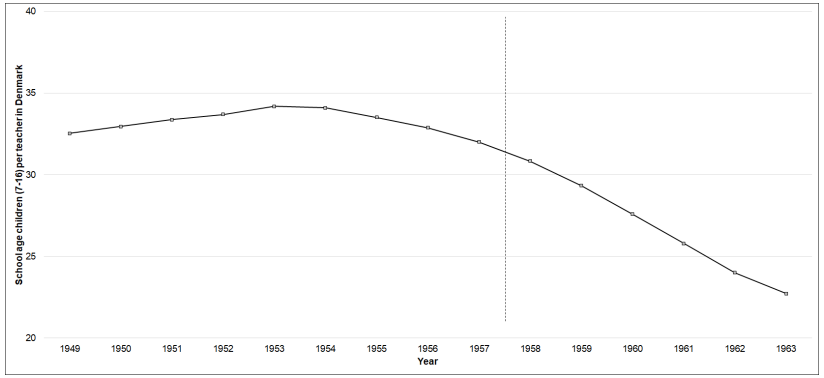
a) Expenditures per school-aged child (7–16)



b) Year-by-year change in expenditures

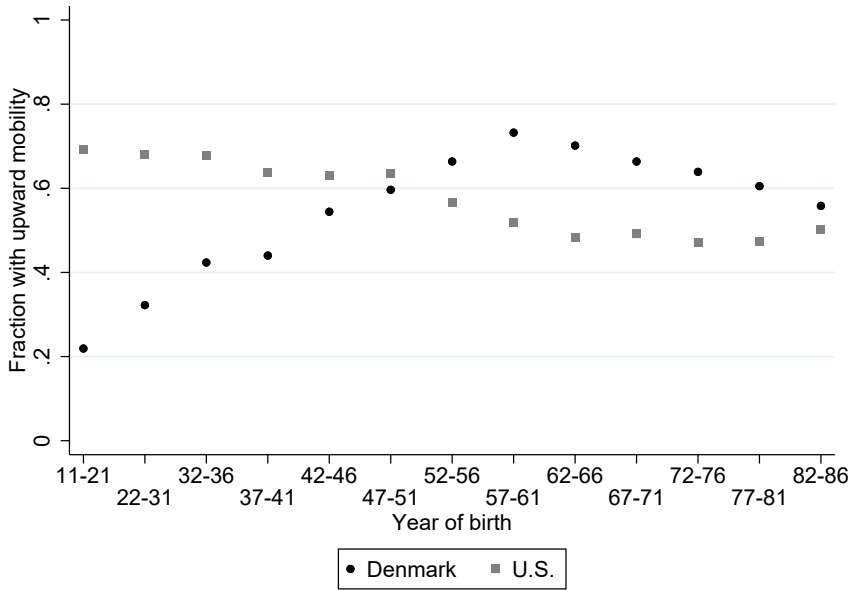


Number of school-aged children (7–16) per teacher)



Source: Karlson and Landersø (2021).
Note: The figure is based on administrative data from the Statistical Yearbooks, 1954–1971. a) shows by year the total municipality expenditure per child aged 7–16. b) shows the year-by-year change in the total expenditure. We use the size of each birth cohort (reported by Statistics Denmark) to estimate the number of school-age children, because the specific cohort-sizes are reported in 5-year bins before 1970.

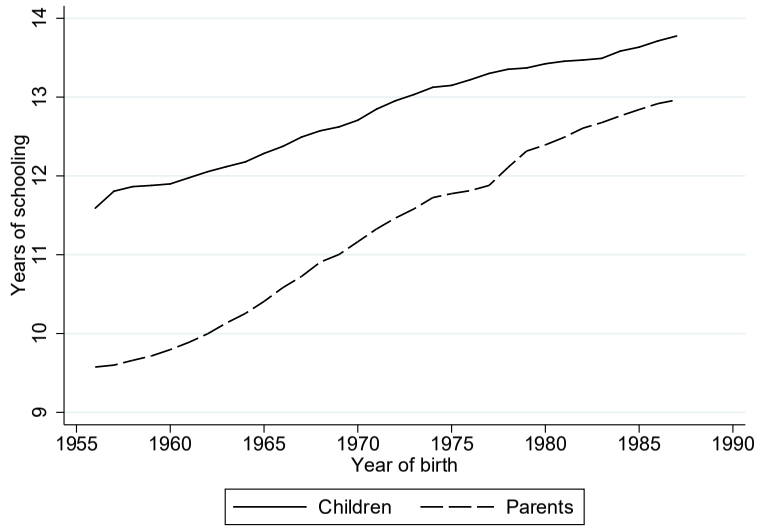
Figure A.4: Upward mobility: Fraction with higher education than their parents by child birth year and country



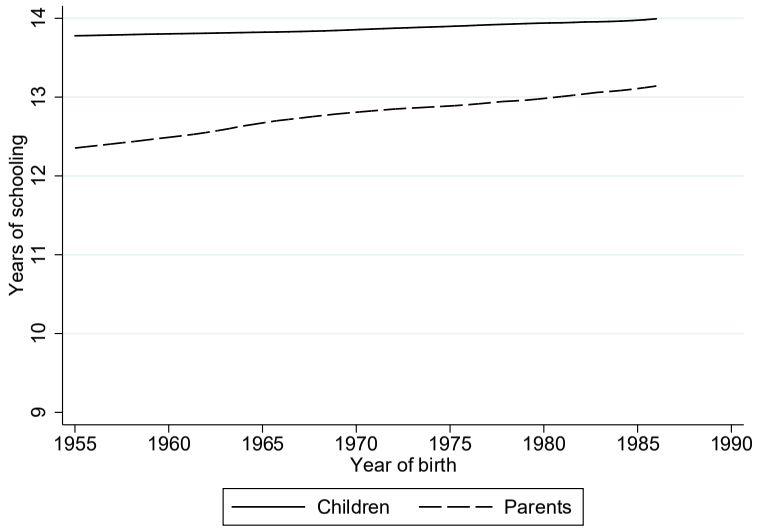
Source: Karlson and Landersø (2021).
Note: Fig. a) shows the fraction of children with higher years of schooling than their parents (highest of mother and father). Danish estimates are based on survey and register data, and U.S. estimates are based on the General Social Surveys (GSS).

Figure A.5: Education levels by child birth year and country

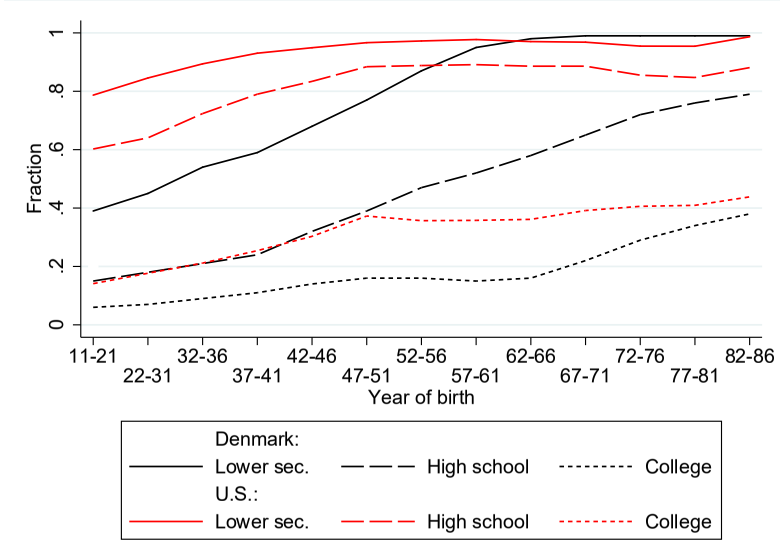
a) Average years of schooling, Denmark



b) Average years of schooling, U.S.

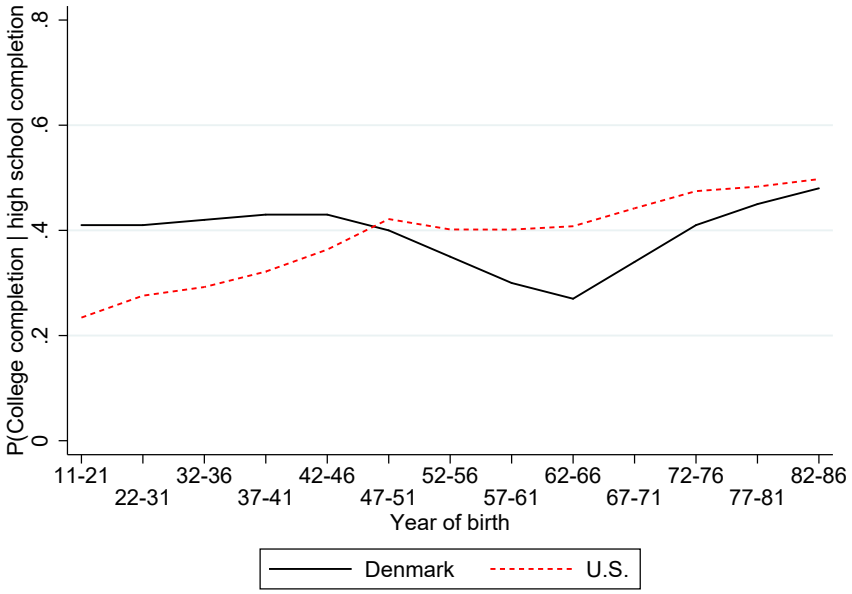


c) Education levels



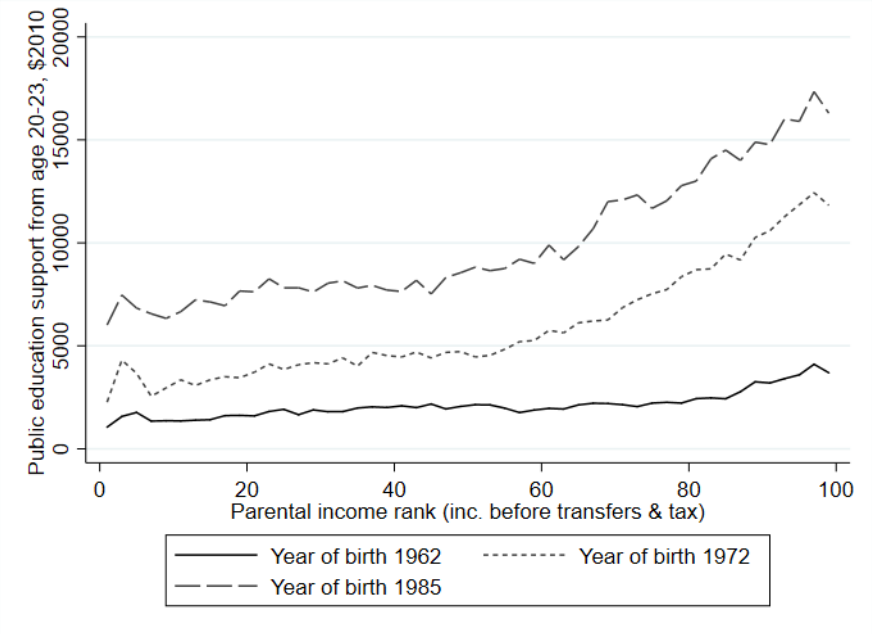
Source: Karlson and Landersø (2021).
Note: Fig. a) shows education levels; lower secondary (at least 9 years of schooling), high school (at least 12 years of schooling), and college (at least 15 years of schooling). Figs. b) and c) show average years of schooling for children and their parents (highest level of father and mother) by birth year. Danish estimates are based on survey and register data, and U.S. estimates are based on the General Social Surveys (GSS).

Figure A.6: Probability of completing college conditional on high school completion, by child birth year and country



Source: Karlson and Landersø (2021).
Note: The figure shows the probability of completing college (defined as 15 years of schooling or higher) conditional on completing high school (defined as 12 years of schooling). Danish estimates are based on survey and register data, and U.S. estimates are based on the General Social Surveys (GSS).

Figure A.7: Public education support in Denmark from age 20-24 by parents' income rank and year of birth



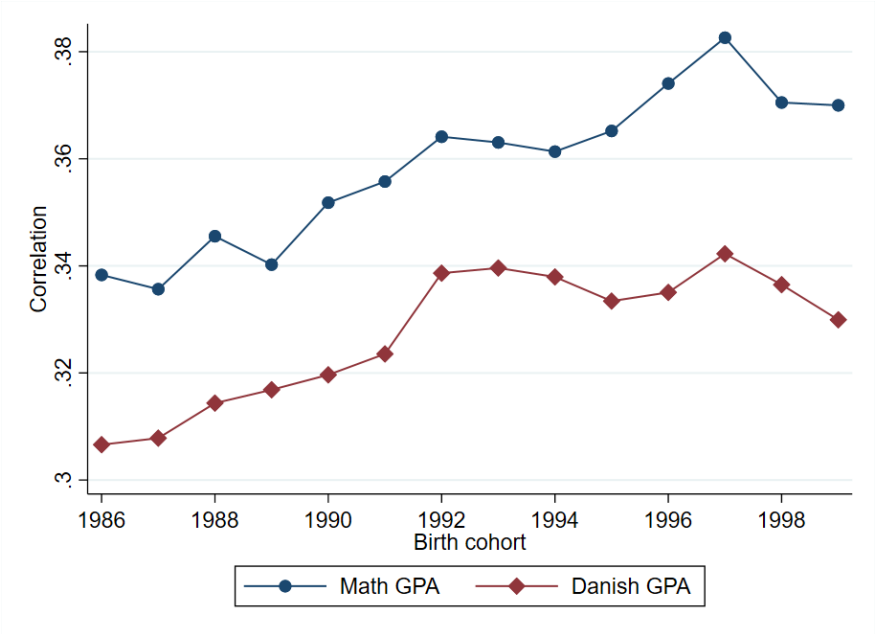
Source: own calculations.
Note: The figure shows the total education support (Statens Uddannelsesstøtte) received from age 20–24 for the 1962, 1972, and 1986 cohort, respectively, by their parents' income rank (total gross income excluding public transfers) measured when the children are age 20-22. The data are described in Web Appendix C.

Table A.1: Children's language test score quintiles in grade 2 and 8, by parents' education, Denmark and the U.S.

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
Parents less than college					
Grade 2					
Denmark	0.25	0.21	0.21	0.19	0.14
U.S.	0.24	0.22	0.20	0.18	0.15
Grade 8					
Denmark	0.25	0.22	0.20	0.18	0.15
U.S.	0.25	0.22	0.20	0.19	0.15
Parents college or higher					
Grade 2					
Denmark	0.12	0.16	0.19	0.23	0.29
U.S.	0.11	0.16	0.22	0.23	0.29
Grade 8					
Denmark	0.10	0.16	0.20	0.24	0.30
U.S.	0.12	0.15	0.20	0.24	0.29

Source: Hjorth-Trolle and Holm (2021).
Note: The table shows children's language test score quintiles measured in grade 2 and 8 (at age 8 and 14) by parents' highest education (less than college vs. college or higher). Results for Denmark are based on full population register data, and results for the U.S. are based on NLSY97 data. Parents with less than high school constitute 67% of the sample in both countries.

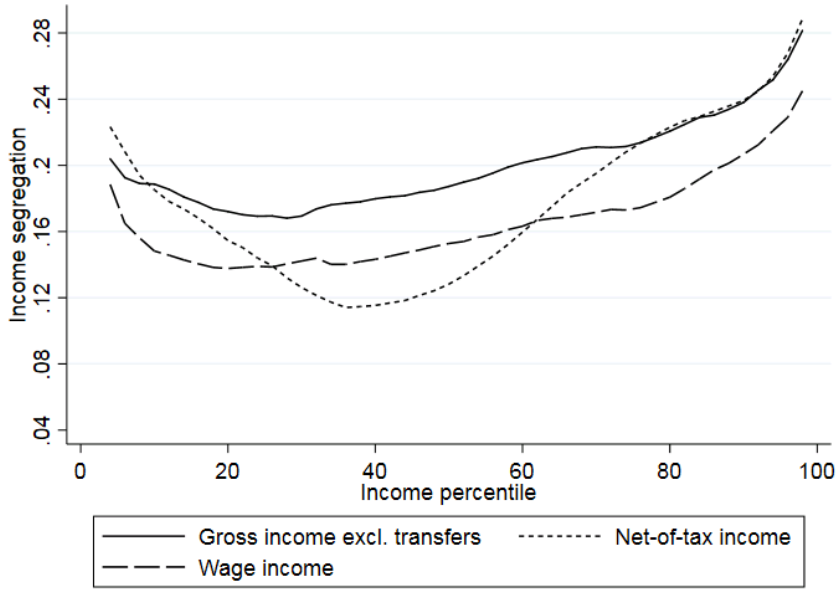
Figure A.8: Correlation between children's 9th grade GPA and parents' years of schooling



Source: own calculations.
Note: The figure shows the (Pearson) correlation between children's math and Danish GPA (written, external scored exams) in grade 9 (age 16), and parents' years of schooling for cohorts born 1987–2001. The data are described in Web Appendix C.

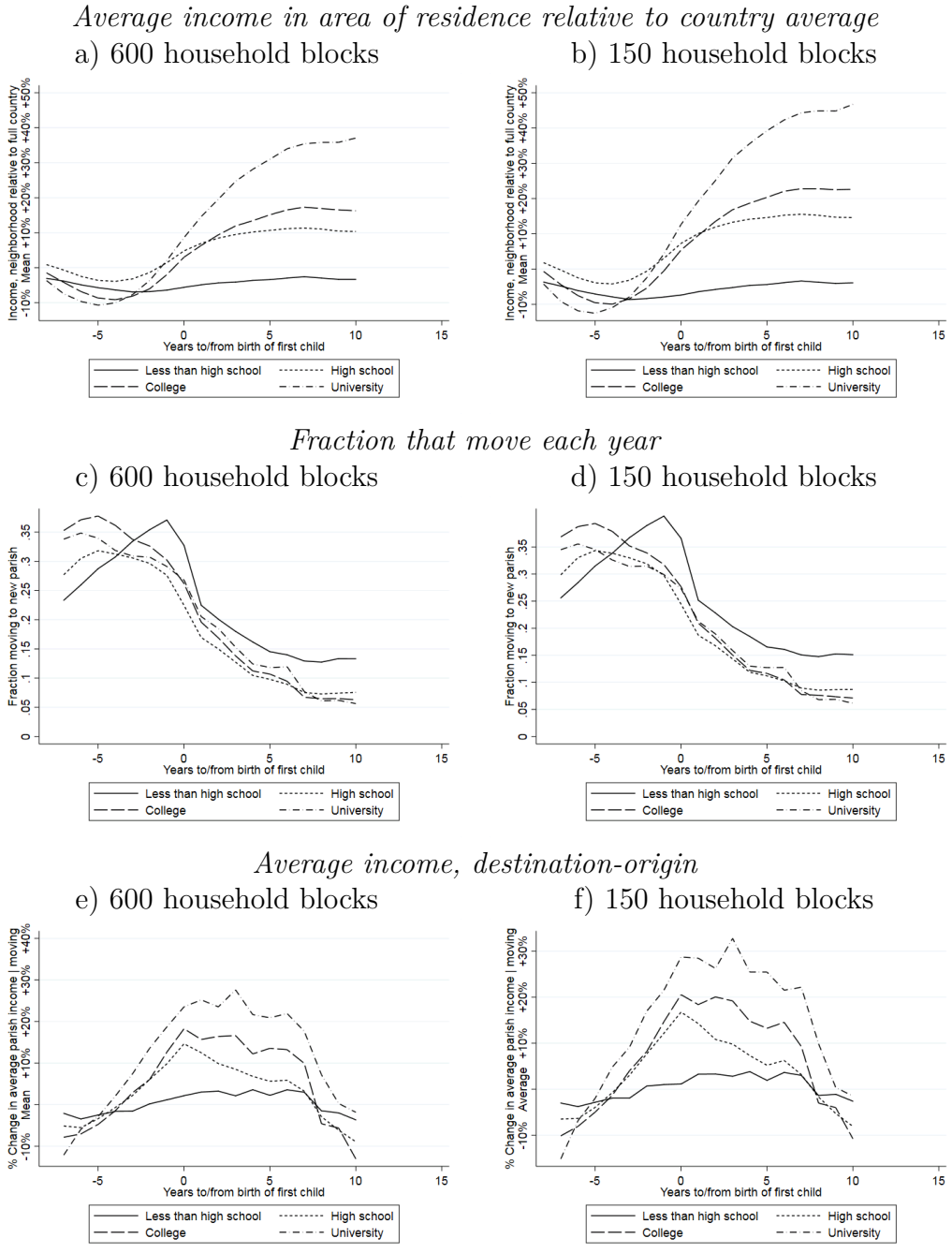
A.3 Results from Section 4 in the main text

Figure A.9: Income segregation for families with children by income type, Greater Copenhagen area



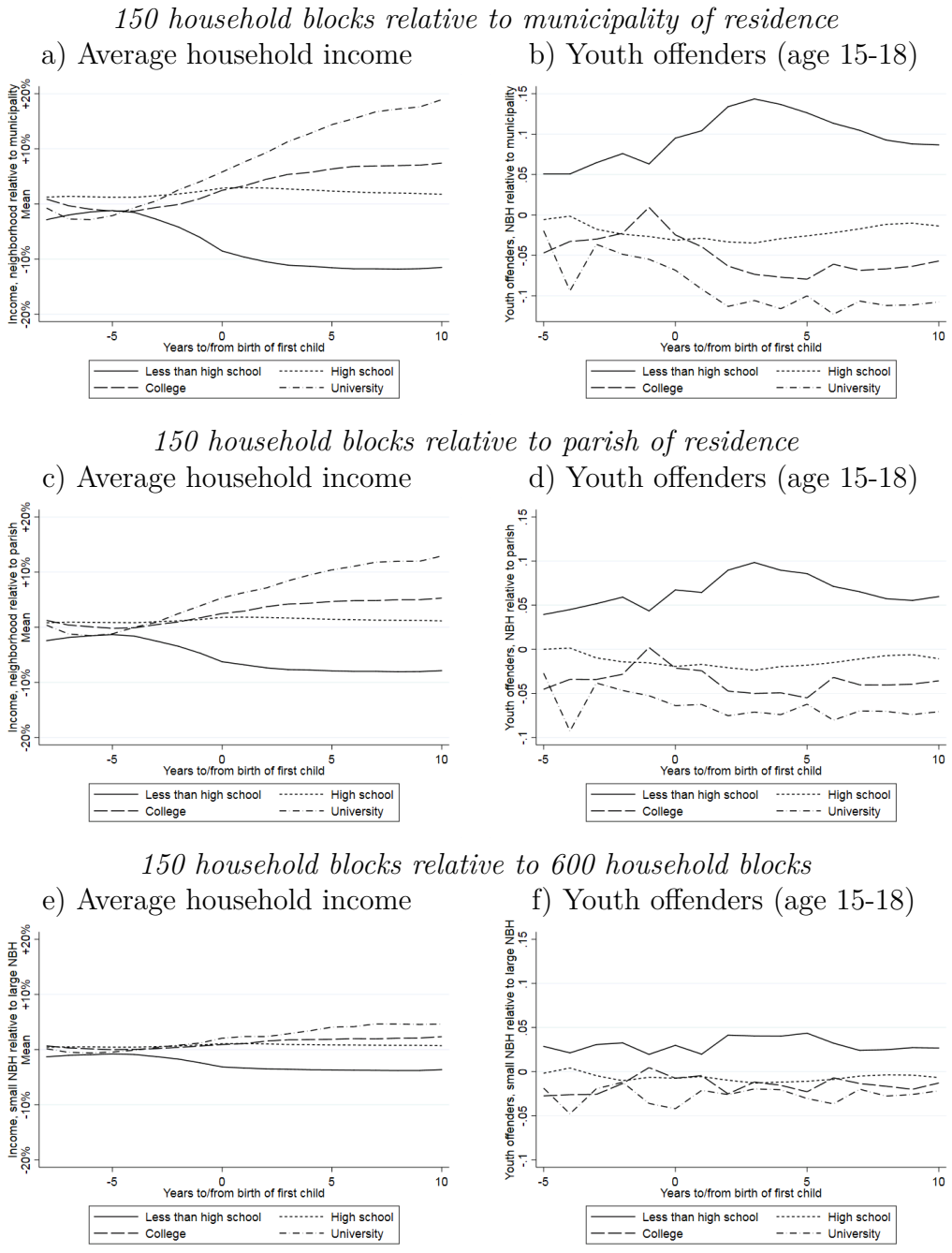
Source: own calculations.
Note: The figure shows income segregation as also measured in Fig. 6 for 150 household blocks in the Greater Copenhagen area (the capital area of Denmark). The data are described in Web Appendix C.

Figure A.10: Average income in area of residence and moving pattern, by time to/from birth of first child and area type



Source: own calculations.
Note: The figure shows average income level in the parish / large neighborhood / and small neighborhood of residence by years to/from the birth of the first child and mother's education level. The figure is computed for the mothers of cohorts born 1994–1997, and income is measured as gross income excluding public transfers.

Figure A.11: Household income and fraction of adolescents (age 15-18) who are charged with a crime; neighborhood where mothers (and child) lives, relative to levels in larger areas



Source: own calculations.
Note: The figure shows. in the small neighborhood of residence, i) the average household income of all families and ii) the average fraction of adolescents (age 15-18) who have been charged with a crime in a given year. The figure present these statistics by mothers' education and relative to the levels in larger areas (in which the small neighborhood is nested). The figure is computed for the mothers of cohorts born 1994–1997. The data are described in Web Appendix C.

B Lifetime Measures of Well-being

B.1 Variable Definitions for Figure 5

Variable	Definition
Wage Inc.	**Summary:** Total wage income. **Details:** Taxable salary including perks, tax-free salary, anniversary and severance pay as well as the value of stock options. The salary is after deduction of contributions to employer-administered pension schemes and contributions to the Danish labour market supplementary pension fund (ATP).
Disposable Inc.	**Summary:** Total income minus taxes and interest expenses. It includes public transfers and the rental value of own home. **Details:** The following items are added: total wage income, remuneration, social security contributions, net profits from self employment, public transfers (unemployment benefit and severance pay, excluding civil servants), private pensions paid, interest income and realized gains on securities, residual income including child support. The following items are subtracted: interest expenses, taxes, labor market contributions and special pension, maintenance paid/contributions to a former spouse as well as to children under age 18. Finally, the estimated rental value of own home is added.
Household Consumption	**Summary:** Total household expenditures, imputed from the relationship between survey consumption from Danish Expenditure Survey and Danish registers. **Details:** Total household expenditures, imputed from the relationship between total expenditures from Danish Expenditure Survey (1997+) on variables found in the register: household disposable income and net assets in t and $t-1$. The imputation is conducted using a random forest estimator with hyperparameters selected by 5-fold cross-validation.

Exp. PDV of Disp. Inc. (PDV)

Summary: The expected present discounted value of disposable income.

Details: Let PDV denote the expected present discounted value of disposable income. We use a recursive formula to compute the PDV at time t for individual i, going back from age $T = 85$. We calculate the expected disposable income for an individual at t given a rich vector of individual characteristics, z_{it}, and calculate the discounted expected future sum for the remainder of an individual's life:

$$PDV_{it} \equiv E\left[\beta(d_{i,t} + PDV_{i,t+1})|z_{it}\right],$$

where d_{it} is the dividend at time t, and is comprised of disposable income. At the end of life, PDV_{iT} is 0. β is a discount factor.

Permanent Income

Summary: The annuitized value of PDV and financial wealth.

Details: We define Permanent Income PI_{it} as

$$PI_{it} = (PDV_{it} + a_{it})\frac{r}{1-(1+r)^{t-T}}$$

where PDV_{it} is PDV as defined above and a_{it} is the total value of a household's assets net of liabilities. We use a constant rate of discount $r = 0.04$, and $T = 85$.

Value Function

Summary: The sum of flow utility and the discounted expected value of following the optimal policy in the future.

Details: Similar to the Permanent Income estimation process, we use a recursive method to the estimate value function as follows:

$$V(j, z_j) = u(j, z_j) + \beta E[V(j+1, z_{j+1})|j, z_j]$$

We specify a CRRA utility function, i.e. $u(c_{it}) = \frac{c_{it}^{1-\rho}-1}{1-\rho}$. For a benchmark comparison, we also estimate value function when we specify a linear utility function, i.e. $u(c_{it}) = c_{it}$. In case of linear utility, the value function is equal to the expected present discounted value of future consumption. The measure of consumption here is the adult equivalent consumption measure (household consumption with equivalence scale).

C Data Appendix

Construction of Fig. 1 and Fig. A.1

Danish data:

- Birth weight: The figure is constructed from information of child birth weight (from birth register MFR) merged to information on mother's years of schooling (from the educational register UDDA) using unique individual identifiers of child and mother. The figure considers children born 2000–2004. Mothers' education is measured in 2014.
- Admission to neonatal ward: The figure is constructed information of treatment in the neonatal ward (from birth register MFR) merged to information on mother's years of schooling (from the educational register UDDA) using unique individual identifiers of child and mother. The figure considers children born 2000–2004. Mothers' education is measured in 2014.
- Sociability scores: The figure is based on information from Bleses et al. (2018) (using survey information).
- Test scores: The figure is based on information on language tests from Beuchert and Nandrup (2018) (using register data on mandatory tests for all children in Danish schools).
- Crime: The figure is constructed from information of all criminal convictions (from the crime-conviction and -charges registers KRAF and KRSI) merged to information on mother's years of schooling (from the educational register UDDA) using unique individual identifiers of child and mother. The figure is based on the 1983 cohort. Crime conviction excludes traffic offenses.

- Education: The figure is constructed from information of educational attainment of child (measured at age 30) merged to information on mother's years of schooling (both from the educational register UDDA) using unique individual identifiers of child and mother. The figure is based on the 1983 cohort.

- Wage earnings: The figure is constructed from wage earnings information (from the income register IND) merged to information on mother's years of schooling (from the educational register UDDA) using unique individual identifiers of child and mother. The figure is based on the 1973 cohort.

- Work force: The figure is constructed from information of labor market status (from the labor market register RAS) merged to information on mother's years of schooling (from the educational register UDDA) using unique individual identifiers of child and mother. The figure is based on the 1956 cohort.

- Survival: The figure is constructed from mortality information (from the mortality register DOD) merged to information on mother's years of schooling (from the educational register UDDA) using unique individual identifiers of child and mother. The figure is based on the 1956 and 1957 cohorts.

All subfigures in Fig. 1 and Fig. A.1 for Denmark exclude immigrants and descendants. Mother's education categories are defined as:

- Less than high school: Years of schooling < 11

- High school: $11 \leq$ Years of schooling < 15

- College: Years of schooling ≥ 15

U.S. data:

- Birth weight: The figure is constructed child birth weight using children of the NLSY79 dataset (CNLSY). The National Longitudinal Survey of Youth 1979 (NLSY79) is a longitudinal nationally representative dataset of individuals born between 1957-1964 in the US.

- Admission to neonatal ward: As there is no information about the nature of hospital stays for children around birth, this figure tracks what percent of children born have hospital stays that are at least two times the length of the median hospital stay of 3 days. The figure considers children born from all years for individuals in the NLSY79.

- Sociability scores: The figure is constructed from sociability scores recorded in the CNLSY. More details about the sociability scores are available at https://www.nlsinfo.org/content/co children/topical-guide/assessments/temperament-how-my-child-usually-acts

- Test scores: The figure is constructed from PIAT reading comprehension test scores recorded in the CNLSY, for children between 8 and 14 years of age. More details about the PIAT scores are available at https://www.nlsinfo.org/content/cohorts/nlsy79-children/topical-guide/assessments/piat-reading-reading-recognitionreading.

- Crime: The figure is constructed from questions of whether individuals were convicted for individuals in the NLSY97, from ages 15-25.

- Education: The figure is constructed from educational attainment measured at 1990 for individuals between the ages of 29 and 31 from the NLSY79.

- Wage earnings: The figure is constructed from wage earnings measured at 2002, for individuals between the ages of 39 and 41 from in the NLSY79.

- Work force: The figure is constructed from labor force participation measured at 2014, for individuals between the ages of 53 and 55 from the NLSY79. It measures inividuals that report themselves as having been in the workforce for at least 4 weeks in the year. The statistic is similar if we use 1 weeks, or 26 weeks.

- Survival: The figure is constructed from mortality information measured in 2018 for individuals between the ages of 56 and 51. It draws from the reason-for-noninterview question constructed by the BLS, which records the reason the respondent's was not interviewed in a year; this also has the information for whether the respondent is deceased[1].

Construction of Fig. A.7

To construct the figure, we first use the demographic register (BEF) to identify (non-immigrant) individuals born in 1962, 1972, and 1985, respectively, including both own and parents' unique individual identifiers. We then merge this data to the income register (IND) with information on education support transfers when individuals were aged 20-24. Finally, using parents' unique individual identifiers, we add information on parents' income when the child was aged 20-22 (i.e., years 1982-1984 for the 1962 cohort and so forth) and rank parents' income W/o transfers within each borth cohort in question.

Construction of Fig. A.8

The figure is constructed by first combining the exam-grade register (UDFK) with the demographic register (BEF) including information on year of birth and parents' unique individual identifiers. We then add information on parents' years of schooling from the education register (UDDA).

Construction of Fig. 6b and Fig. A.9

To construct Fig. 6b, we first use the demographic register (BEF) to identify the cohorts in question along with parents' unique identifiers. We merge this to the student-institution register (KOTRE) that contains information on students in Danish educational institu-

[1] In order to corroborate the result, the authors also confirmed the pattern using the Health and Retirement Study (HRS)

tion (lower-secondary schools, which we consider, upper secondary institutions, and post-secondary institutions). We thereby identify the schools the different cohorts attended when they were in grade 8. Finally, we combine the data with information of parents' income from income register (IND).

To construct Fig. A.9, we first combine the demographic (BEF) and residential (BOL) registers for 2004 to identify each household's 150 household block of residence (see Damm and Schultz-Nielsen, 2008) and whether there are any children present in each household. We next limit the data to households with children living in the Greater Copenhagen area, Finally, we merge this data to the income register (IND) to identify each household's income.

Construction of Fig. 7, Fig. A.10, and Fig. A.11

To construct the figures, we first combine the demographic (BEF) and residential (BOL) registers for each year from 1982–2012 to identify each household's municipality, parish, 600 household block, and 150 household block of residence (see Damm and Schultz-Nielsen, 2008, for a description of the blocks). We then merge this data to the income register for each year to identify each household's income and calculate average income for each area-type. Similarly, we merge information on crime charges from the crime charges register, and calculate the fraction of adolescents aged 15-18 who have been charged for a non-traffic related crime.

Next, we identify women who have their first child in the years 1994-1997 using the demographic register. From the residential register, we identify the mothers' municipality, parish, 600 household block, and 150 household block of residence (see Damm and Schultz-Nielsen, 2008) in each year before and after the birth of her first child. We also merge information on mother's completed education (measured 10 years are the birth of her first child) from the education register.

Finally, we combine the data with average income and youth offenders in each area and year to the mothers' area of residence in each year before and after the birth of her first

child.

Construction of Fig. 10

To construct the figure, we first combine the demographic (BEF) and residential (BOL) registers with the income register (IND) to calculate parish average income W/o transfers as the average income of all parents (excluding immigrants) with children aged 5-11 in 2015 (to be used for the outcome *smoking during pregnancy*) and 2002 (to be used for the remaining outcomes). We then rank the parishes from 0-1. Next, we merge information from the Danish Longitudinal Study of Children (DALSC) to parish of residence using the demographic and residential registers in 2002 and plot averages of the variables in question across parish income rank. Similarly, we merge information from the birth register for children born in 2010 with the demographic and residential registers in 2015, and plot the fraction of mothers who are reported as smoking during the pregnancy in the birth register (MFR) across parish income rank.

Construction of Fig. 11

To construct the figure, we first use the demographic register (BEF) to sample cohorts born 1972-1984 and we exclude immigrants. We then merge this data to the income register (IND) when the children were aged 31–35 (i.e. 2003-2007,...,2015-2019 depending on cohort) and calculate the average annual income. Using the unique individual identifiers of parents, we next add information on parents income when the child was aged 8-14 (i.e. 1980-1986,...,1992-1998 depending on cohort) and calculate the average annual income of parents (the mean of the mother's and father's income irrespective of whether they live together). The estimation procedure follows Landersø and Heckman (2017).

References

Beuchert, L. V. and A. B. Nandrup (2018). The Danish National Tests at a Glance. *Nationaloekonomisk Tidsskrift 1*, 1–35.

Bleses, D., A. Hojen, L. Justice, P. Dale, L. Dubdal, S. Piasta, J. Markussen-Brown, M. Clausen, and E. F. Haghish (2018). The effectiveness of a large-scale language and preliteracy intervention: The spell randomized controlled trial in denmark. *Child development 89*, 342–363.

Damm, A. P. and M. L. Schultz-Nielsen (2008). Danish neighborhoods: Construction and relevance for measurement of residential segregation. *Nationalokonomisk Tidsskrift*.

Hjorth-Trolle, A. and A. Holm (2021). Double (dis)advantage: The development of socioeconomic gaps in academic achievement in the u.s. and denmark. Technical report, Working paper.

Karlson, K. B. and R. Landersø (2021). The making and unmaking of opportunity: Educational mobility in 20th century-denmark. Technical report, Rockwool Foundation Working Paper.

Landersø, R. and J. J. Heckman (2017). The scandinavian fantasy: The sources of intergenerational mobility in denmark and the u.s. *Scandinavian Journal of Economics 119*(1), 178–230.

Olmstead, A. L. and P. W. Rhode (2000). The diffusion of the tractor in american agriculture: 1910-60. Technical report, NBER working paper.

Statistics Denmark (2017). Agricultural statistics through 100 years – 1916-2015. Technical report.