

Intergenerational Wealth Formation over the Life Cycle: Evidence from Danish Wealth Records 1984-2013*

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Abstract

This paper provides novel insights on intergenerational wealth mobility and its relationship to *lifetime economic resources* using thirty years of wealth records for the Danish population. Non-parametric evidence reveals an almost linear relationship between wealth ranks of children and parents, except at the very top of the distribution where the association is stronger. The slope of the graph—the rank correlation—is 0.27 when both parents and children are in mid-life (age 45-50). We find a U-shaped pattern when looking at the rank correlation as a function of child age with a correlation of 0.35 when children move into adulthood (age 20), going down to 0.17 in the mid-twenties and then moving gradually up again to 0.27 in the forties. After death of parents, the correlation lies in the range 0.35-0.40. We provide a simple theoretical framework to understand intergenerational wealth mobility over the life-cycle. The theory explains the life-cycle pattern in measured wealth mobility through life-cycle patterns of transfers and earnings: wealthy parents make inter vivo transfers early in childrens' life, their children have low income in the twenties when investing in human capital, but a high permanent income and, finally, they receive large bequests. The U-shaped pattern requires that inter vivos transfers are quantitatively important and the increase in correlation at the receipt of bequests reveals the quantitative importance of bequests. Our main interest is in the correlation across generations in lifetime resources, which according to the theory may be captured by appropriately estimating intergenerational correlation in wealth. Our preferred estimate of the intergenerational correlation in lifetime resources is 0.25, which is significantly higher than the correlation of permanent incomes equal to 0.20.

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1 Introduction

Wealth formation and wealth inequality have received increasing attention academically and publicly after the publication of the best-selling book by Thomas Piketty (2014). In this paper, we provide novel insights on intergenerational wealth mobility over the life cycle using thirty years of wealth records for the Danish population. A voluminous literature has analyzed how economic well-being is related across generations by studying intergenerational linkages in outcomes such as income, education, and health (see surveys by Solon 1999 and Black and Devereux 2011). Only few studies exist on wealth (e.g., Charles and Hurst 2003) even though variation in wealth across individuals at a given age level may be one of the best proxies for the variation in lifetime economic resources and for the (in)equality of opportunities.¹

Correlation of wealth across generations may be driven by mechanical correlation in innate abilities across generations and deliberate parental investments in human capital of children as in the standard theory of intergenerational income mobility by Becker and Tomes (1979, 1986), but it may also reflect direct transfers of wealth from the previous generations made during life (*inter vivos*) or at death (*inheritance*). Finally, decisions on consumption and saving are crucial for building up wealth and therefore for understanding correlation of wealth across generations (Stiglitz 1969). Thus, formation of wealth across generations may summarize many different intergenerational channels important for individual well-being.

While correlation of wealth across generations may be of interest in its own right, we argue that the main parameter of interest is the correlation in *lifetime economic resources*, which determines overall consumption possibilities. Naturally, lifetime resources of an individual are related to—but not directly observable from—income and wealth observed over the life-cycle.

We start our analysis by providing a simple theoretical framework to understand wealth formation across generations over the life cycle and its relationship to lifetime resources. We build on the standard Becker and Tomes (1979) with human capital investment extended to a multi-period overlapping generations model with *inter vivo* wealth transfers and bequests. Each generation has standard preferences over consumption that govern savings behavior, and makes wealth transfers determined by simple joy-of-giving motives. This framework provides a number of interesting insights. First, the intergenerational correlation in lifetime economic resources may be inferred from

¹Charles and Hurst (2003) use wealth data from the Panel Study of Income Dynamics (PSID) to estimate the elasticity of child wealth with respect to parental wealth for the United States. They also review a few older studies looking at the intergenerational correlation of wealth. These studies have looked at small non-representative samples with few observations and poor data quality.

(bias-adjusted) estimates of the intergenerational correlation of wealth measured at the same stage of the life-cycle for both generations. This is because the relationship between wealth and lifetime resources evolves over the life-cycle reflecting the paths of consumption, income receipts and transfers, and observing parents and children at the same stage eliminates this life-cycle effect. Second, the intergenerational correlation in life-time income underestimates the correlation in life-time economic resources, even though children of wealthy parents have higher permanent income. Third, correlations between parental wealth measured at a fixed age (in our application, in mid-life) and child wealth observed over the life cycle of the child are informative of the underlying mechanisms governing wealth formation. In particular, the correlation may be non-constant and non-monotonic over the life cycle of the child.

We provide three sets of empirical results and their interpretation. First, we look at the basic relationship between wealth of children and wealth of (biological) parents. Our baseline analysis is based on the cohorts of children who are 45-50 years old (mid-life) in 2010, where we measure their wealth (average over the years 2009-2011). Parental wealth is measured 25 years before in 1984-1986 where parents are about the same age as the children. We start with a non-parametric analysis of the relationship between the positions of children and parents in the wealth distribution measured by within-cohort percentile ranks. This evidence reveals an almost linear relationship with the exception of at the very top of the parental wealth distribution. Parents in percentile 10 of the parental wealth distribution have on average children in percentile 40 of the childrens' wealth distribution, while parents in percentile 90 have children in percentile 60, and within this range moving up one percentile in the parental wealth distribution is associated with a 1/4 percentile increase in the average position of children. The overall rank-rank slope—the rank correlation coefficient—is 0.27. The same linear relationship is evident not just for the mean, but also elsewhere in the distribution, for example when computing quantiles P25 and P75.

In order to compare with previous work, we also estimate the intergenerational wealth elasticity, which in our baseline specification equals 0.24. Charles and Hurst (2003) find an (age-adjusted) elasticity of 0.37 for the United States using the PSID survey data. If we measure parental wealth 12 years before child wealth and include age controls to make the result more comparable to Charles and Hurst (2003) then we obtain an elasticity of 0.25. The lower estimate for Denmark is not surprising. Denmark has a very homogeneous population and a high degree of redistribution, and comparative studies find that Denmark has a high intergenerational mobility in earnings/income compared to the US and many other countries (Björklund and Jäntti 2009; Chetty et al. 2014).

When repeating our baseline analysis for earned income (wage income and self-employment income but excluding capital income) observed in mid-life of children and parents, we find an almost completely linear rank-rank relationship with a slope of 0.20. Hence, wealth displays less mobility than income. This is in particular the case at the top of the distributions where child wealth is much more strongly related to parental wealth than is the case for income.²

Second, we exploit the long panel dimension of our data to study the wealth formation over the life cycle of the child starting when the child become adult (age 20) and going up to mid-life in the forties. We find a U-shaped pattern when looking at the rank correlation as a function of child age with a correlation of 0.35 when children move into adulthood, going down to 0.17 in the mid-twenties and then moving gradually up again to 0.27 in the forties. The theory explains this life-cycle pattern in wealth mobility through life-cycle patterns in transfers, earnings and consumption: wealthy parents make significant inter vivo transfers early in children's life, their children have low income in the twenties when investing in human capital, but high permanent income and can expect to receive large bequests. In particular, the U-shaped pattern over the life cycle implies that inter vivos transfers are quantitatively important. Borrowing early in life implied by consumption smoothing creates in itself a negative correlation between parental wealth and child wealth early in life, and the observed positive correlation can therefore only be reconciled by significant parental transfers early in life. Consumption smoothing implies that the correlation declines as wealth is run down when young and then increases as wealth is built up again in mid-life when income is relatively high.

Third, we study the role of bequests. To identify the casual effect on wealth of children when parents die, we employ an event study design where we look at the correlation between wealth of parents in mid-life and wealth of children after death of parents (T-group) and compare it to the correlation between children and parents in a corresponding group (C-group), but where parents do not die.³ Before death of parents in the T-group, the intergenerational correlation coefficients of both groups are nearly identical and close to the baseline coefficient of 0.27. Afterwards, the correlation coefficient jumps to 0.37 in the T-group, while it is basically unchanged in the C-group.

Fourth, we try to estimate the correlation across generations in lifetime economic resources. It is well-known that the relationship between current and permanent income varies over the life-cycle

²The stronger relationship at the top of the wealth distribution compared to the overall average may reconcile why studies based on estate tax returns (Menchik 1979; Wahl 2003; Clark and Cummins 2015) find lower intergenerational wealth mobility than the study by Charles and Hurst (2003) based on a random survey sample of the population.

³A similar approach is used in Boserup et al. (2016) to study the impact of bequests on the intra-generational distribution of wealth, but without studying the intergenerational distributional aspect.

and, as a consequence, that estimates of the intergenerational income correlation are sensitive to the age at which income is measured (Solon 1992; Haider and Solon 2006). Wealth reflects not just income dynamics, but also saving and transfers therefore raising the question of which of the estimated correlations approximates best the correlation of lifetime resources. Our framework highlights that the key requirement is to observe parents and children at the same stage of the life-cycle.⁴ The framework also implies that controlling for permanent income of parents and children is potentially important. We implement this approach when parents and children are in their late 40s and obtain an estimate of about 0.25, which is significantly higher than the estimate of the intergenerational correlation in permanent income. We also measure, subject to the limitation of our data that does not allow for a perfect implementation of this aspect, the correlation in lifetime resources after individuals have received bequest and obtain an even higher estimate. The receipt of bequests has a large effect on wealth on impact, but it constitutes a much smaller share of lifetime resources (of which wealth at any particular point in time represents only a fraction) and this observation allows to reconcile estimates before and after bequests.

The remaining part of the paper is organized as follows. Section 2 provides a simple theory of wealth formation across generations and is used to focus and interpret the empirical analyzes. Section 3 describes the data and provides some institutional background information. Section 4 describes the results of the empirical analyzes. Finally, Section 5 offers concluding remarks and an appendix provides additional details concerning the data and some additional empirical results.

2 A simple theory of wealth formation across generations

Before turning to wealth, we introduce and model a broader concept of lifetime resources R_g . Without loss of generality, they consist of two components: the present values of the lifetime earnings Y_g and transfers received from the previous generation Q_{g-1} . Transfers in turn have two components: inter-vivo transfers during life q_{g-1} and bequests b_{g-1} . The link between generations can also run through lifetime earnings. We assume that lifetime earnings are given by

⁴The literature on income mobility emphasizes two other reasons for bias in estimates of intergenerational correlation. First, measurement error and transitory income component may lead to underestimation of the correlations. The measurement error is arguably less of an issue here given administrative data, our ability to focus on multi-year averages and the use of rank correlation (see Chetty et al. 2014). Heterogeneity in income profiles highlighted by Haider and Solon (2006) is not a part of our framework, but we focus on mid-life estimates as the income mobility literature suggests that this is the time when estimated income mobility reveals the underlying correlation in permanent incomes.

$$Y_g = e_{g-1} + u_g,$$

where e_{g-1} is parental investment in child's human capital and u_g is a random term. For now, we are going to assume that u_g is uncorrelated across generations and will comment on a more general case at the end of this section. Hence, child's resources are equal to

$$R_g = Y_g + Q_{g-1} = e_{g-1} + q_{g-1} + b_{g-1} + u_g.$$

Both parental investments and transfers bear a relationship to parental resources. We are going to assume a simple reduce form relationship $e_{g-1} = \alpha_e R_{g-1}$ and $Q_{g-1} = \alpha_Q R_{g-1}$, or, specializing further $q_g = \alpha_q R_{g-1}$ and $b_{g-1} = \alpha_b R_{g-1}$. We will use α_Q for the most part and separate the two components of transfers as necessary, keep $\alpha_Q = \alpha_q + \alpha_b$. We make the assumption of constant shares for simplicity. The important aspect here is not that the shares are constant but rather that spending is expressed as a function of lifetime resources rather its components. The latter assumption requires weak separability between variables determining income and other decisions. Both assumptions can be easily micro-founded using simple Cobb-Douglas specification.⁵

Given shares, resources of subsequent generations are simply related as

$$R_g = (\alpha_e + \alpha_Q) R_{g-1} + u_g, \tag{1}$$

which shows that the intergenerational parameter of interest is $\beta_R \equiv \alpha_e + \alpha_Q = \alpha_e + \alpha_q + \alpha_b$, implying that human capital investments, inter vivo transfers and bequest are all important for the intergenerational relationship in welfare across generations and that the strength of this relationship simply reflects the share of total resources that is spent on all these sources of intergenerational transmission.

Lifetime resources and lifetime spending of an individual are hard to measure empirically and we are therefore interested in knowing how close intergenerational correlations in other economic

⁵Consider the budget constraint of $\sum_{i=1}^T c^i + e_g + Q_g = R_g \equiv Y_g + Q_{g-1}$. For any warm-glow preferences over human capital investments and transfers $v(\{c^i\}_{i=1}^T, e_g, Q_g)$, the optimal choice of transfers and human capital investments will be given by $e_g(R_g)$ and $Q_g(R_g)$. This is still true when Y_g is a choice variable (e.g., a function of labor supply, effort etc.), as long as preferences are weakly separable $u(v(\{c^i\}_{i=1}^T, e_g, Q_g), Y_g)$. Further specializing the consumption component to Cobb-Douglas $v(\{c^i\}_{i=1}^T, e_g, Q_g) = \frac{1-\alpha_e-\alpha_Q}{T} \sum_{i=1}^T \ln(c^i) + \alpha_e \ln e_g + \alpha_Q \ln(Q_g)$ yields constant shares.

outcomes are to β_R . For example, a large part of the intergenerational literature has estimated the intergenerational correlation in labor market income aiming at measuring the correlation in lifetime/permanent income. In the model, the relationship between lifetime income of generation g and generation $g - 1$ equals⁶

$$Y_g = (\alpha_e + \alpha_Q) Y_{g-1} - \alpha_Q u_{g-1} + u_g. \quad (2)$$

This relationship shows that a regression of lifetime income of generation g on lifetime income of generation $g - 1$ gives an estimate β_Y below the correlation in life-time resources β_R because of the direct relationship between Y_{g-1} and u_{g-1} . This is because children's income is a function of the overall parental lifetime resources rather than parental income alone, so that parental income (even lifetime income) is only a proxy for the relevant metric of parental status. In particular, any difference between the correlation of lifetime resources $\alpha_e + \alpha_Q$ exhibited in equation (1) and the correlation of permanent income in equation (2) is present to the extent that $\alpha_Q \neq 0$, i.e. it is due to the presence of transfers.

In order to compare the intergenerational correlation of lifetime resources with that of wealth, we consider observing an individual at some age t . At that point, an individual will have received fraction ρ^t of lifetime income, received γ^t of lifetime transfers and spent fraction ζ^t of lifetime resources on consumption, human capital investments in children and transfers. This is without loss of generality: any specific assumptions about preferences and assumptions about age-income profile imply some paths of ρ^t , γ^t and ζ^t . Naturally, all of these paths have to ultimately be equal to 1 as individuals age and it is natural to assume that all of them are increasing.⁷ However, two points are worth noting. First, ζ^t is the overall spending on all causes including transfers, so that as long as bequests are non-zero $\zeta^t < 1$ during the lifetime and jumps discretely to 1 at death. Second, γ^t jumps to 1 discretely at the time bequests are *received*.

As the result, wealth at age t is equal to

$$w_g^t = \rho^t Y_g + \gamma^t Q_{g-1} - \zeta^t R_g$$

Substituting for Y_g , Q_g and using (1) allows to express w_g^t in terms of R_{g-1} and u_g

⁶To see it, simply observe that $Y_g = \alpha_e R_{g-1} + u_g$, and $R_{g-1} = (\alpha_e + \alpha_Q) R_{g-2} + u_{g-1}$, imply that $Y_g = \alpha_e(\alpha_e + \alpha_Q) R_{g-2} + \alpha_e u_{g-1} + u_g$. Substituting $\alpha_e R_{g-2} = Y_{g-1} - u_{g-1}$ yields equation (2).

⁷In principle, one could consider γ^t to be non-monotonic to account for the possibility of transfers from children to parents, but we abstract from this possibility.

$$w_g^t = R_{g-1} \left((\gamma^t - \zeta^t) \alpha_Q + (\rho^t - \zeta^t) \alpha_e \right) + (\rho^t - \zeta^t) u_g$$

Wealth at age t is related to parental resources. This relationship is governed by transfers α_Q and by human capital investments α_e . At any point in time, this relationship reflects the difference between the share of transfers (γ^t) or income (ρ^t) that has been received relative to the share of consumption. This is a simple characterization of the wealth accumulation profile that accounts for the profiles of income, transfers and consumption.

This characterization of wealth combined with the law of motion for lifetime resources (1) may be used to relate wealth across generations:⁸

$$w_g^t = w_{g-1}^s \cdot (\alpha_e + \alpha_Q) \cdot \xi_t^s - u_{g-1} \cdot \nu_t^s + (\rho^t - \zeta^t) u_g \quad (3)$$

where ξ_t^s and ν_t^s are constants defined as

$$\xi_t^s \equiv \frac{(\gamma^t - \zeta^t) \alpha_Q + (\rho^t - \zeta^t) \alpha_e}{(\gamma^s - \zeta^s) \alpha_Q + (\rho^s - \zeta^s) \alpha_e}$$

and

$$\nu_t^s \equiv \gamma^t \alpha_Q + \rho^t \alpha_e - \zeta^t (\alpha_e + \alpha_Q) - \xi_t^s \cdot (\alpha_e + \alpha_Q) (\rho^s - \zeta^s)$$

Focusing on the intergenerational relationship (3), wealth of children at time t depends on wealth of parents at time s and own shock u_g . Because wealth of parents at time s is not simply proportional to R_{g-1} , tracing out the precise relationship involves separating the contribution of the parental shock u_{g-1} . The intergenerational correlation coefficient $\alpha_e + \alpha_Q$ governs the relationship between wealth of parents and children, but it is potentially mitigated by two sources of bias that are captured by the parameters ξ_t^s and ν_t^s that are driven by life-cycle contributors to wealth. We will consider them in turn.

First, note that $\xi_t^s = 1$ when $t = s$. When wealth is measured at the same age for both parents and children, the relationship reflects intergenerational correlation of lifetime resources. This is intuitive: when measured at the same age, wealth should bear the same relationship to lifetime resources for each generation. This leads to our first observation that we will rely on in empirical

⁸Evaluating the same expression for generation $g-1$ at some age s allows for relating w_{g-1}^s to R_{g-2} . Using formula (1) to substitute for R_{g-1} , so that w_g^t is expressed in terms of R_{g-2}, u_{g-1} and u_{g-2} , and then substituting for R_{g-2} in terms of w_{g-1}^s yields the relationship between w_g^t and w_{g-1}^s :

work:

Remark 1. Elasticity of children wealth to parental wealth is equal to $\alpha_e + \alpha_Q$ when measured at the same stage of life-cycle for parents and children

When $t \neq s$, this is no longer true and instead ξ_t^s reflects the fact that wealth of children accounts for a different share of transfers, lifetime income, and spending than does wealth of parents measured at a different point of the life-cycle. We will consider in empirical work how the correlation in wealth changes over the child's life-cycle which amounts to holding s constant and varying age of the child t . We focus on parents sufficiently late in life-cycle so that the denominator is positive (wealth is positive).

Consider first the case when there are no transfers $\alpha_Q = 0$. In that case, the relationship between own wealth and parental resources reflects $\rho^t - \zeta^t$: the life-cycle relationship between income and consumption that determines saving. Under standard (consumption smoothing) assumption of the path of income being steeper than the path of consumption, this implies that ξ_t^s should change from negative to positive over the life-cycle reflecting borrowing early during the life-cycle and accumulation later on. In order for ξ_t^s to be always positive, therefore, we need that $\alpha_Q > 0$. Second, while $\rho^t - \zeta^t$ is expected to be increasing, $\gamma^t - \zeta^t$ need not be. In fact, it is possible to have large share of transfers received early and the rest when bequests are received — this would correspond to γ^t constant or slowly increasing and $\gamma^t - \zeta^t$ declining. In particular, the pattern of correlation of wealth is informative about this possibility.

Remark 2. The shape of the intergenerational elasticity over the life-cycle is governed by the paths of income-to-consumption $\rho^t - \zeta^t$ and transfers-to-consumption $\gamma^t - \zeta^t$. Steep income profile and consumption smoothing imply that $\rho^t - \zeta^t$ is increasing over the life-cycle from negative to positive values. Hence, when $\alpha_Q = 0$, the life-cycle relationship should be negative early in the life-cycle and increasing. The necessary condition for declining life-cycle profile requires $\alpha_Q > 0$ and $\gamma^t - \zeta^t$ falling over time.

In particular, it is also possible to have a U-shaped profile of the intergenerational wealth elasticity over the life-cycle of a child.

Remark 3. Early in the life-cycle, $\rho^t \approx 0$, $\zeta^t \approx 0$. Then, ξ_t^s is proportional to $\alpha_Q \gamma^t$. In particular, it may be large when γ^t is large (early transfers to children/young adults). Suppose that γ^t stays constant or increases slowly with age (small transfers to middle-age children). Then, $\gamma^t - \zeta^t$ is declining and with $\rho^t - \zeta^t$ negative, ξ_t^s needs to decline. Finally, as $\rho^t - \zeta^t$ increases, the correlation

may increase (depending on the behavior of $\gamma^t - \zeta^t$)

Finally, consider the role of bequests. In order to measure intergenerational correlation of lifetime resources, we need $\xi_t^s = 1$ and thus $t = s$, so that both parents and children should either be before or they should be observed after the receipt of bequests. Holding the timing of when parental wealth is observed (s) constant, the receipt of a bequest corresponds to discrete shift in γ^t at parental death (receipt of bequests) and thus a discrete increase in b_t^s . Hence, following the receipt of bequest the correlation should increase in proportion to a change in γ^t . If $t \approx s$, the observed correlation may be equal to $\alpha_Q + \alpha_e$ before or after receipt of the bequest depending on whether wealth of parents themselves was measured before or after the receipt of their own bequest.

The discussion so far has focused on the coefficient on parental wealth in formula (3) and its relationship to the parameter of interest $\alpha_Q + \alpha_e$. The straightforward estimate from regression of children on parental wealth would be biased though due to the presence of $u_{g-1}\nu_t^s$ term in formula (3). Intuitively, its presence is again due to the fact that parental wealth at a particular point in time is only a proxy for parental lifetime resources. There are two approaches to this term. One could address contribution of u_{g-1} by either instrumenting parental wealth or by controlling for u_{g-1} . We will pursue an alternative approach. Using equation (2) to obtain an expression for u_{g-1} and substitute in formula (3) to obtain

$$w_g^t = w_{g-1}^s \cdot (\alpha_e + \alpha_Q) \cdot \xi_t^s + Y_{g-1} \cdot \frac{\nu_t^s}{\alpha_Q} - Y_g \cdot \nu_t^s \frac{\alpha_Q + \alpha_e}{\alpha_Q} + (\rho^t - \zeta^t - \frac{\nu_t^s}{\alpha_Q})u_g \quad (4)$$

In this specification, controlling for permanent income of parents and children addresses the bias.

3 Description of data and institutional background

Our empirical analysis is based on data from public administrative registers gathered by Statistics Denmark and linked together using personal identification numbers. Every citizen in Denmark is assigned a unique personal identification number at birth and the identification numbers of the mother and the father are registered for all Danes born in 1960 and onwards.⁹ This enables us to combine different data sources at the individual level and to link data across generations.

The data on individual wealth and income is based on administrative tax return records. The Danish Tax Agency (SKAT) collects, in addition to information of various income sources, infor-

⁹Registrations of parents exist before 1960 but are incomplete.

mation about the values of asset holdings and liabilities measured at the last day of the year for all Danes, and the bulk of the wealth components are third-party reported.¹⁰ The available pieces of information at Statistics Denmark are the aggregate value of assets and liabilities, respectively, covering the period 1980 to 2011, and from 1997 and onwards it is also possible to obtain complete portfolio information with respect to the value of bonds, stocks, cash in banks, house, mortgage loans, and sum of other loans. None of the wealth components are top coded.

The information about the value of financial assets and liabilities at the end of the year is reported to the tax authorities by banks, other financial institutions, and some government institutions, while the cash value of property is assessed by the tax authorities, based on detailed information of the property, and used for taxation of the imputed rent on the property. The third-party reported value of assets includes all deposits, stocks, bonds, value of property, and deposited mortgages. Pension funds are not part of the data, which is also the case in the US study by Charles and Hurst (2003).¹¹ The third-party reported value of liabilities includes debt in financial institutions, mortgage credit debt, credit and debit card debt, deposited mortgage debt, student debt and debt in The Mortgage Bank (a public institution), debt to financial corporations, debt to the Danish municipalities, and other liabilities such as unpaid taxes and mortgage debt, which are not deposited.

Until 1996, Denmark had a wealth tax, and taxpayers had to self-report car values, boat values, caravan values, title deed of cooperative dwellings, premium bonds, cash deposits, stocks (both listed and non-listed thereby including privately held companies), and private debt. These components are not included in the computations after 1996. Until 1996 the value of stocks was self-reported, while afterwards it became third-party reported by banks and financial institutions (excluding non-listed stocks). The registration of the company value of self-employed has changed several times, but has stayed unchanged since 1997, where assets and liabilities of the firm were

¹⁰The tax authorities use the income information to generate pre-populated tax returns. The information on wealth was originally used to compute the wealth tax, whereas today it is used by the tax agency to cross check if the reported income level is consistent with the change in net-wealth during the year under the assumption of a given estimated consumption level. A recent study by Kleven et al. (2011) reveals, using a large scale randomized tax auditing experiment constructed in collaboration with the Danish tax authorities, only small differences between the third-party reported income items and the corresponding items on the final tax return. This indicates that the third-party reported information of the Danish Tax Agency is of a very high quality.

¹¹Pensions represent primarily compulsory saving (the voluntary component is small). The two important parts reflect (1) the value of universal government pension benefit (which would be comparable to the expected value of Social Security payments in the US) and (2) employer contributions that are proportional to wages and determined by bargaining agreements—the closest analogue in the US would be employer contributions to 401(k) or equivalent accounts. Numbers provided by the Danish central bank indicate that pension's share out of total gross wealth averaged 22% over the years 1997-2011.

registered separately and included, respectively, in the assets and liabilities of the owner. Another definitional change occurs in 1983. Before 1983 all family wealth of a married couples was assigned to the husband, while the wealth of husbands and wives has been registered separately afterwards.

The largest change in the definition of wealth occurs around 1997 when the wealth tax was abolished. However, for 1995 and 1996 Statistics Denmark computed assets and liabilities of each individual using both the new definition of wealth and the old definition. In the appendix, we exploit this overlap to show that results are insensitive to the change in the measurement of wealth, and we provide more details on the wealth data.

According to the theory, if the goal is to estimate the relationship across generations in lifetime economic resources then we should observe wealth of the individual and the parents at the same point in the life cycle, and the ideal point of time would be when they have both received all their earnings and all transfers from the previous generation. In practice, this is difficult and an alternative way is to measure their wealth in the middle of the life cycle where their incomes are good proxies for permanent income that may be used together with wealth to estimate the correlation in lifetime resources according to eq. (4) in the theory. Therefore, our baseline sample is child cohorts who are 45-50 years old in 2010 (the highest age where we are sure to know the identity of both parents) and their (biological) parents observed at the same point in the life-cycle. We take the average wealth of children over the three-year period 2009-2011 and measure (average) parental wealth 25 years before, corresponding to the median age of the parents when getting the children, i.e. 1984-1986. Thus, parents and children are approximately the same age when we measure their wealth. We take three year averages of wealth of each individual to reduce the importance of transitory components, as often done in the literature on intergenerational income mobility following Solon (1992). We provide sensitivity analyzes where we experiment with the length of the window of measurement and conclude that it matters very little for the results.

In order to explore how the relationship change over the life-cycle of the child, which is informative about the underlying mechanisms driving wealth formation, we exploit the longitudinal dimension of the data and look at child wealth from becoming adult (20 years old) until mid-life (45-50 years old). We also provide sensitivity analysis with respect to changing the time of measurement of parental wealth. Finally, we exploit the longitudinal dimension of the data and parental death in an event study design to measure the role of bequests.

Table 1 provides summary statistics of the main sample where we have about 364 thousand children, where both parents are alive in 2011 for 41 percent of the children, one parent is alive for

42 percent of the children, and none of the parents are alive for 17 percent of the children. The mean age is 47.2 for the children and only slightly higher for the parents. All monetary variables are measured in DKK ($\$1 \approx \text{DKK}5-6$) and deflated with nominal GDP to 2010-prices. The average level of income and assets are about the same for children and parents, while debt is somewhat higher for the children. This is also reflected in net-wealth, which is negative for more than 20 percent of the child generation, while it is below 20 percent for the parents when measured at the same point in the life-cycle. One reason for this may be that pension wealth is unobservable and is higher for the child generation because labor market pension contribution rates have been increasing. Finally, it is well-known that Danish households have high debt-to-income ratios (the debt-income ratio in Table 1 is 2.6 for children and 2.1 for the parents) compared to other countries, which has received international attention recently (European Commission 2012; International Monetary Fund 2012).¹²

Table 2 provides summary statistics of the sub-sample used to analyze the effects of bequests. We do not have direct information on bequests, but employ an event study design where we look at child wealth before and after death of parents. Since Danish laws permit a spouse to retain undivided possession of the estate, wealth is normally not transferred to the next generation before death of both parents. We therefore focus on a sample of children who have one living spouse in 2009, and divide the children into a treatment group where the parent dies in 2010, and a control group where the parent does not die in 2010. We continue to focus on the cohorts of children who are 45–50 years old in 2010 and continue to measure wealth of parents in 1984–86. Table 2 shows that the distributions of wealth and income are reasonably close to each other across treatment and control groups for both parents and children.

4 Empirical analysis

This section describes the empirical results. First, we present baseline evidence on the relationship between wealth of parents and children, showing graphical non-parametric relationships and using parametric specifications to obtain population summary statistics. Second, we analyze the development of the intergenerational correlation over the life-cycle of the child and compare it to the predictions of the theory. Third, we analyze the role of bequests for the intergenerational correla-

¹²The difference to the US and other countries may reflect that Denmark has a reasonably high universal public pension benefit level, substantial labor market pension savings by international standards, and an extensive social safety net that reduces the need for precautionary savings.

Table 1: Summary statistics—Baseline sample

	Children		Parents	
	Mean	SD	Mean	SD
Age	47.2	1.7	47.9	5.1
Income	372,700	344,491	365,804	343,859
Value of assets	1,468,104	4,222,321	1,399,431	3,397,146
Value of liabilities	960,840	2,793,953	757,098	2,325,781
Net wealth	507,264	2,510,350	642,333	2,267,429
Percentiles of wealth				
20th	-132,788		0	
40th	32,386		21,114	
60th	330,869		351,527	
80th	849,631		1,212,174	
Share with				
Stocks	0.25			
Property	0.63			
Bonds	0.08			
Bank deposits	0.91			
Bank debt	0.74			
Mortgage debt	0.59			
Share men	0.51		0.49	
Share married	0.63		0.88	
Share self-employed	0.07		0.17	
Observations	363,857		727,714	

Notes: The table reports mean values, standard deviations and percentile values of different variables. All monetary variables are measured in DKK (\$1≈DKK5-6) and deflated with nominal GDP to 2010-prices. Net wealth, income and value of assets and liabilities are averaged over the years 2009-2011 for children and 1984-1986 for parents. Income is earnings and self-employment income but excluding capital income.

Table 2: Summary statistics—Bequest sample

	Children (2007–2009)		Parents (1984–1986)	
	Control group	Treatment group	Control group	Treatment group
Mean wealth	650,980	587,172	576,116	558,412
20th percentile	-92,882	-95,734	8,561	8,866
40th percentile	73,392	52,949	247,371	234,737
60th percentile	454,867	414,489	540,218	526,611
80th percentile	1,041,054	992,703	921,644	924,750
Mean income	346,836	335,738	297,496	251,436
20th percentile	204,846	188,503	156,135	89,420
40th percentile	294,833	289,118	243,481	193,533
60th percentile	357,507	350,909	323,777	279,595
80th percentile	450,467	440,436	411,161	378,062
Observations	135,335	5,708	135,335	5,708

Notes: The table reports mean values and percentile values of wealth and income of children and parents in the treatment and control group. Child values are measured as averages over the years 2007-2009, i.e. before death of the parent in the T-group in 2010. Parental values are measured as averages over the years 1984-1986. Monetary values are measured in DKK (\$1≈DKK5-6) and deflated with nominal GDP to 2010-prices. Income is earnings and self-employment income but excluding capital income.

tion. Fourth, we use information of wealth and income to estimate the intergenerational correlation in lifetime resources.

4.1 Non-parametric evidence and aggregate measures of intergenerational wealth mobility

We start by providing non-parametric evidence of the relationship between child wealth and wealth of the parents when children and parents are in the middle of the life cycle using the baseline sample described above. Most of our analysis is based on the relationship between positions of children and parents in the wealth distribution measured by within-cohort percentile ranks. This has several advantages: it compares people with others from the same cohorts and thereby controls for life-cycle differences in wealth, it works well with zero and negative observations that are common in wealth data, and it is a very robust measure as it is unaffected by all types of monotone transformations of the underlying data. For each child, we compute the percentile rank in the distribution of child wealth for individuals at the same age (with maximum rank normalized to 100), and we do the same for parental wealth based on the average age of the parents.¹³

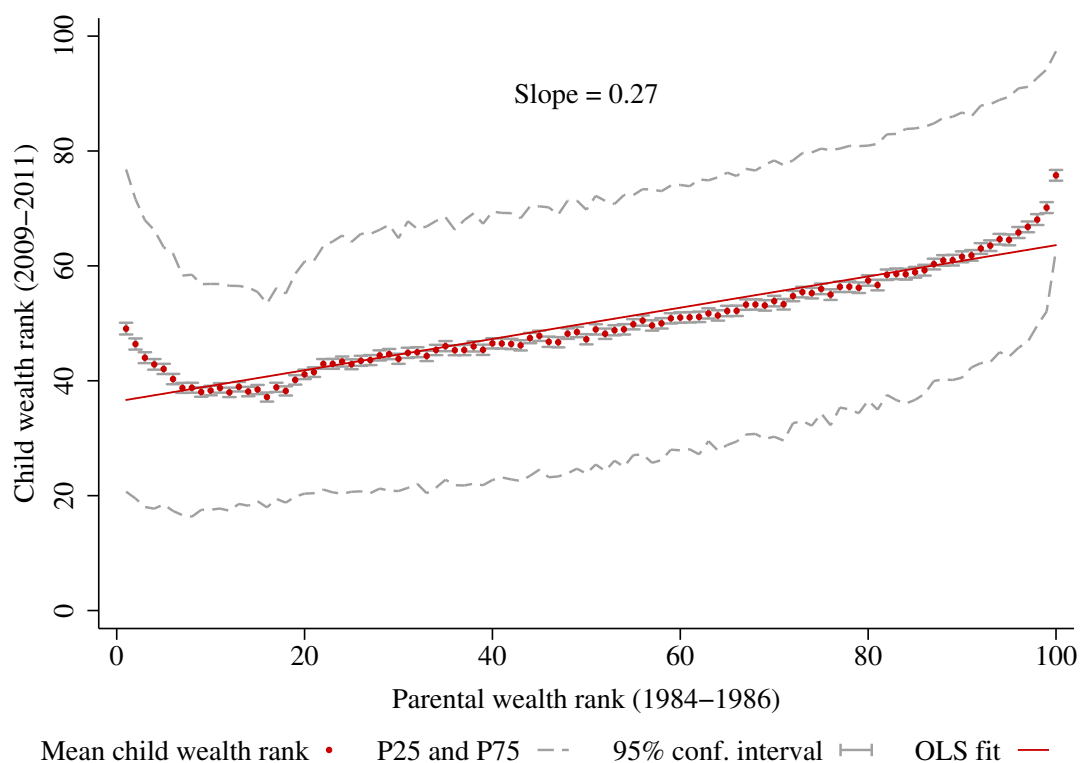
¹³Within an age cohort, ranks are calculated as $((i - 0.5)/N) \cdot 100$, where i denotes individuals (sorted by wealth, and $i = 1, 2, \dots, N$). A small random number is added to the wealth of each individual to ensure that all individuals may be ranked. We use these ranks based on the entire distribution throughout the analysis unless stated otherwise.

Figure 1 shows a binned scatter plot where child-parents pairs are divided into 100 groups according to the percentile rank of parental wealth and showing for each percentile the mean rank of children. Note that the graph also shows a very small 95 percent confidence interval at each point estimate, reflecting that the child mean rank at each parental wealth percentile is very precisely estimated. The graph reveals an almost linear relationship with the exception of at the very top and bottom of the parental wealth distribution. Children of parents in percentile 10 are on average in percentile 40, while children of parents in percentile 90 on average are in percentile 60, and within this range moving up one percentile in the parental wealth distribution is associated with about 1/4 percentile increase in the average position of children. The overall slope of 0.27 reported in the figure is an OLS estimate using the underlying micro data.

The relationship is much stronger at the top of the distribution with a child average rank going from percentile 68 to percentile 73, when going from percentile 99 to percentile 100 in the parental wealth distribution. The dip down at the bottom of the parental distribution may reflect that the wealth of the parents in the first percentiles is a bad proxy for their "true type" and ex ante expected wealth. These parents have large debt and significant negative wealth that may reflect involvement in risky investment decisions that either have gone wrong or have not paid off yet. Consistent with this hypothesis, we find that self-employed are over-represented in the first percentiles. The dip down may also be related to some measurement error in the wealth measurement, which is more relevant for self-reported components. In Figure 2, we provide a sensitivity analysis where we exclude self-employed from the analysis (panel A) and change the measurement of parental wealth from 1984-1986 to 2009-2011. The graph without self-employed has a smaller dip down in the bottom of the distribution but without changing the overall rank correlation. Measuring wealth of parents today instead of 25 years ago nearly removes the dip down at the bottom of the distribution, but it has only a small effect on the overall rank correlation, which increases from 0.27 to 0.28.

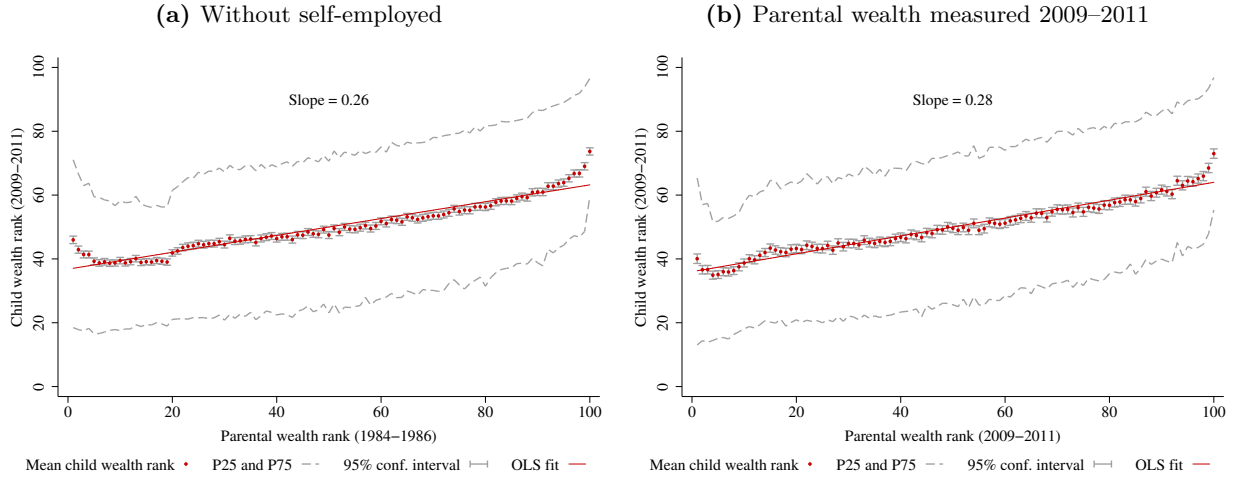
Figure 1 displays also the 25th and 75th percentiles of the conditional child rank distribution computed for each wealth percentile of parents. For example, for children born to parents in percentile 10, around half of them have a rank between 20 and 60, while 25% of them have a rank below 20 and another 25% have a rank above 60. The child rank levels at the 25th percentile and the 75th percentile increase steadily as we move up in the parental distribution mirroring the development in mean rank level. Again an exception is at the very top of the wealth distribution where the child rank level at the 25th percentile jumps from around 50 to 60 when going from

Figure 1: Mean child wealth percentile by parental wealth percentile: Baseline



Notes: This figure shows a non-parametric binned scatter plot of the mean percentile wealth rank, including 95% CIs, of children age 45-50 in 2010 by wealth percentiles of parents. Child wealth is individual wealth averaged over the years 2009-2011, and parental wealth is the average of father's and mother's wealth averaged over the years 1984-1986. Percentile rank is computed within each child cohort. The OLS slope reported in the figure is estimated using the underlying micro data. The dashed curves are 25th and 75th percentiles of the conditional child rank distribution computed for each wealth percentile of parents.

Figure 2: Mean child wealth percentile by parental wealth percentile: Sensitivity analysis



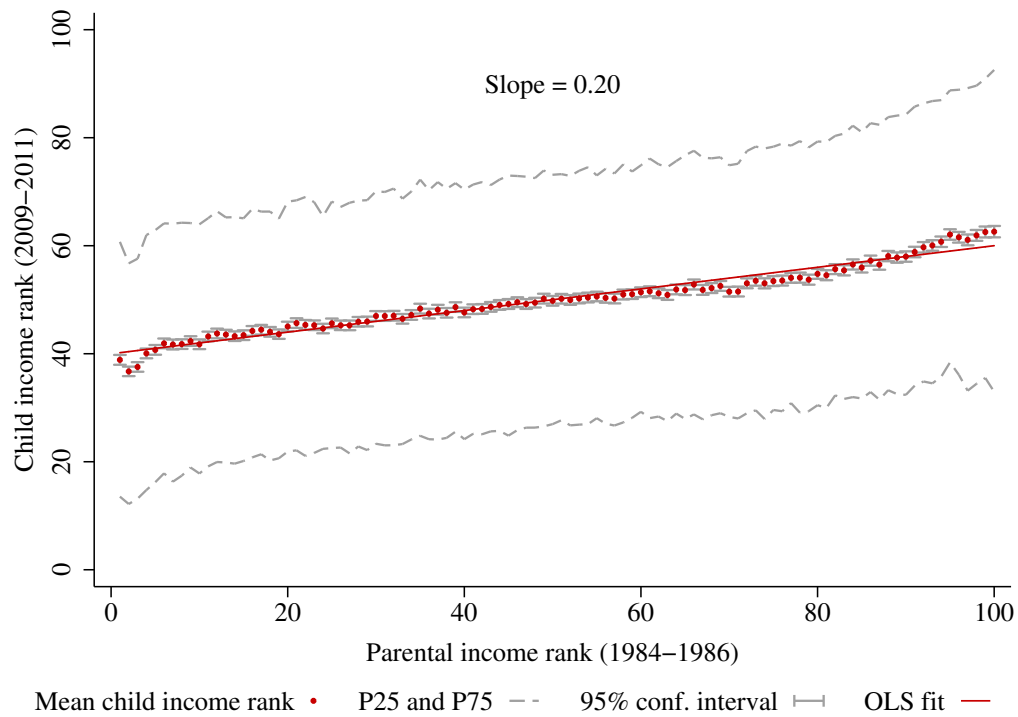
Notes: Panel A is similar to figure 1 but made for the sub-sample where neither parent nor child are registered as self-employed at the period of measurement. Panel B is similar to figure 1 but parental wealth is measured in 2009–2011, like child wealth, instead of in 1984–1986.

percentile 99 to 100 in the parental wealth distribution. Thus, for the top 1% of parents, less than 25% of their children have a rank below 60. Moreover, the graph shows that 25% of the children have a rank equal to 98% or higher.

Figure 2, panel A is similar to the above baseline figure but is made for a sub-sample where neither parents nor children are self-employed when observing their wealth. The graph is very similar to Figure 1, and with identical overall rank correlation. The main difference is that the dip down at the bottom of the parental distribution is much less pronounced. In panel B, we redo the baseline graph but based on parental wealth measured in 2009–2011 instead of in 1984–1986. This move 25 years forward in the time of measurement of parents has nearly no impact on the graph with the exception of nearly removing the dip down at the bottom of the parental distribution, which increases the overall correlation coefficient a little.

In Figure 3, we repeat the baseline analysis for income. In the income concept, we include earnings and self-employment income but not capital income, as we want to focus only on the return to human capital. We find an almost completely linear relationship between ranks of children and parents with a rank correlation of 0.2, which should be compared to the 0.27 for wealth. Hence, wealth displays less mobility than income. This is in particular the case at the top of the distributions where child wealth is much more strongly related to parental wealth than is the case for income.

Figure 3: Mean child income percentile by parental income percentile



Notes: This figure shows a non-parametric binned scatter plot of the mean percentile income rank, including 95% CIs, of children age 45-50 in 2010 by income percentiles of parents. Child income is individual income averaged over the years 2009-2011, and parental income is the average of father's and mother's income averaged over the years 1984-1986. Percentile rank is computed within each child cohort. The OLS slope reported in the figure is estimated using the underlying micro data. The dashed curves are 25th and 75th percentiles of the conditional child rank distribution computed for each income percentile of parents.

It is useful to have a single measure of the overall degree of wealth mobility. Our preferred measure is the rank correlation coefficient. Because of the uniform distribution of the rank measure, this may be obtained from a linear regression of child rank on the rank of parents, corresponding to the slope of the OLS fitted line in Figure 1. The result of this regression, reported in panel A of Table 2, is the baseline estimate of 0.27, which is very precisely estimated (standard deviation of 0.002) because of the large sample size. Thus, on average a one percentile increase in the position of parents in the wealth distribution is associated with a 0.27 percentile increase in the average position of children, in line with the conclusion above that the slope in Figure 1 is $1/4$ almost everywhere with the exception of at the tails of the parental distribution. Other studies of intergenerational mobility, for example the study of wealth by Charles and Hurst (2003), analyze data where parents are alive when wealth of children is measured—note that this creates an asymmetry as grandparents may be dead when measuring the wealth of parents. Column 2 shows that the correlation coefficient drops from 0.27 to 0.25, if restricting the sample in this way. In column 3, we repeat the baseline analysis for the case where parental wealth is measured 12 years before the children, lying in between the 25 year difference in the baseline analysis and the 0 year difference result in panel B of Figure 2, making the result more comparable to Charles and Hurst (2003). In this case, the correlation estimate increases somewhat. In column 4, we consider the impact of including age dummy variables. Our percentile rank measure is already controlling for age as it is computed within child cohorts but the estimate may still change when including age controls because of the natural association between parental wealth and parental age at child birth. The table shows that the rank correlation decreases slightly to 0.26. In column 5, we combine all three criteria studied in columns 2-4, which bring the analysis closer to Charles and Hurst (2003). In this case, the rank correlation is almost the same as in the baseline case.

For comparison, panel B of Table 2 also reports the elasticity of child wealth with respect to parental wealth, corresponding to estimating an ordinary least squares regression after using a natural logarithmic transformation of the data (for those with positive wealth). Studies on intergenerational income mobility normally report the intergenerational elasticity, and this is also done by Charles and Hurst (2003) in their study of intergenerational wealth mobility. In the baseline case, we obtain a child-parents elasticity of 0.24, implying that children born to parents with a wealth level that is 1 percent above the mean of the parental generation can expect to obtain a wealth level that is 0.24 percent above the mean of the child generation. We obtain nearly the same estimate in column 5, which may be compared to the result of 0.37 for the United States

reported by Charles and Hurst (2003). The lower estimate for Denmark is not surprising. Denmark has a very homogeneous population and a high degree of redistribution, and comparative studies find that Denmark has a high intergenerational mobility in earnings/income compared to the US and many other countries (Björklund and Jäntti 2009; Chetty et al. 2014).

When applying the log transformation, we are throwing away all child-parents pairs where either the child or the parents have zero or negative net wealth, which may generate selection problems.¹⁴ In panel C, we show the result when we instead apply the inverse hyperbolic sine transformation $w = \log(W + \sqrt{W^2 + 1})$, which behaves like the log transformation while allowing for negative values. In this case, the elasticity estimates become considerably lower than the log transformation estimate in the first columns but considerably higher in column 3.

4.2 Intergenerational correlation over the life cycle

In this section, we exploit the long panel dimension of our data to study the wealth formation over the life cycle of the child starting at age 20 and going up to age 45. Compared to the previous section, we limit the sample to the cohort born in 1965 who is 45 years old in 2010, and 20 years old in 1985. As in the previous section, we measure parental wealth in mid-life in 1984-1986. We also measure child wealth as a three-average starting with 1984-1986.

Figure 4 shows the correlation between the wealth of parents measured in mid-life, as in the previous section, and wealth of the children measured at different points in the life cycle. For comparison, the figure shows a similar graph for the correlation in income. The wealth correlation is U-shaped. It starts at a high level of 0.35 and then declines until the mid-twenties at a level close to 0.17 and then increases up to around 0.27 as in our baseline graph in Figure 1. The theory points to two counteracting forces that determine the intergenerational correlation in wealth when the child is young. The more prone parents are to give *intervivo* wealth transfers, the higher is the correlation. On the other hand, the stronger the relationship between parental wealth and permanent income of the child and the more prone children are to receive wealth transfers late in life, the higher is the consumption level of the child when young, and the lower is the intergenerational wealth correlation. Without any *intervivo* transfers received by the child when young, the intergenerational wealth

¹⁴Most of the empirical literature analyzing intergenerational relationships have looked at economic outcomes that do not attain negative values by definition, for example earnings. In this case, it is natural to apply the log transformation, which has appealing properties. This is, however, not the case when analyzing net wealth, which may well be negative, and where standard life cycle theory predicts negative values for young persons who have increasing earnings profiles. Another reason for observing negative wealth of households in our case, and also in C&H, is that we are unable to include pension wealth.

Table 3: Estimates of child-parents wealth relationship with rank, log and IHS transformation of the data

	Child wealth				
	(1)	(2)	(3)	(4)	(5)
	Baseline	Parents alive in 2011	Parental wealth 1997-1999	Age controls	Par. alive, 1997-1999, age controls
<i>A. Rank transformation</i>					
Parental wealth	0.272 (0.002)	0.250 (0.002)	0.305 (0.002)	0.260 (0.002)	0.269 (0.003)
Observations	363,857	157,314	271,600	363,857	156,297
<i>B. Log transformation</i>					
Parental wealth	0.238 (0.003)	0.236 (0.004)	0.256 (0.003)	0.231 (0.003)	0.248 (0.004)
Observations	207,266	92,054	162,444	207,266	94,750
<i>C. IHS transformation</i>					
Parental wealth	0.215 (0.002)	0.191 (0.004)	0.284 (0.003)	0.194 (0.002)	0.230 (0.004)
Observations	363,857	157,314	271,600	363,857	156,297

Notes: This table reports results from OLS regressions of child wealth (in some transformation) on parental wealth (transformed). The dependent variable is rank, log and IHS transformation of the average 2009-2011 wealth of children. In the baseline case, parental wealth is measured in 1984-1986. Columns 2-5 show different deviations from the baseline case. Column 2 looks at a restricted sample where both parents are alive when measuring child wealth, i.e. alive in 2011. Column 3 considers the case where parental wealth is measured in 1997-1999 instead of 1984-1986. Column 4 reports the result from including child and parental age dummy variables in the baseline regression. Column 5 reports the result from imposing all the criteria in columns 2-4.

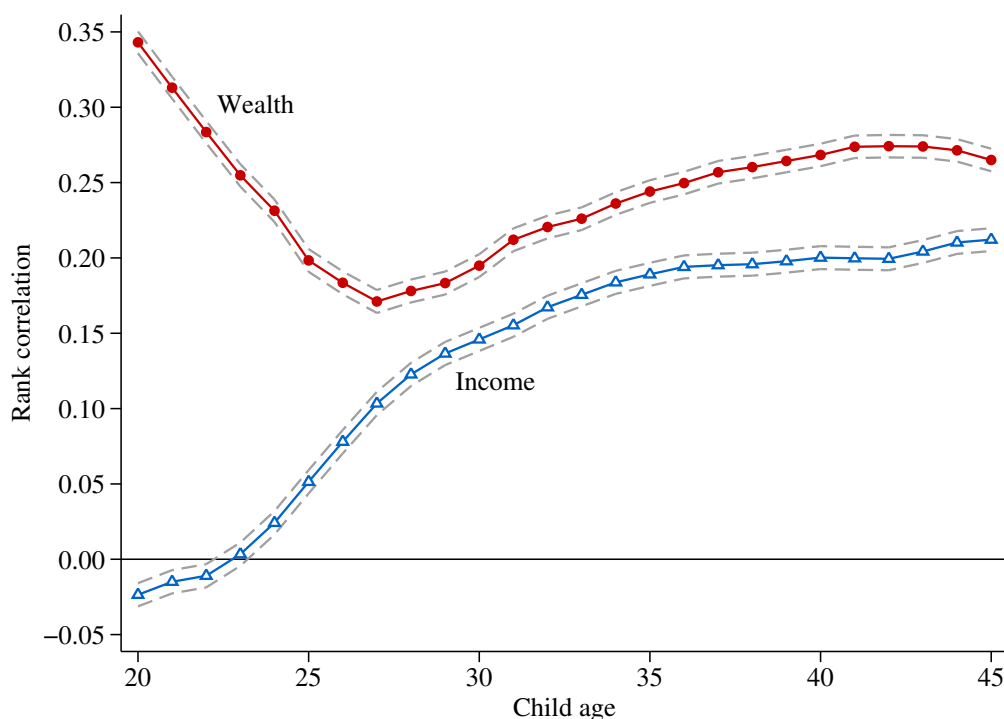
correlation is negative. Thus, the high correlation in wealth at the time when the child moves into adulthood is in the theory explained by a sufficiently high level of *intervivo* transfers. The decline in the wealth correlation during the twenties is consistent with investments in human capital and higher consumption levels of children with wealthy parents due to higher levels of economic resources in the future. In mid-life these child have high incomes and build up wealth thereby creating a higher correlation with parental wealth again. All in all, this pattern over the life cycle is consistent with our theory of intergenerational wealth formation over the life-cycle with wealthy parents leading to significant *intervivo*-transfers and human capital investments early in adulthood and to high permanent incomes of children later in life (although the theory for simplicity only has three periods of life).

Appendix B provides a repeated cross-section analysis showing that the U-shaped life-cycle profile in wealth correlation exists over time and is not related to the particular cohorts studied here.

The graph for the intergenerational correlation of income over the life cycle is very different from the correlation of wealth. The correlation is lower at all ages and the correlation starts by being negative, implying that high income parents have low-income children in the early twenties, and then increases gradually as a function of child age. To get a better understanding of the connection between the results for wealth and income, we divide the children into 10 groups depending on the decile the parents belong to in the parental wealth distribution, and then plot the average wealth and income percentile ranks of the children over the life-cycle. Figure 5 shows the results.

The graph for wealth shows that children systematically, with the exception of decile 1, at all points in the life-cycle lie higher in the wealth distribution when the parents belong to a higher wealth decile. The relationship with parental wealth is particular strong in the beginning of the life-cycle where the groups of children lie in the range 35–70 depending on the position of the parents. The variation becomes smaller until the mid-twenties and then increases again, thereby mirroring the U-shaped pattern of the intergenerational wealth correlation in Figure 4. The graph for income shows a *negative*—but very small—correlation between wealth of parents and income of children in early adulthood. Over the life-cycle of the child the relationship between income of the child and original wealth of the parents is reversed, and from the child turns thirty years old and forward the relationship is stable and reveals a systematically higher permanent income level of children having parents who were high up in the wealth distribution when the child was young. In accordance, with the theory this is showing that the high intergenerational correlation in wealth

Figure 4: Intergenerational rank correlation in wealth and income over the life cycle of the child



Notes: The figure shows OLS estimates of the intergenerational rank correlation of wealth and income at each age of the child and 95% confidence intervals. Children are 45 years old in 2010 and 20 years old in 1985. Their wealth is measured as three year averages from 1984-1986 to 2009-2011. Parental wealth is the average of father’s and mother’s wealth averaged over the years 1984-1986. Percentile ranks are computed within each child cohort.

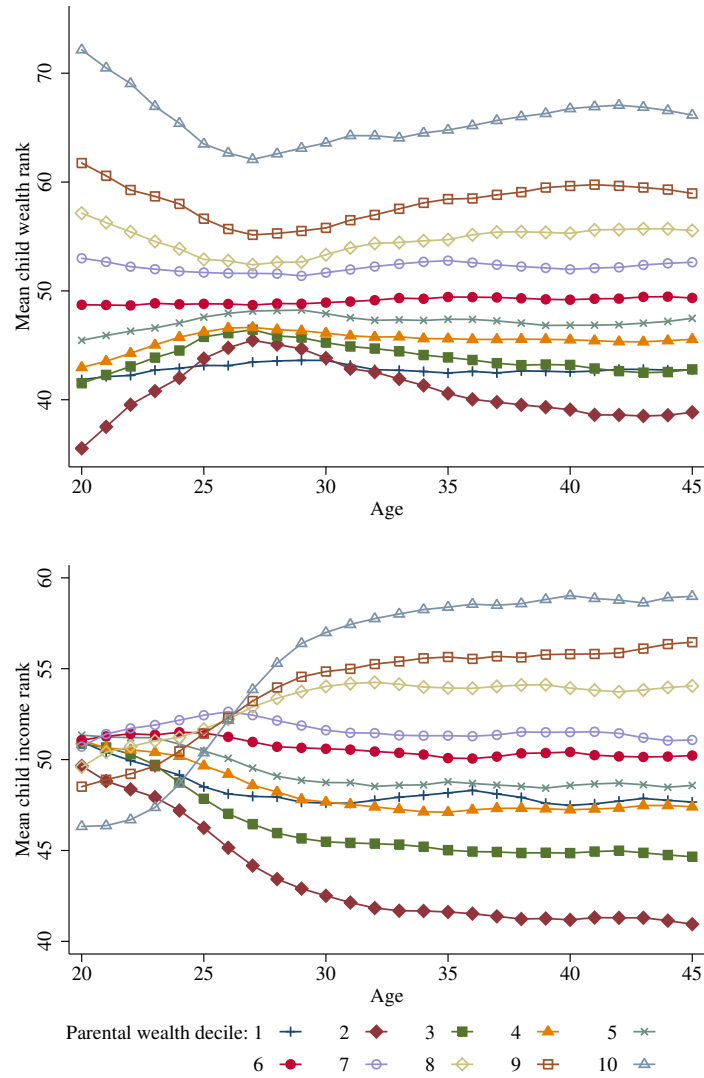
when the child is young is *not* driven by a high income of children with wealthy parents—implying that it has to be driven by *intervivo* transfers—and that children of wealthy parents have high permanent incomes.

Note, finally, that when looking at the patterns of wealth and income in Figure 5 over the stable life-cycle period from age 35 to 45 then parental wealth is a stronger predictor of the position of the child in the wealth distribution, with children being in the percentile range 38-67 in panel A, than in the income distribution, with children being in the percentile range 42-58 in panel B.

4.3 Role of bequests

In this section, we focus on the effects of bequests and the intergenerational correlation after death of parents. We do not have direct information of bequest, as described in Section 3, but employ an event study design where we look at child wealth before and after death of parents. Since Danish laws permit a spouse to retain undivided possession of the estate, wealth is normally not

Figure 5: Development in child wealth and income by deciles of parental wealth distribution



Notes: The two graphs show average rank of children for wealth and income, respectively, at each age of the child by deciles of parental wealth. Children are 45 years old in 2010 and 20 years old in 1985. Their wealth is measured as three year averages from 1984-1986 to 2009-2011. Parental wealth is the average of father's and mother's wealth averaged over the years 1984-1986. Percentile ranks are computed within each child cohort.

transferred to the next generation before death of both parents. We therefore focus the analysis on the sample of the children who have one living spouse in 2009, and divide the children into a treatment group where the parent dies in 2010, and a control group where the parent does not die in 2010. We continue to focus on the cohorts of children who are 45–50 years old in 2010 and continue to measure wealth of parents in 1984-86.

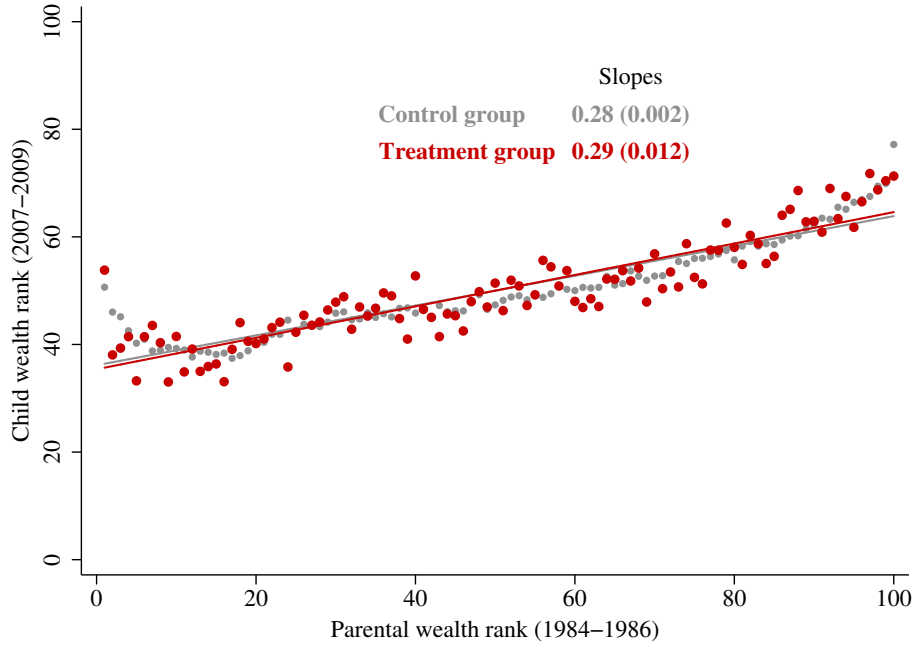
Note that, for this analysis, we compute the percentile ranks for each individual separately for the T-group and for the C-group. The reason is that we wish to measure the change in the intergenerational rank correlation within the T-group, which should not be mixed up with the effect that T-group children move up in the overall wealth distribution compared to C-group children where parents die later.

The graphs in Figure 6 are identical to our baseline graph in Figure 1, but instead of looking at the sample of children where parents are alive in 2010, we look separately at the T-group and the C-group of the new sample before (2007-2009) and after (2011-2013) death of the parent in the T-group. Panel A shows the result for the two groups before parental death. It reveals no systematic differences between the two groups and the rank correlations are almost identical and only a little higher than the 0.25 reported in Figure 1. In the period after parental death, panel B shows that T-group observations lie mostly below the C-group observations in the lower part of the diagram and mostly above in the upper part of the diagram, and the rank correlation increases to 0.37. The rank correlation for the C-group is nearly unchanged and the difference-in-difference estimate of the change in the rank correlation gives an increase of about 0.1 due to bequests, corresponding to an increase of 35 percent.

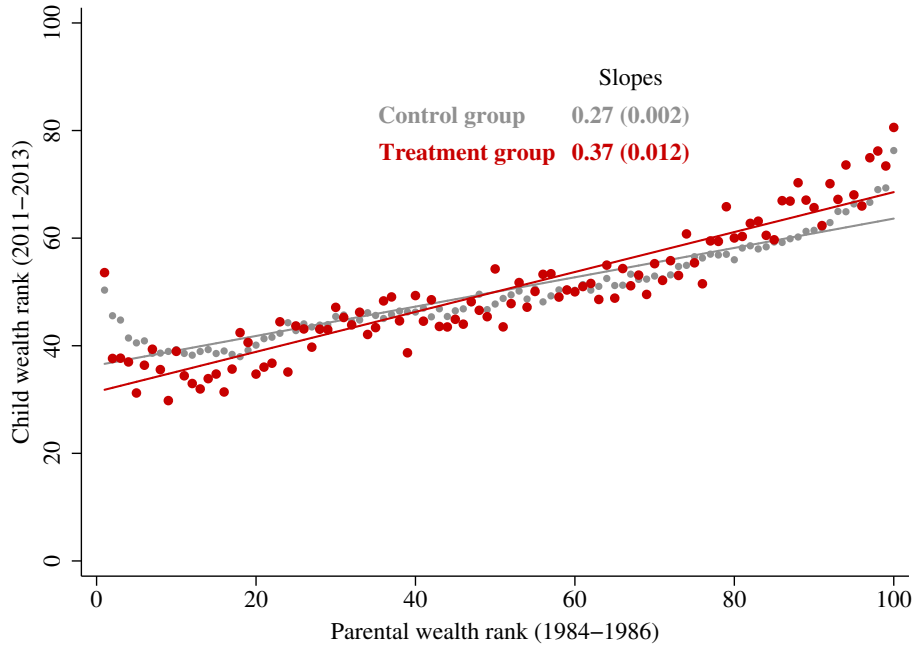
If this measurement, we cannot be sure that grandparents died before measuring parental wealth because we cannot observe grandparents of children this old. In Figure 7, we provide a sensitivity analysis where we instead measure parental wealth in 2007-2009, where parents are around 68-73 years old, making it unlikely that any of the grandparents are alive. In this case, pre-bequest correlations are 0.28 for both groups, and it is also 0.28 for the control group in the post-bequest period, while the intergenerational correlation coefficient of the T-group increases to 0.40.

Thus, our estimates of the intergenerational correlation measured in mid-life after receiving bequests are in the range 0.37-0.40. This level of intergenerational correlation is higher than any of the estimates obtained earlier in the life cycle (see panel A of Figure 4).

Figure 6: Impact of bequests on intergenerational rank correlation



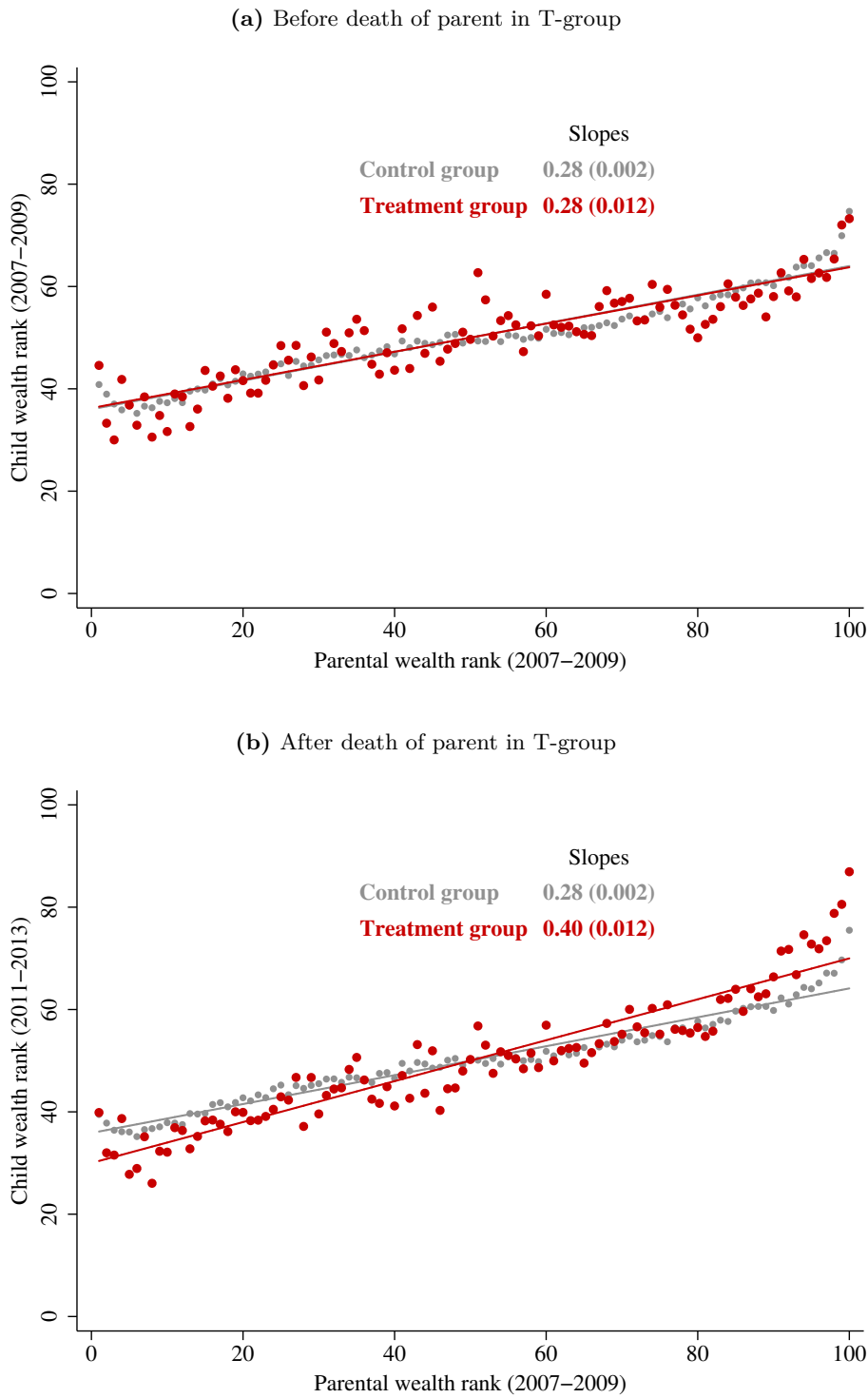
(a) Before death of parent in T-group



(b) After death of parent in T-group

Notes: The graphs are similar to Figure 1 but are made for different samples. The T-group is individuals who are age 45-50 in 2010, with one parent alive in 2009 and no living parents in 2010. The C-group is individuals who are age 45-50 in 2010, with one parent who is alive in 2009 and 2010. Panel A shows the mean percentile wealth rank based on average wealth of the child in 2007-2009 and by wealth percentiles of parents based on average wealth in 1984-1986. Panel B is similar to panel A, but the child rank is based on average wealth in 2011-2013. Percentile rank is computed within each child cohort. The OLS slopes, and their standard deviations in parentheses, reported in the figure are estimated using the underlying micro data.

Figure 7: Impact of bequests on intergenerational rank correlation: Parental wealth measured in 2007-2009



Notes: The graphs are similar to those in Figure 6, but are based on parental wealth measured in 2007-2009 instead of 1984-1986.

4.4 From correlation of wealth to correlation of lifetime resources

In our theoretical discussion, we showed that the intergenerational correlation of lifetime resources is equal to wealth correlation as long as both parents and children are measured at the same stage of the life-cycle and the bias in formula (3) is addressed. Figure 1 presents the correlation without addressing that bias. Our theoretical framework revealed that addressing the bias simply requires controlling for permanent income of parents and children (equation 4). Table 4 shows the corresponding results using the 45-50 year old cohort of children and their parents observed at approximately the same age. In the first two columns, we contrast the estimates of wealth and income correlation absent controls: the correlation of wealth is higher than the correlation of permanent income (measured as three-year average), but none of them may be interpreted as an estimate of the correlation of lifetime resources. These regressions correspond to equations (2) and (3), respectively, both of which are subject to the omitted variable bias. In the following two columns, we implement two variants of specification (4), controlling for parental and children income rank parametrically and non-parametrically. The estimated coefficient on parental wealth drops modestly to about 0.24. According to our theoretical framework, given that it relies on measurement of wealth at the same stage of life-cycle of parents and children, this is an estimate of the correlation in lifetime resources of parents and children. This estimate is significantly higher than our estimate of the correlation of lifetime income equal to 0.20. In appendix C, we redo the analysis with logarithmic and IHS transformations of the data, instead of the rank transformation. This gives an intergenerational elasticity of lifetime resources equal to 0.18-0.19 and an intergenerational elasticity of permanent income equal to 0.11-0.12, thus confirming the overall conclusion that the intergenerational relationship is significantly stronger for lifetime resources than for permanent income.

In appendix D, we show that controlling for permanent income has modest but stabilizing impact on the correlation of wealth measured at any age (an analogue of Figure 4).

In Table 5, we redo the analysis of bequest with income controls. This implies that the post-bequest estimate drops to 0.34. The large increase in the intergenerational wealth correlation following death of parents raises the question of whether our same-stage-of-life-cycle pre-bequest estimate of 0.24 does in fact measure the correlation of lifetime resources. Our theoretical framework does predict that the correlation should increase on receipt of bequests (this simply corresponds to a discrete jump in γ^t , which then equal one). Furthermore, it makes it clear that either wealth of

Table 4: Correlation of wealth and lifetime resources

	(1)	(2)	(3)	(4)
	Child wealth	Child income	Child wealth	Child wealth
Parental wealth rank (1984-1986)	0.272*** (0.002)		0.240*** (0.002)	0.235*** (0.002)
Parental income rank (1984-1986)		0.200*** (0.002)	0.004* (0.002)	
Child income rank (2009-2011)			0.191*** (0.002)	
Child and parent income percentile dummies				X
Observations	363,857	363,857	363,857	363,857
Adj. R-squared	0.074	0.040	0.110	0.114

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

both parents and children should be observed before bequest or they both should be observed after bequests. Unfortunately, limitations of our data do not allow for observing parents after bequests and our best approximation is to use observations 25 years later when grandparents are almost certain to have died but parents are much older. Hence, we do not have a clean estimate of the correlation in lifetime resources based on after-bequest observations.

What we know is that the large effect of bequests on impact reveals that bequests are quantitatively important. In fact, bequests are on average about 1/3 of pre-bequest children's wealth (Boserup, Kopczuk and Kreiner, 2016). However, children's wealth at ages 45-50 is only a fraction of lifetime resources: it does not account for income yet to be received (both during the remaining career and post-retirement) and it already nets out past consumption. Hence, while bequests have a large impact on wealth at that point, they are a much smaller component of lifetime resources.

5 Concluding remarks

This paper uses Danish administrative records to measure intergenerational correlation of wealth and propose an interpretation of the relationship to the correlation of lifetime resources. We show that the population correlation of wealth is about 0.27 and exceeds the correlation of lifetime income. This correlation evolves over the life-cycle in a way that reveals the importance of life-cycle patterns of income, consumption and transfers. It is very high at the beginning of the

Table 5: Bequest and the intergenerational correlation of wealth

	Child wealth rank			
	Before parental death (2007-2009)		After parental death (2011-2013)	
	Control group	Treatment group	Control group	Treatment group
	<i>A. No income controls</i>			
Intergenerational wealth rank correlation	0.277 (0.003)	0.295 (0.013)	0.273 (0.003)	0.375 (0.012)
	<i>B. Controlling for child and parental income</i>			
Intergenerational wealth rank correlation	0.231 (0.003)	0.256 (0.013)	0.238 (0.003)	0.342 (0.013)
Observations	135,335	5,708	135,335	5,708

Notes: ...

adulthood, revealing that inter vivos transfers are important. It then declines and starts to increase when people are around 30, consistently with life-cycle saving and borrowing dynamics. Finally, it increases very significantly following the receipt of bequests. This life-cycle variation raises the question of the relationship of these estimates to the correlation of lifetime resources and we propose a framework that makes this relationship clear. The correlation of wealth estimated while controlling for permanent income reflects the intergenerational correlation of lifetime resources but this correlation is moderated through terms that link current wealth to lifetime resources that evolve over the life-cycle. As the result, when parents and children are observed at different stages of their respective life-cycles, the observed correlation accounts for these differential relationship. Correspondingly, when both sides are observed at the same stage of the life-cycle, the correlation of wealth reveals the correlation of lifetime resources. Since we can observe both parents and children when they are in their 40s and pre-bequests, we obtain an estimate of the correlation of lifetime resources based on data at these points. This estimate is about 0.25. Due to data limitations, we cannot implement the precisely analogous procedure after bequests. The procedure we pursue generates a higher estimate of 0.34. This higher estimate may be due to the difference in the stage of life-cycle when parents and children are observed, but it may also indicate a departure from our baseline model and a higher elasticity of lifetime resources.

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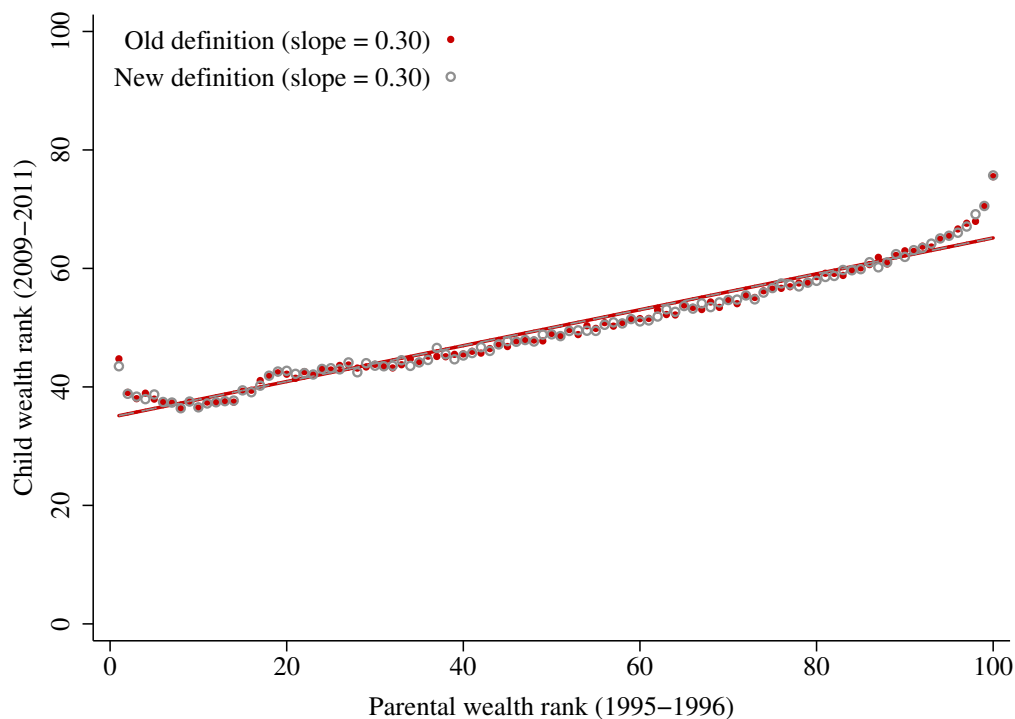
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A Impact of data break in year 1996

The graph below shows that the data break in 1996 is not important. Wealth definitions overlap in 1995-1996 and we obtain basically the same diagram and intergenerational rank correlation with both definitions.

Figure A.1: Influence of change in wealth definition on intergenerational rank correlation

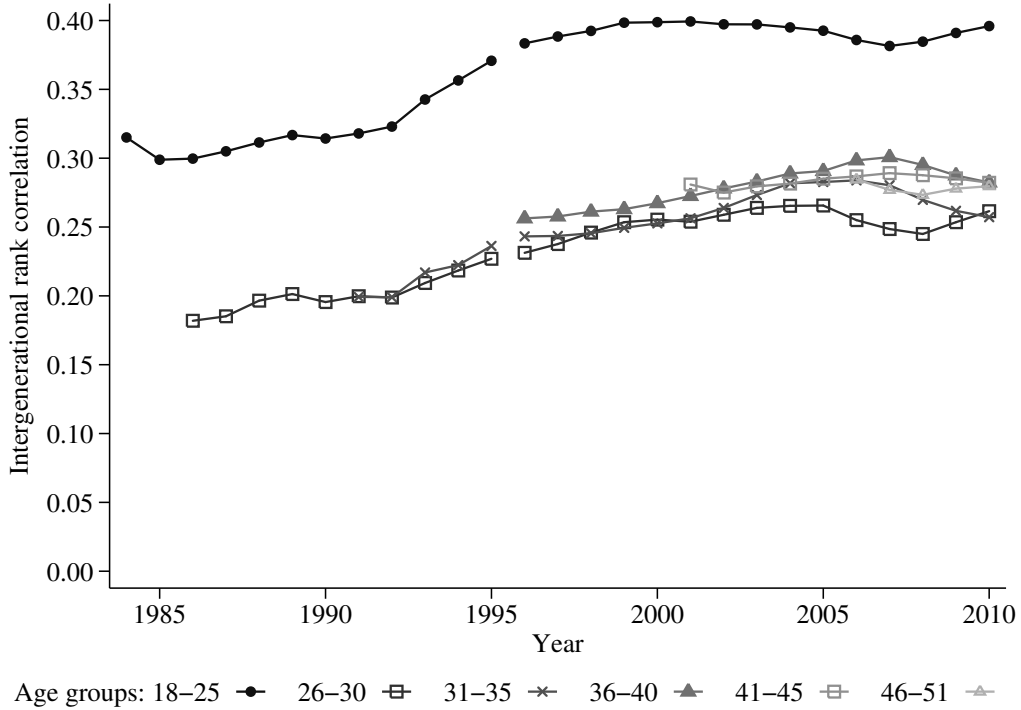


Notes: The wealth measures overlap in 1995 and 1996. The figure shows our baseline rank diagram when parental wealth is measured in 1995-1996 using the two different definitions of wealth.

B Robustness of U-shaped life cycle profile over time and across cohorts

In this graph, we measure children and parents at the same time (which we have to do because of data limitations), while in the others graphs we measure wealth of parents in 1984-1986. The graphs shows the correlation in wealth between children who are 18-25 years and their parents in the different years, using information from different cohorts over time in a repeated cross-section analysis. The graph shows that the correlation has increased somewhat over time. This could in principle be because of improvements in data quality. On the other hand, the large data break in 1996 does not seem to have any important effect on the results. An important conclusion from the graph is in the vertical dimension showing that the youngest group has the highest intergenerational correlation, then it drops down at the bottom for the next age group and then climbs somewhat up again. This mirrors the U-shaped profile in Figure 4.

Figure B.2: Intergenerational wealth correlation over time: repeated cross-section



Notes: In this diagram child wealth and parental wealth is measured in the same years using three-year averages (the observation for 1985 is computed using 1984-1986 data).

C Estimation of the intergenerational elasticity of lifetime resources

Tables C.1 and C.2 show the results, when we redo the analysis with logarithmic and IHS transformations of the data, instead of the rank transformation. This gives an intergenerational elasticity of lifetime resources equal to 0.18-0.19 and an intergenerational elasticity of permanent income equal to 0.11-0.12, thus confirming the overall conclusion that the intergenerational relationship is significantly stronger for lifetime resources than for permanent income.

D Impact of controlling for permanent income in Figure 4

The Figure below shows the impact of controlling for permanent income at any age — the implementation of regression specification (4) not just at the same stage of life-cycle as in Section 4.4 but rather varying age of a child as in Figure 4. The bias that permanent income control corrects for is due to the presence of the $-\nu_t^s u_{g-1}$ term in equation (3) and closer inspection of it reveals that the sign of ν_t^s may vary over the life-cycle. The figure shows that indeed correction of the bias increases the estimate of wealth correlation in late 20s and reduces it in the 30s and 40s so that the underlying direction of the bias changes sign. The revealed pattern of correlation over the life-cycle traces the value $(\alpha_e + \alpha_Q)b_t^s$. Given that the estimated bias-corrected correlation is approximately constant when children are in their 30s and 40s, this suggests that b_t^s is about constant over this

Table C.1: Estimates of intergenerational elasticity of lifetime resources: LOG transformation

	(1)	(2)	(3)	(4)
	Child wealth	Child income	Child wealth	Child wealth
Log parental wealth (1984-1986)	0.227*** (0.003)		0.205*** (0.003)	0.184*** (0.003)
Log parental income (1984-1986)		0.107*** (0.003)	0.039*** (0.004)	
Log child income (2009-2011)			0.342*** (0.006)	
Child and parent income percentile dummies				X
Observations	190,145	190,145	190,145	190,145
Adj. R-squared	0.043	0.010	0.084	0.117

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table corresponds to Table 4, but here we use logarithmic transformation of the wealth and income data instead of the rank transformation.

Table C.2: Estimates of intergenerational elasticity of lifetime resources: IHS transformation

	(1)	(2)	(3)	(4)
	Child wealth	Child income	Child wealth	Child wealth
IHS parental wealth (1984-1986)	0.215*** (0.002)		0.203*** (0.002)	0.190*** (0.002)
IHS parental income (1984-1986)		0.124*** (0.003)	0.141*** (0.008)	
IHS child income (2009-2011)			0.358*** (0.005)	
Child and parent income percentile dummies				X
Observations	363,857	363,857	363,857	363,857
Adj. R-squared	0.025	0.007	0.039	0.057

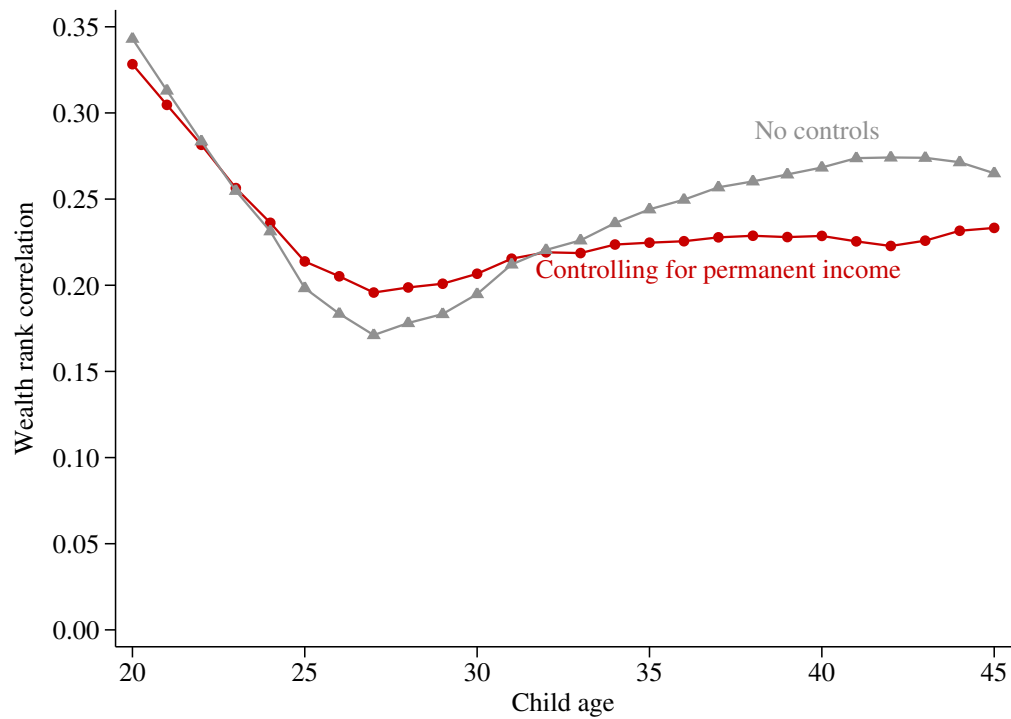
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table corresponds to Table 4, but here we use IHS transformation of the wealth and income data instead of the rank transformation.

range. Furthermore, given that this range includes $t = s$ (parents are measured when they are in their 40s) at which point $b_t^s = 1$, this suggests the estimate of the lifetime correlation is not very sensitive to the precise time when parental and children's wealth is observed, as long as it is measured in 30s or 40s.

Figure D.3: Rank correlation in wealth over the life cycle of the child: With and without income controls



Notes: This curve with income controls corresponds to the curve in Figure 4. The curve with income controls includes average income of the child in 2009-2011 and of the parents in 1984-1986 in the specification when estimating the intergenerational wealth correlation at each age of the child.