The housing channel of inter-generational wealth persistence*

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Abstract

In this paper we document the degree to which parental wealth transmits to the next generation through the housing market. We show that even after controlling for a rich set of observables, households with above median wealthy parents are almost one percentage point (=21%) more likely to enter the housing market in a given year and buy homes worth $41,000 (=20%) more upon entry. Evidence based on grandparent death and international stock market returns support a causal impact of parental wealth on housing market outcomes. With regard to mechanisms, we find evidence in support of cash transfers, parental home equity withdrawal, co-purchasing and intra-family house sales at discounted values. Using a life-cycle model with housing, we quantify how our results depend on expected and realized house price growth, as well as mortgage regulation. We find that especially expected house price growth is important for the strength of the housing channel of inter-generational wealth persistence.

Keywords: Housing market, inter-generational wealth, wealth inequality

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1 Introduction

Wealth inequality has increased substantially over the past decades, spurring a greater interest in the persistence of wealth across generations. This persistence is crucial, as i) inequality due to parental wealth is considered less fair than other types of inequality[1], and ii) high inter-generational persistence means that the recent increase in inequality will be long-lasting. In this study we focus on the *housing market* as a key driver of inter-generational wealth persistence, documenting how households with wealthier parents enter the housing market earlier, and how this contributes to higher wealth later in life.

To motivate why the housing market should be important for inter-generational wealth accumulation in Norway, consider a simple example. Imagine investing \$100 in either housing or stocks in the early 1990s. Crucially, and in line with the data, we let the housing market investment be levered. Twenty-five years later, the \$100 has grown to \$6,000 in the housing market, compared to \$4,600 in the stock market (and a mere \$1,500 in your deposit account).[2] In our simple example, the mortgage is paid down over time, yielding an average leverage of only 0.26. If we allow for refinancing, the housing return becomes *substantially* higher.

While the housing market pays an especially high return on equity – at a low risk – it also comes with some non-trivial barriers to entry. Housing is generally indivisible, and buying or selling a home entails sizable transaction costs. In addition, most countries enforce some sort of mortgage regulation, typically in the form of loan-to-value caps or debt-to-income caps. This means that households may be constrained from accessing this high-return asset. As a result, there is a natural role for affluent parents to support their children in entering the housing market.

In this paper, we use Norwegian tax data merged with housing transaction data from the Land Registry, to study the importance of parental wealth for housing market outcomes. We document substantial gaps in housing outcomes for households with above median wealthy parents relative to households with below median wealthy parents. Specifically, we show that households with richer parents are two percentage points (=50%) more likely to enter the housing market in a given period, buy homes worth \$75 000 (=33%) more upon entry, and are 17 percentage points (=33%) more likely to be homeowners at age 30. We proceed by making four distinct contributions to the existing literature.

Our first main contribution is to use a structural mediation framework to decompose the housing gaps into three components: a *pure parental wealth component*, an *other parental*

[1] See Alesina and Angeletos (2005).

[2] To make it a fair comparison, we assume that when investing in stocks or deposits, you get to invest an additional amount equal to the debt servicing costs of the mortgage each year. For detailed calculations, see Appendix C.

attributes component and a *household attributes component*. This is useful, as it allows us to determine not only the relative importance of different attributes and how this has changed over time, but also determine *why* certain attributes are important. Take household education as an example. Household education can be important in explaining housing gaps if i) there exists a large education gap across those with richer and poorer parents, and/or ii) if education has a large impact on housing outcomes. Our structural framework lets us separate between channel i), i.e. the gaps, and channel ii), i.e. the housing impacts.

Using the structural mediation framework, we find a very limited role for other parental attributes. The reason being that, once parental wealth is accounted for, the housing impacts of other parental attributes are modest in size. We do however find evidence in support of a large household attributes component. On average, household attributes can explain roughly half of the documented housing gaps. The most important household attributes are the probability of co-habitating, income and education, while location and financial wealth are considerably less important. Interestingly, co-habitation and education are important mainly because there are large gaps in these variables (channel i)), while income is important mainly because of its impact on housing outcomes (channel ii)).

Nearly half of the observed housing gaps are attributed to the pure parental wealth channel in the mediation analysis. This means that, even after accounting for a rich set of parental and household attributes, we still find that households with richer parents have a 21% higher probability of entering the housing market in a given year, buy homes worth 20% more upon entering the housing market, and are 13% more likely to be homeowners by age 30. While the impact on entry and homeownership rates has been relatively stable over time, the pure parental wealth impact on house purchase prices has roughly doubled over the past fifteen years.

Our second main contribution is to dwell further into the pure parental wealth channel, by using exogenous variation in parental wealth to identify the impact on housing outcomes, and by establishing some key mechanisms for *why* parental wealth matters for housing outcomes. First, to establish a causal impact of parental wealth on housing market entry, we use variation in parental wealth caused by grandparent death or international stock market returns. Second, in terms of mechanisms, we confirm the importance of traditional cash-transfers, as well as parental equity extraction. Due to our rich data – which includes unique housing id's – we can extend the transfer definition to also include direct house sales from parents to children (at a potential discount), and consider parent-child co-purchasing.

Using an event study setup, we document a sudden spike in both entry probabilities and parental wealth at the time of a grandparent death. The implied impact of parental wealth on entry probabilities is larger than the standard OLS-estimates, and we discuss several reasons why this may be the case, such as dynastic portfolio re-balancing and the special features of inherited wealth. Using the interaction between parental equity shares and international stock market returns as a shift-share instrument, we document impacts of parental wealth on entry probabilities quantitatively in line with the pure parental wealth component identified in the mediation analysis. This is consistent with a causal interpretation of the impact of parental wealth on housing.

In terms of mechanisms, we first document an especially large increase in liquid wealth for households with richer parents in the 1-2 years leading up to a house purchase. This increase can not be explained by higher wage income or portfolio re-balancing, and is likely to be driven by (parental) transfers. This is in line with previous literature – see below – documenting the importance of transfers at the time of entry into the housing market. Following Benetton, Kudlyak, and Mondragon (2022), we also show that parental equity extraction is positively correlated with household entry in the housing market. Moreover, we extend their results and document that the importance of this channel varies with parental wealth (also when conditioning on homeownership), as i) households with richer parents are more likely to have parents who extract equity at the time of entry, and ii) the correlation between equity extraction and entry is stronger for those with richer parents.

A mechanism which has received little attention in the literature – probably due to data limitations – is that of intra-family sales and purchases. We first show that parents are substantially more likely to buy a house in the year when their adult child enters the housing market, and that a large share of this excess purchase propensity is driven by parent-child co-purchasing. Moreover, the prevalence of co-purchasing differs considerably by parental wealth, with richer parents being almost 60% more likely to co-purchase with their child at the time of entry. Next, we document that parents are also much more likely to *sell* a house in the year when a child enters the housing market. Roughly 2/3 of the excess sale propensity at the time of entry is accounted for by parents selling a house directly to a child. Richer parents are 12% as likely to sell a house at the time of entry as poorer parents, and 8% more likely to sell a house directly to a child. These differences can be explained by a significant reduction in secondary housing for richer parents only.

Co-purchasing a house benefits the household as it relaxes borrowing constraints. However, buying a home directly from ones parents does not necessarily imply an economic benefit. While some intra-family sales are reported as gift-sales, the vast majority is reported as taking place at market value. However, market value is decided upon by a realtor, and can be influenced by the seller. To evaluate whether parents are selling houses to their children at a (non-reported) discount, we predict market values based on housing characteristics and compare the estimates to the reported sales price. Our results suggest that parents sell housing directly to their children at a discount of almost \$85,000 (=25%). As a result, intra-family house sales pose a substantial economic benefit.[3]

Our third main contribution is to use the same structural mediation framework as above, to quantify the housing channel of inter-generational wealth persistence. That is, we estimate the share of inter-generational wealth persistence which is working through the housing market. Specifically, we define inter-generational wealth persistence as the impact of having rich parents on the probability that the household itself will be rich at midlife. This persistence in wealth across generations is then decomposed into an other parental attributes component, a household attributes component, and a *housing* component. Note that it is not sufficient for the housing component to be important that there exists large housing gaps between those with richer and poorer parents (as documented above). In addition, housing outcomes must have substantial impacts on midlife wealth.

We find that households with richer parents are 15 pp (=35%) more likely to themselves be rich at midlife. Perhaps surprisingly, the *combined* impact of other parental attributes and household attributes can explain only somewhere between 10-20% of this inter-generational wealth persistence. The housing market channel however, can explain about 25%. This implies that households with richer parents are more than three percentage points, or roughly 10%, more likely to be rich themselves at midlife due to earlier and/or larger housing investments when young.

Our fourth – and final – main contribution is to analyze how our results depend on realized and expected house price growth and mortgage market regulation, using a life cycle model with housing. House price growth is potentially important for external validity, as Norway has experienced higher house price growth than, for instance, the United States. We do not model parents' choice of bequests, but instead consider a model where children inherit exogenously. We distinguish between purely monetary inheritance and transfers of innate characteristics. More precisely, our framework contains three different forms of inheritance. First, a lump sum transfer early in life, second, an annuity which is received as additional income every year, and third, a transfer of increased homeownership preferences. The size of these parental support measures are picked to generate a housing channel of inter-generational wealth persistence in line with the data. Although not targeted, the model also matches the documented housing gaps.

The model findings suggest that while realized house price growth has a modest impact on the housing channel, expected house price growth has a substantial impact. Consider

[3]The effects might be even larger, as parents can purchase and renovate, increasing the market value, before selling to their children, i.e. "reverse flipping". More generally, as any capital gains are taxed, a lower purchase price also lowers the tax payments of the parents.

first the case in which we keep expected house price growth unchanged. If we change *realized* house price growth from the Norwegian level to the US level – implying nearly a halving of the price growth – the housing channel of inter-generational wealth persistence falls by just above 20%. If we change both *expected and realized* house price growth however, the housing channel of inter-generational wealth persistence falls by just above 70%. This suggests that household behavior in *response* to house price growth is a key factor. Although our model results highlight the importance of (expected) house price growth, they does not imply that the Norwegian case is without external relevance. In fact, Knoll, Schularick, and Steger (2017) show that post-war real house price growth in Norway has been *exactly* equal to the cross-country average, and very similar to that in, for instance, Canada and the UK.[4]

We also find that downpayment requirements affect the housing channel of inter-generational wealth persistence. Intuitively, a higher downpayment requirement increases the barriers to entry in the housing market, making parental support more important. Increasing the downpayment requirement from 10 to 30 percentage points increases the housing channel of inter-generational wealth persistence by almost 20%. While downpayment requirements are intended to make households less vulnerable to adverse shocks, our model results illustrate the cost of doing so in terms of increased wealth persistence across generations.

Related literature

Our paper lies in the intersection of three distinct literatures, which together establish i) the persistence of wealth across generations, ii) the importance of parents for child housing market outcomes, and iii) the relevance of housing outcomes for later-in-life wealth.

First, several studies have documented that wealthy parents tend to have wealthy children. See for instance Chiteji and Stafford (1999), Charles and Hurst (2003), Boserup, Kopczuk, and Kreiner (2014), Black, Devereux, Lundborg, and Majlesi (2017), Adermon, Lindahl, and Waldenström (2018) and Fagereng, Mogstad, and Rønning (2021). In addition to documenting the correlation between parental wealth and child wealth, much of this literature has focused on differentiating between "nature" and "nurture", typically finding some support for both channels.

Second, a number of papers have shown that parents matter for children's housing market outcomes. Most of these studies — including Engelhardt and Mayer (1998), Guiso and Jappelli (2002), Luea (2008), Kolodziejczyk and Leth-Petersen (2013), Blickle and Brown

[4] To see this, subtract annual average inflation from annual nominal house price growth in Appendix Table A.5, and calculate the cross-country average. Doing so, we find that annual average real house price growth in Norway is 2.3%, which is exactly equal to the cross-country average. The outliers are Japan and France, with very high house price growth (above 4%), and the US, with very low house price growth (0.2%) – see Figure A.8.

(2019), and Brandsaas (2021) – focus on the impact of parental transfers on housing market entry. Relatedly, Benetton, Kudlyak, and Mondragon (2022) study the importance of parental home equity extraction, showing that children are more likely to enter the housing market in years when parents extract equity. Halvorsen and Lindquist (2017), Lee, Myers, Painter, Thunell, and Zissimopoulos (2020) and Bond and Eriksen (2021) document a positive correlation between parental wealth and entry into the housing market, while Daysal, Lovenheim, and Wasser (2022) show that changes to parental housing wealth increases child housing wealth in early adulthood.

Finally, there also exists a somewhat smaller literature establishing the importance of housing and mortgage decisions for wealth accumulation over the life cycle. Di, Belsky, and Liu (2007) and Turner and Luea (2009) show that homeownership status is important for wealth accumulation using PSID data, while Bach, Calvet, and Sodini (2020) use Swedish tax data and find that housing and mortgage choices taken while young are key determinants of a household's position in the wealth distribution at retirement. Relatedly, Bernstein and Koudijs (2020) document the "critical importance" of mortgage decisions for household wealth building. In this paper, we lean on the combined insights of these three literatures to quantify and decompose the housing channel of inter-generational wealth persistence.

2 Data

We use on Norwegian administrative data from Statistics Norway, merged with housing transaction data from the Land Registry. The former gives us household balance sheet information, and allows us to link parents and children. The latter gives us accurate information on housing transactions, and allows us to follow the ownership of specific houses over time, through unique housing id's. In this section we discuss sample selection and the measurement of key variables, and provide some summary statistics of especial interest.

Sample construction We start out with a sample of 3.4 million individuals aged 18 or above, for which we know the identity of their parents. We then keep only the individuals for which we observe parental wealth at age 20±1, meaning that both parents are alive and file taxes in Norway.[5] Because our tax data starts in 1993, this means that the oldest (child) individual included in our sample will be born in 1972. Not surprisingly, this reduces the number of individuals in our sample quite substantially.

We proceed by collapsing the data to the household level. Household identifiers are

[5]This implies that we do not restrict the sample to households whose parents are still alive at time t, but drop individuals whose parents were not alive when the individual was 20 years old.

available since 2004, and this is when we start our sample. Household age and household education are defined as the average value across all (adult) household members. Most other variables – such as income and wealth variables – are defined as the sum across all households members. This includes parental income and wealth variables. The individual house purchase value is defined as the purchase price times the ownership share. The household house purchase value is found by summing over the individual house purchase values. We define parents as living in a big city if at least one household member has parents living in a big city. Collapsing the data to the household level leaves us with 1.5 million households in the period 2004-2017.

Measurement of main variables Our main dependent variables are different housing market outcomes. Prior to 2010, we do not observe housing wealth directly, and so we define a household as a homeowner if it has real wealth above a minimum level, set to capture the value of the cheapest available housing. From 2010 and onward we observe housing wealth, and we define a household as a homeowner if it has above-zero primary housing wealth. Due to the improved measurement post-2010, we restrict some of our analysis to this period. We classify a household as entering the housing market in year t if i) the household purchases a home in year t, and ii) the household was not a homeowner in year $t-1$. House purchases, as well as purchase prices, are precisely measured in the housing transaction data.

We use two main measures of parental wealth, both of which capture gross financial wealth, but at different times. First, we construct a time-invariant parental wealth indicator p_i^{w20}, based on the three-year average of parental wealth around the time when the household is 20 years old. $p_i^{w20} = 1$ if parental wealth for household i is above the year-specific median, and zero otherwise. Second, we construct a time-varying indicator of parental wealth $p_{i,t}^w$, which is equal to one if parental wealth in year t is above the year-specific median.

We also use an indicator of "midlife" net household wealth, based on the sum of financial wealth and real wealth net of debt. As discussed above, the oldest (child) individual in our sample is born in 1972, making him or her 45 years old in 2017 – the last year of our sample. To ensure that we observe midlife wealth for a non-trivial share of our sample, we measure it at age 41±1. Hence, midlife wealth $\bar{w}_i = 1$ if net household wealth in the households early 40s is above the year-specific median, and zero otherwise.

For our event study on grandparent death, we consider the death of any of the grandparents for any of the (adult) members of the household, based on year-of-death data. For our stock market return instrument we rely on the interaction of stock wealth shares and international stock market returns. Specifically, we instrument for $p_{i,t}^w$ using stock-share$_{i,t-1} \times r_t$, in which stock-share$_{i,t-1}$ is measured as the share of non-deposit financial wealth relative to total financial wealth and r_t captures the return on the S&P500 stock market index.

Several control variables are included in the analysis. In terms of household characteristics, we typically control for average household age, total income, financial wealth, education, location and number of adult household members (i.e. co-habitation). Education is measured as the maximum education level obtained for an individual. When collapsing to the household level, we use the average of the individual education measures. Location is measured based on a dummy variable for whether the household currently resides in a big city. In terms of parental characteristics, we typically control for total income, average maximum education obtained, current location and number of children (i.e. number of siblings for the (child) household).

Summary statistics Summary statistics for the last year in our sample are provided by parental wealth status in Table 1. Not surprisingly, the parents of households who are richer at age 20 appear better off along most dimensions also in year 2017. On average, they have about ten times as much financial wealth, earn nearly twice as much in total income, and have an average maximum obtained education score of 5.1 compared to 4.5 for the less wealthy.[6]

In terms of household characteristics, those with richer parents have almost five times as much financial wealth and earn nearly 40% more. They are also somewhat more likely to be co-habitating, as the average number of adult household members is 1.4, compared to 1.2 for those with less wealthy parents. Perhaps surprisingly, there is no difference in the average number of siblings, although the standard deviation (not reported) is larger for those with less wealthy parents.[7]

[6] The education indicator variable takes values from 0 to 8, see the documentation from Statistics Norway: https://www.ssb.no/en/klass/klassifikasjoner/36/koder

[7] 1.7 siblings on average might seem high given the relatively low birth rates in Norway in recent decades. We note that this is for a sample of individuals born between 1972 and 1999, and should not be directly compared to the number of children per women, as i) the numbers reported here are conditional on having at least one child, and ii) half-siblings are counted as siblings (for instance, if two women have two children each with the same man, this will result in an average number of children per woman of 2, but will result in 2 siblings per child.)

	Full sample	Low parental wealth	High parental wealth
p^{w20}	0.5	0	1
Parent financial wealth$_t$ (USD)	310,000	56,000	600,000
Parent total income$_t$ (USD)	172,000	129,000	216,000
Parent max education	4.8	4.5	5.1
Financial wealth$_t$ (USD)	57,000	20,000	94,000
Homeowner$_t$ (%)	47	41	52
Total income$_t$ (USD)	59,000	50,000	68,000
Max education	4.6	4.3	4.9
Household members	1.3	1.2	1.4
Siblings	1.7	1.7	1.7
N	837,260	474,564	481,399

Table 1: Summary statistics 2017. Average values.

Notes: p^{w20}=1 if parental financial wealth at household age 20±1 is above the year-specific median and zero otherwise, parent financial wealth and parent total income is measured as the contemporaneous sum across all parents, parent max education is measured as the average across all parents, financial wealth and total income is measured as the sum across all adult household members, the homeownership indicator takes a value of one if at least one household member owns housing wealth and zero otherwise, max education is measured as the average across all adult household members, household members include the number of adult household members, siblings is the average number of siblings across all adult household members found by taking the average number of children per parent and subtracting one. All prices are in 2015-values. When converting from NOK to USD we use USDNOK=8.5.

3 Empirical strategy

In this section we outline our empirical strategy to estimate the impact of parental wealth on child housing outcomes. First, we describe the structural mediation framework we use to decompose the housing gaps in Section 3.1. Second, we discuss the sources of exogenous variation in parental wealth used to identify the pure parental wealth channel in Section 3.2.

3.1 The impact of parental wealth on housing market outcomes

Let housing market outcomes h_i depend on parental wealth when the household is aged 20±1, p_i^{20w}, other parental attributes p_i^o, household attributes x_i, and other factors grouped together in the error term η_i, as in equation (1).

$$h_i = \beta_0 + \beta_1 p_i^w + \beta_2 p_i^o + \beta_3 x_i + \eta_i \tag{1}$$

Given the expression for housing market outcomes in (1), the regression coefficient from regressing h_i on p_i^{20w} – that is $\frac{cov(h_i, p_i^{20w})}{var(p_i^{20w})}$ – is given by the expression in equation (2). Equation (2) is the key equation in our framework, and says that the impact of parental wealth on housing market outcomes (i.e. the left-hand side) consists of four channels; the pure parental wealth channel, the other parental attributes channel, the household attributes channel, and finally, any omitted variables correlated with parental wealth.

$$\frac{cov(h_i, p_i^{20w})}{var(p_i^{20w})} = \underbrace{\beta_1}_{\text{i)parental wealth}} + \underbrace{\beta_2 \frac{cov(p_i^o, p_i^{20w})}{var(p_i^{20w})}}_{\text{ii)parental attributes}} + \underbrace{\beta_3 \frac{cov(x_i, p_i^{20w})}{var(p_i^{20w})}}_{\text{iii)hh attributes}} + \underbrace{\frac{cov(\eta_i, p_i^{20w})}{var(p_i^{20w})}}_{\text{iv)unobservables}} \tag{2}$$

As discussed in the data section, we consider several different housing market outcomes, h_i. Specifically, we estimate the impact of parental wealth on entry probabilities, the purchase price upon entry, and homeownership indicators at age 30.[8] Parental wealth is as before an indicator for whether parental financial wealth exceeds the year-specific median when the (child) household is aged 20±1. For expositional reasons, equation (2) treats parental attributes and household attributes as standard variables. In practice, however, these are vectors. Appendix D extends equation (2) to vector notation. Parental attributes include education, income, location and number of children, while household attributes include age, education, income, location, wealth and number of adult household members.

In order to decompose the impact of parental wealth on housing market outcomes, we compute the components in equation (2) separately. First, we estimate equation (1) to obtain $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$. Second we regress p_i^o on p_i^{20w} to obtain $\frac{cov(p_i^o, p_i^{20w})}{var(p_i^{20w})}$ and regress x_i on p_i^{20w} to obtain $\frac{cov(x_i, p_i^{20w})}{var(p_i^{20w})}$. This means that in addition to quantifying each component, we can also decompose each component into two parts. The first part is the "gap", given by the covariance-variance part, while the second part is the "housing impact" given by the $\hat{\beta}$-coefficients. Take household attributes as an example. The household attributes channel will be large if i) there is a large gap in household attributes between those with richer and poorer parents (i.e. $\frac{cov(x_i, p_i^{20w})}{var(p_i^{20w})}$ is large) and/or household attributes has a large impact on housing outcomes (i.e. $\hat{\beta}_3$ is large). The results from the decomposition exercise are illustrated graphically and discussed in depth in Section 4.

[8]For purchase price upon entry and homeownership indicators at different ages, there is no time-variation within a household. For entry probabilities however, the h_i in equation (2) changes to $h_{i,t}$, in which case also $p_{i,t}^o$, $x_{i,t}$ and $\eta_{i,t}$ have time subscripts.

The outlined analysis implicitly assumes that $cov(\eta_i, p_i^{20w}) = 0$. If this is not the case, the $\hat{\beta}$-estimates might be biased. While we are able to include a large number of important control variables as part of our parental and household attributes, there might still be unobservable variables which impact housing market outcomes and are correlated with parental wealth. Examples of such variables include preferences, such as risk aversion, which we do not observe. Preferences might plausibly be correlated across generations, and could impact housing market outcomes beyond any impact working through income, education, wealth and demographics. In order to identify the causal impact of parental wealth on housing market outcomes, we explore sources of plausibly exogenous variation in parental wealth, as discussed in the upcoming section.

3.2 Identifying the pure wealth channel

In order to account for potential omitted variables in equation (1), we consider two different measures of parental wealth. First, we use grandparent death as a source of variation in parental wealth in an event study setup. Grandparent death is as good as randomly distributed across the parental wealth distribution, but represents a special form of highly liquid "dynastical wealth". Second, we instrument for parental wealth using the interaction of stock market wealth shares and international stock market returns as a shift-share instrument, relying on the exogeneity of the latter.

3.2.1 Grandparent death

We start by documenting that entry probabilities and parental wealth spike at the time of grandparent death, by estimating the simple event-study regression outlined in equation (3) with $y_{i,t} = \{entry_{it}, p_{i,t}^w\}$. Note that parental wealth now has a time subscript, and measures whether or not contemporaneous parental financial wealth is above or below the year specific median. The reason being that that the death of a grandparent induces an immediate and typically short-lived increase in contemporaneous parental wealth, without generally affecting parental wealth when the (child) household is aged 20.

Event-time dummies δ_k capture the time to grandparent death (k=0), while δ_t represents year fixed effects. We also document that grandparent death has a positive impact on household transfers, by estimating equation (3) with $y_{i,t} = \text{total income}_{i,t}$. The reason being that some of the inheritance from grandparents is channeled directly to the grandchildren. This, of course, highlights the importance of controlling for household transfers in the analysis.

$$y_{i,t} = \alpha + \sum_{k \neq -3} \delta_{i,k} + \delta_t + \epsilon_{i,t} \tag{3}$$

If we use grandparent death as a traditional instrument, it must satisfy the exclusion restriction, which says that grandparent death should only affect entry into the housing market through parental wealth, conditional on control variables. The validity of this assumption relies on our interpretation of inherited wealth and intra-dynasty wealth allocation. First, the death of a grandparent is generally going to increase not only parental wealth, but also the compsition of parental wealth. If inherited wealth is special, i.e. more liquid or more likely to be passed on to ones children, this will influence the results. Second, one might view grandparent death as simply a re-shuffling of dynasty wealth, rather than an increase in wealth for the parent generation.

Even if the exclusion restriction is satisfied, it is worth considering the difference between the average treatment effect (ATE) and the local average treatment effect (LATE) in our setting. Note that not everyone will be affected by grandparent death as an instrument for parental wealth. As inheritances are always positive, only households who at baseline have below median parental wealth, but whose parental wealth increases due to the death of a grandparent, will be compliers in this setup. That is, households with richer parents will never be affected by the instrument. Also, only those who receive sufficiently large inheritances to shift them from below median parental wealth to above median parental will be affected. That is, relying on grandparent death as an instrument, implies estimating the impact of parental wealth on entry probabilities based on households with initially poorer parents who receive large inheritances. This is a particular group, and could imply that the LATE is quite different from the ATE.

For the reasons outlined, we prefer to use grandparent death as an event study, simply documenting that at the time of the death of a grandparent, we see a statistical and economically significant spike in both parental wealth and entry probabilities. However, it is also possible to interpret it as a standard instrument, obtaining the instrumented increase in parental wealth by dividing the reduced form estimates by the first stage. The OLS-estimates, the reduced form estimates and the first-stage estimates are reported and discussed in Section 4.

3.2.2 Stock market shocks

The return on the international stock market creates plausibly exogenous variation in parental wealth. We instrument for parental wealth using lagged parental stock share times the return on the S&P 500 index r_t. The first stage is reported in equation (4). Note that we do not require parental stock shares to be exogenous, rather we rely on the exogeneity of the international stock market returns for identification. Identification by exogenous "shifts" rather than "shares" in shift-share instrument analyses is discussed in detail in Borusyak, Hull, and Jaravel (2022).

$$p^w_{i,t} = \alpha + \beta_1 \text{stock-share}_{i,t-1} \times r_t + \beta_2 p^o_{i,t} + \beta_3 x_{i,t} + \epsilon_{i,t} \tag{4}$$

$$h_{i,t} = \alpha^{IV} + \beta_1^{IV} \hat{p_{i,t}}^w + \beta_2^{IV} p^o_{i,t} + \beta_3^{IV} x_{i,t} + \epsilon^{IV}_{i,t} \tag{5}$$

Once we have the instrumented parental wealth, we use this to estimate equation (5). As with the above event study, it is useful to consider the type of parental wealth we capture with the stock market instrument, and who the compliers will be. Starting with the former, stock wealth is likely to be less "special" than inherited wealth, as it is wealth that parents are more likely to have earned themselves, and does not represent dynastical wealth. We therefore expect smaller effects than in the case of grandparent death. With respect to compliers, the stock market return can be both negative and positive, meaning that compliers can experience both a reduction and an increase in parental wealth. This is again different than in the above case, implying that a larger subset of the population can potentially be compliers. All else equal, we would therefore expect smaller differences between the average treatment effect and the local average treatment effect in this case.

4 Empirical results

In this section, we document substantial gaps in housing outcomes between those with richer and poorer parents. In Section 4.1, we decompose these gaps into a pure parental wealth component, an other parental attributes component and a household attributes component, in accordance with equation (2). In Section 4.2, we use grandparent death and stock market returns as a source of exogenous variation in parental wealth to causally identify the pure parental wealth impact on housing market outcomes.

4.1 Decomposing the gap in housing outcomes

Entry probability Figure 1 depicts average entry rates for households with above and below median parental wealth over time. Entry is only defined for those not in the housing market (entry=0) or those entering the housing market in a given year (entry=1). Focusing first on the black solid and dashed lines, we see that those with richer parents always have a higher entry probability than those with poorer parents. Note that the average difference is given by the left hand side of equation (2), i.e. $\frac{cov(h_{i,t}, p_i^{20w})}{var(p_i^{20w})}$ with $h_{i,t} = entry_{i,t}$. In the beginning of our sample, those with richer parents are just above one percentage point more likely to enter the housing market each period. That is, they are almost 50% more likely to enter the housing market than those with poorer parents. By the end of our sample, this difference has increased to two percentage points, or just above 50%.

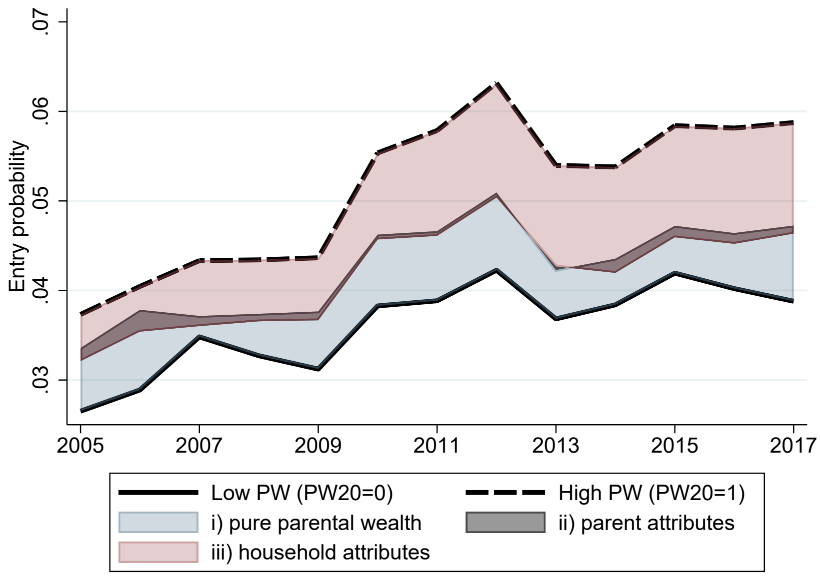


Figure 1: Entry probability by parental wealth: decomposed into channels i)-iii) as in equation (2)

Notes: $h_{i,t}$ is an indicator variable for entering the housing market. $p_i^{w20} = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of hh members. Sample consists of potential entrants and entrants in the housing market.

The gap between the solid black line and the dashed black line can be decomposed into a pure wealth component, a parent attributes component and a household attributes component, in accordance with equation (2). The household attributes channel, captured in red, reflects the importance of household income, financial wealth, location, education and number of adult household members. At the start of our sample, the household attributes channel explains roughly 1/3 of the entry probability gap. By the end of our sample, the household attributes channel has grown to roughly 60%.

We further decompose the household attributes channel in Figure A.2 in the appendix. The most important household attribute is the number of adult household members, followed by household education and income, which are of roughly equal importance. This is driven by i) households with richer parents being more likely to co-habitate, and having higher income and education, and ii) these attributes being important for entry into the housing market. The increase in the household attributes channel over time is mostly driven by an increase in the importance of education and the number of adult household members. Interestingly, the increasing importance of education is driven entirely by education becoming more important for entry into the housing market (i.e. higher impact), while the increasing importance of number of household members is driven entirely by a stronger correlation between parental wealth and the probability of co-habitating (i.e. higher gap).

In contrast to the household attributes channel, other parental attributes explain very little of the entry gap – see the gray component in Figure 1. That is, the correlation between parental wealth and housing market entry does not seem to be working through other parental characteristics such as parental income, education, location or the number of siblings (i.e. number of children for the parent household). That is not because these other parental attributes are not correlated with parental wealth, but because their impact on housing market entry – once parental wealth is controlled for – is limited.

Finally, the pure parental wealth component, captured by the blue area, accounts for more than 45% of the entry gap on average, and 40% in the final year of our sample. That is, by the end of our sample, even when controlling for a rich set of household and other parental characteristics, those with richer parents are still 0.8 percentage points or 21% more likely to enter the housing market in a given year.

The results in Figure 1 are based on a static parental wealth ranking done when the household is 20±1 years old. We have redone the analysis using instead a parental wealth ranking based on parental wealth in year $t-1$. The results – depicted in Figure A.1 – are very similar.

To summarize, the entry probability gap between those with richer and poorer parents has been increasing over time. By the end of our sample, households with richer parents are roughly 50% more likely to enter the housing market in any given period. Controlling for household attributes and other parental attributes can explain less than 60% of this gap.

House purchase price Conditional on entry, another important margin of adjustment is the purchase price. Figure 2 depicts the purchase price upon entry (in mill. 2015-NOK) by parental wealth. That is, only households which enter the housing market in the given year are included in the sample.

By the end of our sample, those with richer parents buy homes worth approximately 600,000 NOK (≈ 75 000 USD) more when entering the housing market. This means that those with richer parents buy homes worth 33% more than those with poorer parents upon entry. The purchase price gap has doubled in absolute terms over the time period, and has increased somewhat also in percentage terms.

Household attributes are somewhat less important in explaining the purchase price gap than the entry gap. By the end of our sample, the household attributes channel can explain about 40% of the purchase price gap, compared to 60% for the entry gap. The number of adult household members is again the most important household attribute – see Figure A.4 in the appendix. It is worth pointing out, however, that this is because we measure house values as the sum of house values across all household members (i.e. the sum of purchase price times the ownership share for all household members). On average, a couple household will own more housing wealth than a single household. Because the probability of co-habitating is larger for those with richer parents, household size becomes an important driver. Household income and education are also important, as was previously the case. Not surprisingly, location – which was not important for explaining the entry gap – is more important for explaining the purchase price gap.

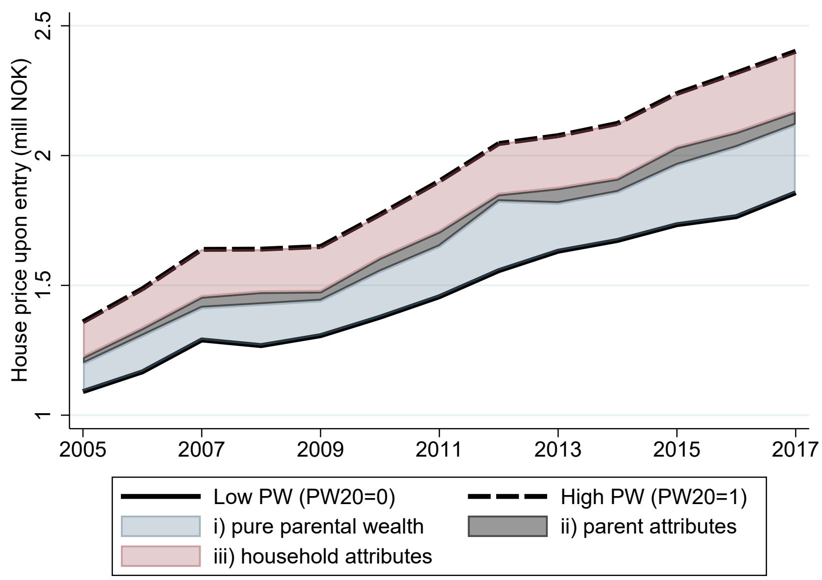


Figure 2: House purchase price by parental wealth: decomposed into channels i)-iii) as in equation (2)

Notes: h_i is house purchase price upon entry. $p_i^{w20} = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of adult hosuehold members. Sample consists of only households entering the housing market.

Other parental attributes are, as before, not important drivers of the purchase price gap. This leaves a large role for the pure parental wealth gap, which accounts for almost 60% of the observed difference between purchase prices for those with above or below median wealthy parents. That is, even after controlling for a rich set of observables, households with richer parents buy homes worth an additional NOK 350,000 ($\approx$ 20%) when entering the housing market. Note that the pure parental wealth channel has roughly doubled in size over the sample period. Figure A.3 confirms that the results are very similar when using lagged parental wealth at time of entry rather than parental wealth at age 20±1 when constructing the parental wealth rankings.

Homeownership rate at 30 Entry probabilities are only available for those who are not in the housing market in $t-1$, while house purchase price upon entry is only available for those who we observe entering the housing market. Homeownership rates at a given age, on the other hand, are available for everyone who we observe at this age, thereby also potentially including households who never enter the housing market. Here we show how homeownership rates at age 30 vary with parental wealth, using only households with an average age of 30 in a given year. The same exercise can of course be done for any other age. As illustrated in Figure A.7, homeownership rate gaps tend to peak at around 30, so we would expect somewhat smaller effects at other ages.

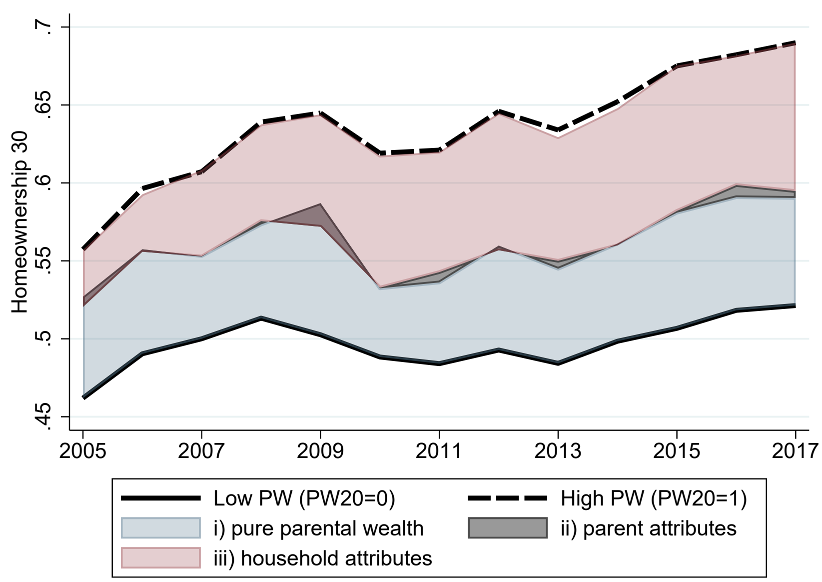


Figure 3: Homeownership rate at 30 by parental wealth: decomposed into channels i)-iii) as in equation (2)

Notes: h_i is homeownership rate at 30. $p_i^w = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of adult household members. Sample consists of only 30-year old households.

The homeownership rate gap at 30 has increased quite substantially over time, as seen in Figure 3. By the end of our sample, almost 70% of households with richer parents are home owners, compared to just above 50% of households with poorer parents. This translates into a homeownership rate gap of 17 percentage points or 33%.

In terms of decomposing the homeownership rate gap, the relative size of the different components are similar to the entry probability gap. The importance of household attributes increases over time, accounting for more than 50% of the homeownership gap by the end of our sample. The relative importance of the different household attributes is however quite different – see Figure A.6. Household income is by far the most important component, leaving a smaller role for the number of adult household members and education.

As before, other parental attributes are not quantitatively important. As a result, the pure parental wealth component can account for nearly 50% by the end of the sample. This implies that, after controlling for a rich set of observables, households with richer parents are still about seven percentage points or 13% more likely to be homeowners at age 30 than households with poorer parents.

4.2 Identifying the pure parental wealth channel

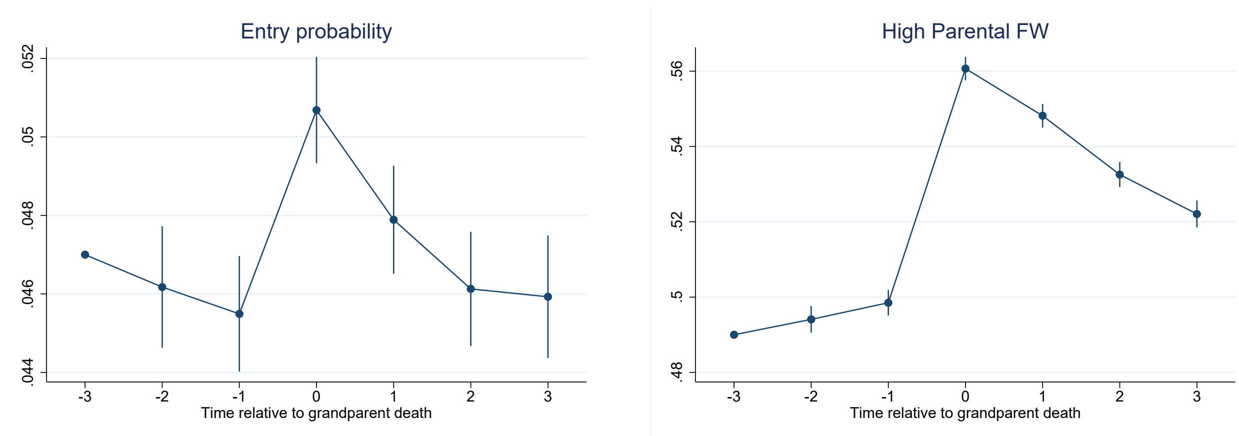
So far, we have studied the impact of parental wealth on housing market outcomes, controlling for a rich set of other parental attributes and household characteristics. However, in the presence of omitted variables or other threats to identification, exogenous variation in parental wealth is necessary to establish the causal impact of parental wealth on housing market outcomes. Here we consider two separate sources of plausibly exogenous variation in parental wealth: grandparent death and international stock market returns.

4.2.1 Event study: Grandparent death

We start by showing that grandparent death has a substantial and visible impact on both entry probabilities and parental wealth in an event study setup, following equation (3). In this sample, we only include households for which we observe at least one grandparent death. As a baseline, we use all grandparent deaths. If the wealth of the first deceased grandparent is mostly inherited by the spouse, one could imagine larger effects on parental wealth and entry probabilities from the second grandparent death. However, the results are not sensitive to whether we use all grandparent deaths or only the death of the ”final grandparent” on one side of the family.

As seen from Figure 4a), the probability of entering the housing market increases by approximately 0.4 percentage points or 9% in the year of a grandparent death. The effect decreases, but is still significant in the following year. At the same time as entry probabilities increase, there is also a sharp increase in the share of households who have richer parents. See

Figure 4b). The share of households with high parental wealth increases by six percentage points or 12% in the year of a grandparent death. This effect is more persistent, falling steadily over time. Four years later, about 2/3 of the increase has been reversed.



(a) Entry probability in housing market

(b) High parental wealth indicator

Figure 4: Event study around grandparent death (t=0)

Notes: Entry: $entry_{i,t} = 1$ if household i purchases a house in year t and did not own housing in year $t-1$, $entry_{i,t} = 0$ if household i household i did not purchase a house in year t and did not own housing in year $t-1$. Parental wealth: $p_i^w = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, and zero otherwise. Sample consists of households for which we observe at least one grandparent death.

Figure 4 shows a strong reduced form relationship between grandparent death and entry probability, and a strong relevance of grandparent death for parental wealth. Importantly however, grandparent death also affects other balance sheet items, such as total household income. The reason being that households on average receive cash transfers when a grandparent dies, either as a direct inheritance, or as a parental transfer. In the upcoming analysis we control for this, but acknowledge that there might be measurement error due to us only observing balance sheet items at an annual frequency.

We start by estimating the reduced form impact of grandparent death on entry probabilities. With control variables, the event of a grandparent death increases the entry probability by 0.3 percentage points or 5% in the same year, as seen from Column 2 of Table 2. The impact on parental wealth is reported in Columns 3-4. With controls, the event of a grandparent death increases the contemporaneous probability of having parents with above median wealth by 3.3 percentage points or 7%.

	(1) P(entry)	(2) P(entry)	(3) FW-P^{high}	(4) FW-P^{high}	(5) P(entry)	(6) P(entry)
GP^{death}	0.404***	0.251***	4.69***	3.28***		
	(0.0369)	(0.0367)	(0.0845)	(0.0559)		
FW-P^{high}					2.25***	0.841***
					(0.0277)	(0.0472)
N	2.5m	2.4m	2.5m	2.5m	2.5m	2.5m
Mean	4.93	4.93	47.3	47.3	4.93	4.93
HH fixed effects	No	Yes	No	Yes	No	Yes
Controls	No	Yes	No	Yes	No	Yes

Table 2: The impact of grandparent death on entry and parental wealth.

Notes: Entry: $entry_{i,t} = 1$ if household i purchases a house in year t and did not own housing in year $t-1$, $entry_{i,t} = 0$ if household i household i did not purchase a house in year t and did not own housing in year $t-1$. Parental wealth: $p_i^w = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, and zero otherwise. Sample consists of households for which we observe at least one grandparent death.

In order for grandparent death to be a valid instrument for parental wealth, there must be no other channels in which grandparent death affects entry probabilities, conditional on the included control variables. As we discuss below, this assumption might not hold, and we prefer to think of the grandparent death analysis as an event study rather than an IV-analysis. That being said, the implied IV estimates can be obtained by dividing the reduced form results in Column 2 by the first stage results in Column 4. Scaling the reduced form results, we find that a one percentage point increase in the parental wealth indicator increases the entry probability by 7.7 percentage points. This is a big effect, and implies an increase in entry probabilities of more than 150%. For comparison, the last two columns of Table 2 provide the OLS-estimates. With controls, the OLS-estimates suggest that a one percentage point increase in the parental wealth indicator increases the entry probability by 0.8 percentage points.

Why are the implied IV-estimates so much larger than the OLS-estiamtes? First, there might be negative bias in the OLS-estimates, which cause us to underestimate the impact of parental wealth on entry. However, such a bias would have to be implausibly large to fully account for the difference. Second, ”compliers” might be special. That is, the households which obtain higher parental wealth as a result of grandparent death might have especially large impacts on entry into the housing market. This could be the case, as these households must initially have below median parental wealth, and the parents must receive sufficiently large inheritances to "tip them over" to the other side of the median. However, we have redone the analysis using only those with parental wealth in the second and third quartile, or using a continuous parental wealth measure, and the results are unchanged.

Third, it could be that inherited wealth is special, and that parents are more likely to spend it in support of their children's housing market outcomes. This could for instance be the case if parents to a larger extent view inherited wealth as belonging to the dynasty rather than to themselves. Finally, one could argue that grandparent death does not represent a shock to parental wealth, so much as a shock to dynastic portfolio composition. This argument relies on children holding a claim to their parents wealth. Legally, children are guaranteed an inheritance of 2/3 of their parents wealth, but only up until 1 mill NOK, or about $125,000. For parents with large wealth holdings therefore, the share of wealth which their children are legally guaranteed to inherit is small. In addition, the older generation are of course always at liberty to consume their wealth before they die. Even though the legal justification is not waterproof, many households probably expect to inherit at least part of their parents wealth.

4.2.2 Instrument: Stock market return

In this section we use the interaction of parental stock wealth shares and international stock market returns as an instrument for parental wealth. The parental stock share has a median value of 0.21 and a mean value of 0.30, while the annual stock market return varies from -24% in 2008 to 18% in 2012. The stock market measure can therefore both decrease and increase parental wealth.

The regression results are reported in Table 3. Column 1 reports the OLS results, indicating that a one percentage point increase in the parental wealth indicator increases the entry probability by 1.3 percentage points. This is somewhat larger than in the previous Table 2, which was based on a much smaller, and younger, sample. The reduced form results are reported in the second column, while the first stage results are reported in the third column. As seen from the table, a larger interaction term between parental stock wealth and international stock market returns significantly increases both the entry probability and the probability of having richer parents.

	(1) P(entry)	(2) P(entry)	(3) $p^w_{i,t}$	(4) P(entry)	(5) P(entry)
$p^w_{i,t}$	0.0131***			0.0189***	0.0204***
	(0.00156)			(0.00180)	(0.00167)
stock-share$_{i,t-1} \times r_t$		0.0166***	0.875***		
		(0.00187)	(0.0838)		
Model	OLS	OLS	OLS	IV	IV
N	3,955,433	3,955,433	3,955,433	3,955,433	3,955,433
Clusters	1,043,389	1,043,389	1,043,389	1,043,389	1,043,389
Mean	0.0438	0.0438	0.457	0.0438	0.0438
Standard controls	Yes	Yes	Yes	Yes	Yes
HH stock share interaction	No	No	No	No	Yes

Table 3: IV-analysis: stock market return.

Notes: Entry: $entry_{i,t} = 1$ if household i purchases a house in year t and did not own housing in year $t-1$, $entry_{i,t} = 0$ if household i household i did not purchase a house in year t and did not own housing in year $t-1$. Parental wealth: $p^w_i = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, and zero otherwise. Instrument: stock-share is the share of non-deposit financial wealth, r_t is the annual return on the S&P 500.

Scaling the reduced form results by the first stage results gives the same estimate as the IV-estimate reported in Column 4. It says that a one percentage point increase in parental wealth – resulting from the stock market return measure – increases entry probabilities by 1.9 percentage points. Note that, although the IV-estimate again exceeds the OLS-estimate, the difference is much smaller than in the previous section and the 95% confidence intervals overlap. These results are therefore consistent with there not being any sizable bias in the OLS-estimates.

While we control for household financial wealth, one might worry that households with high parental wealth have a higher stock share, making them more likely to enter the housing market exactly in the years with high stock market returns. In Column 5 we explicitly control for the interaction of (child) household stock market shares and international stock market returns. This increases the estimated impact of parental wealth only slightly.

5 Mechanisms

So far, we have documented the importance of parental wealth for housing outcomes. In this section we explore the mechanisms for *why* parental wealth matters. In line with previous literature, we find support of financial transfers and parental equity extraction positively affecting entry rates, and further show that these effects are larger for those with richer parents. In addition, we provide novel evidence on co-purchasing, as well as direct sales from parent to child at heavily discounted prices.

5.1 Financial transfers

Several papers have documented that transfers are important for entry into the housing market. While it seems plausible that more affluent parents are both more likely to provide transfers and provide larger transfer conditional on doing so, few papers study how transfer vary with parental wealth. We provide evidence consistent with the importance of transfers, and document that the magnitudes are larger for those with richer parents.

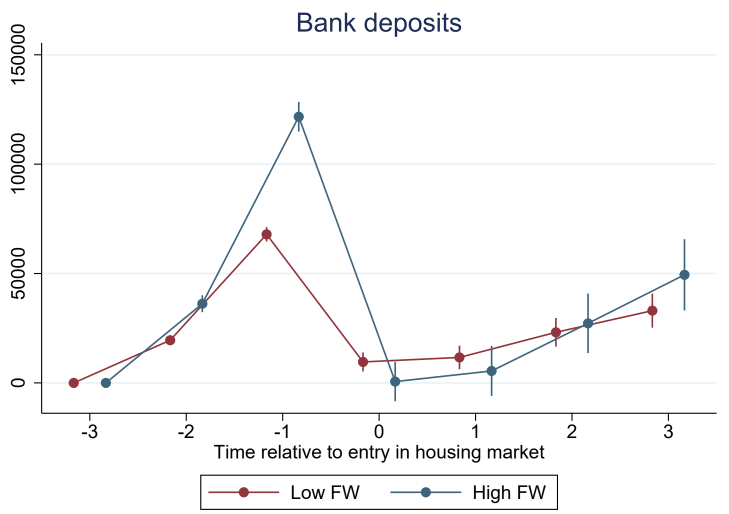


Figure 5: Bank deposits (NOK). Event study around housing market entry (t=0)

Notes: Entry: $entry_{i,t} = 1$ if household i purchases a house in year t and did not own housing in year $t-1$, $entry_{i,t} = 0$ if household i household i did not purchase a house in year t and did not own housing in year $t-1$. Parental wealth: $p_i^w = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, and zero otherwise.

Figure 5 depicts the results from an event study on the evolution of bank deposits around a house purchase by parental wealth.[9] In the year prior to the house purchase, bank deposits increase substantially for both groups. This increase is reversed in the year of purchase, suggesting that the additional bank deposits are being used as downpayment to buy a house. Households with richer parents increase bank deposits by roughly NOK 120,000

[9]The large increase in bank deposits prior to a purchase is consistent with the results in Aastveit, Juelsrud, and Wold (2022), but there we do not condition on parental wealth.

(=$15,000), while households with poorer parents increase bank deposits by roughly NOK 70,000 (=$9,000). However, relative to average deposit holdings for the two groups, the increase is comparable.

The increase in deposits could result from lower consumption, portfolio rebalancing or increased income. While we do not observe consumption in the tax data, we note that the increase is probably too large to be due solely to reduced consumption. Another possibility is that households reduce their holdings of other financial assets or real wealth, i.e. portfolio rebalancing. However, we do not see any evidence of this in the data. As a result, much of the observed increase in bank deposits is likely to result from higher income. We do not observe substantial increases in wage income or capital income. While we do see some increase in total income, it is not enough to explain the increase in bank deposits, and it is similar across parental wealth groups. There is, however, reason to believe that transfer income – which should be included in total income – is poorly measured in our data, as it is self-reported (in contrast to other balance sheet items), and only formally required if exceeding NOK 100,000.[10] We therefore find it likely that transfers play an important role in explaining the observed pattern in Figure 5.

5.2 Parental equity extraction

Benetton, Kudlyak, and Mondragon (2022) show that households are more likely to enter the housing market in a year when parents extract home equity. We find evidence of a similar effect in the Norwegian data. Moreover, we show that the importance of this channel differs between those with richer vs. poorer parents - also when conditioning on homeownership. Hence the home equity channel represents another mechanism for why households with richer parents have higher entry probabilities.

Due to higher house price levels in Norway than in the US – and because we observe total debt rater than only mortgage debt – we require slightly larger increases in debt in order to classify it as an equity extraction. Specifically, we define a parental equity extraction as an increase in debt which exceeds 10% *and* $2,000 (compared to 5% and $1,000 in Benetton, Kudlyak, and Mondragon (2022)). We use the static definition of wealthy parents, i.e. we consider parental wealth at the time when the household is 20 years old.

At the time of entry into the housing market, we find higher frequencies of equity extraction for richer parents. Specifically, 35% of parents with above median wealth extract equity in the year of entry, compared to 28% of parents with below median wealth. This difference

[10] Even if the transfer does exceed NOK 100,000 it is no longer taxed. This could in principle lead to more reporting as there is no tax-motive for failing to report the transfer. However, it could also lead to less reporting, as it might be viewed as less important to do so.

is not driven by homeownership. Conditioning on parents being homeowners has virtually no effect on the reported figures.

We follow Benetton, Kudlyak, and Mondragon (2022) and regress entry on parental equity extraction. In the year of a parental equity extraction, the entry probability into the housing market is 1.0-1.5 percentage points (=22-43%) higher – see Columns 1-3 of Table 4. This effect is larger in absolute size than the one identified by Benetton, Kudlyak, and Mondragon (2022), but smaller in percentage terms, as our baseline entry probability is higher. Overall we view the correlation as being roughly similar in magnitude.

Interestingly, the correlation between parental equity extraction and entry into the housing market is larger for those with richer parents. This is illustrated in Columns 3-6, in which we interact equity extraction with having richer parents at age 20. When including control variables and household fixed effects, we find that entry probabilities are 0.8 percentage points higher when poorer parents extract equity, compared to 0.8+0.5=1.3 percentage points higher when richer parents extract equity.

We conclude that parental equity extraction is likely to be one channel for why households with richer parents have higher entry probabilities, as i) richer parents are more likely to extract equity, and ii) the equity extraction of richer parents is associated with larger increases in entry probabilities.

	(1)	(2)	(3)	(4)	(5)	(6)
	$\text{Entry}_{i,t}$	$\text{Entry}_{i,t}$	$\text{Entry}_{i,t}$	$\text{Entry}_{i,t}$	$\text{Entry}_{i,t}$	$\text{Entry}_{i,t}$
$\text{Equity}_{i,t}$	0.0122***	0.0147***	0.0101***	0.00715***	0.0100***	0.00780***
	(0.000229)	(0.000228)	(0.000246)	(0.000322)	(0.000319)	(0.000341)
$\text{Equity}_{i,t} \times p_i^w$				0.00876***	0.00939***	0.00481***
				(0.000459)	(0.000455)	(0.000491)
N	4,103,487	4,093,527	3,843,963	4,103,487	4,093,527	3,843,963
Mean	0.0438	0.0438	0.0438	0.0438	0.0438	0.0438
Controls	No	Yes	Yes	No	Yes	Yes
HH FE	No	No	Yes	No	No	Yes

Table 4: Parental equity extraction.

Notes: Entry: $entry_{i,t} = 1$ if household i purchases a house in year t and did not own housing in year $t-1$, $entry_{i,t} = 0$ if household i household i did not purchase a house in year t and did not own housing in year $t-1$. Equity extraction: $\text{Equity}_{i,t} = 1$ if parents increase debt by at least 10% *and* \$2,000, and zero otherwise. Parental wealth: $p_i^w = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, and zero otherwise.

5.3 Intra-family sales and purchases

Figure 6a depicts the share of parents who buy a house around the time when a child enters the housing market, by parental wealth. In years when a child is not entering the housing market, around four percent of parents buy a house. In the year when the child enters the housing market, however, this share increases to roughly seven percent. Parental purchases at time of entry are only slightly higher for richer parents. Using unique housing id's, we can further infer whether parents are buying a house *with* their child. This is represented by the lighter shaded part of the bars in Figure 6a. For richer parents, about half of the excess purchase mass at the year of entry is explained by parent-child co-purchasing, which compares to roughly 1/3 for parents with below median wealth. This implies that richer parents are almost 60% more likely to co-purchase a house with their child at the time of entry than poorer parents.

(a) Parents buying

(b) Parents selling

Figure 6: Intra-family sales and purchases by parental wealth.

Notes: Share of first-time buyer parents who sell a house (to their child) and buy a house (with their child) around the child household's entry into the housing market (time $t = 0$) – for households with $p_i^w = 1$ (panel a) and $p_i^w = 0$ (panel b).

Figure 6b depicts the share of parents *selling* a house around the time when a child enters the housing market. In non-entry years, roughly six percent of parents sell a house. This compares to almost ten percent in the year of entry for those with above median wealth, and just above eight percent for those with below median wealth. In general, richer parents are 12% more likely to sell a house in the year of entry. Around 2/3 of the excess mass in parental sales at the time of child entry into the housing market is explained by parents selling a house directly to their child, as captured by the lighter shaded parts of the bars in

Figure 6b. Richer parents are 8% more likely to sell a house directly to their child in the year of entry.

Co-purchasing a house with ones parents is economically beneficial as it relaxes borrowing constraints. Buying a house from ones parents is however only economically beneficial if this is done at a price below the market value of the house.[11] If this is the case, the transaction should be marked as a full or partly gift-sale in the tax records. As it turns out, 97% of all transactions are reported as taking place at market value, and this share does not differ by parental wealth. However, anecdotal evidence suggests that there is room to influence the official market value, which is decided upon by a Realtor. We therefore restrict our sample to the 97% of transactions reportedly taking place at market value, and investigate whether intra-family sales take place at a discount.

To evaluate whether parents sell housing to their children at a discounted value, we predict house purchase prices based on square meters, number of rooms, number of bathrooms, municipality and year of purchase – as in equation (6). These variables have a large amount of missing observations, leaving us with a sample of almost 99,000 entries into the housing market. Of these transactions, 3,300 are sales from a parent to a child. The intra-family sales are left out of the sample when estimating equation (6). The regression results are reported in Table B.1 in the appendix.

$$hprice_{i,t} = \alpha + \beta_1 sqm_{i,t} + \beta_2 rooms + \beta_3 bathrooms + \delta_k municipality_k + \delta_t year_t + \epsilon_{i,t} \quad (6)$$

Using the coefficients from estimating equation (6), we calculate the difference between actual purchase prices and predicted purchase prices for all transactions in our sample. For the intra-family sales, the average purchase price is NOK 700,000 *less* than predicted, which implies a 25% discount. This compares to an average of roughy zero for other sales, suggesting sizable discounts for intra-family sales.

To make sure that the large estimated discount for parental sales is not a statistical fluke, we do a simple exercise in which we redo the calculations for a random sample of transactions. Specifically, we draw 1,000 random samples of 3,300 transactions, to match the size of our intra-family sales sample. For each sample we re-estimate equation (6) without the given sample, using the results to predict purchase prices for all transactions. We then calculate the residual house price for the sample in question. Doing this 1,000 times gives us the

[11] If the household expects to inherit its parental wealth anyway, one could argue that this simply implies a reshuffling of dynasty wealth. However, given that the household is likely to be constrained by the downpayment requirement, such an early-in-life transfer is probably preferable. Moreover, a lower sales price implies lower capital gain taxes, which represents an economic gain to the parents/dynasty.

smooth distribution in Figure 7. On average, residual house prices are close to zero, and virtually all mass lies between NOK -100,000 and NOK 100,000. This is in stark contrast to the residual for intra-family sales, which is seven times as large – captured by the dashed, red line to the left in Figure 7. We thus conclude, that parents are indeed selling houses to their children at substantial discounts.

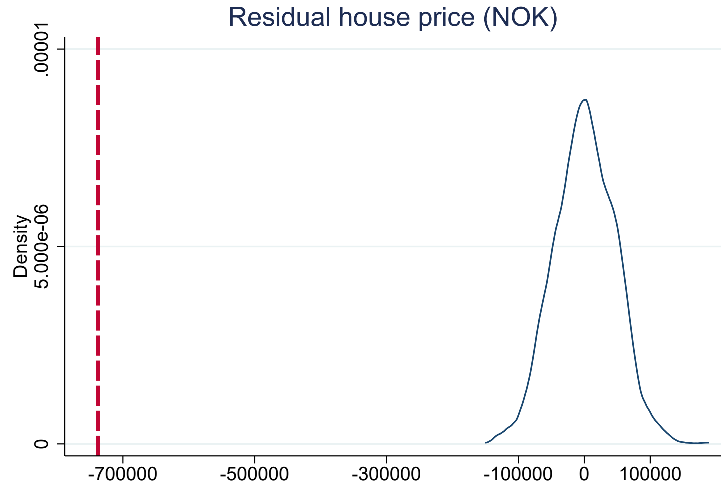


Figure 7: Estimated house sale discounts (NOK).

Notes: The residual house price is the difference between the listed purchase price and the estimated market value. The dashed line captures the residual house price when parents sell to their children. The distribution captures the residual house price for 1,000 random simulation exercises.

In principle, parents could be selling either their primary housing or their secondary housing to their child. The housing transaction data does not separate between primary and secondary housing. However, using the tax data, we can study how parental primary and secondary housing wealth evolves around the time of entry. A simple event study confirms that, perhaps not surprisingly, parents seem to be selling their secondary housing at the time of entry – see Figure 8. The decline in secondary housing wealth is driven entirely by richer parents. A similar event study on primary parental housing does not indicate any decline.

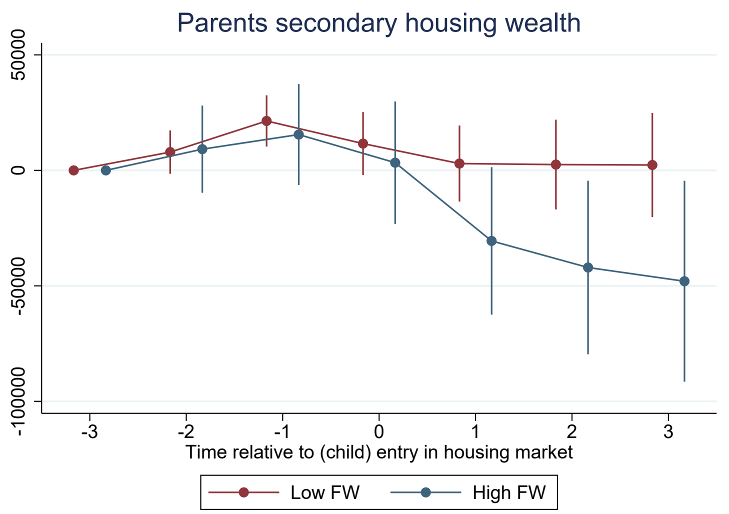


Figure 8: Event study: parental secondary housing wealth.

Notes: Entry: $entry_{i,t} = 1$ if household i purchases a house in year t and did not own housing in year $t-1$, $entry_{i,t} = 0$ if household i household i did not purchase a house in year t and did not own housing in year $t-1$. Parental wealth: $p_i^w = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, and zero otherwise.

6 Inter-generational wealth persistence

In Section 4 we documented large housing gaps between those with richer and poorer parents, and in Section 5 we explored the mechanisms. We now document the degree of inter-generational wealth persistence in our data, and quantify what share of this persistence is working through the housing market. We refer to this as the housing channel of inter-generational wealth persistence.

6.1 Structural framework

We use the same structural mediation framework as outlined in Section 3.1, but now the outcome of interest is the impact of parental wealth on household wealth. We use "bars" to denote values at "midlife", so that, for instance $\bar{w}_i$ captures household wealth at midlife. As discussed in the data section, midlife here refers to ones early 40s. As seen from equation (7), household wealth at midlife depends on parental wealth when the household is 20±1 years old, p_i^{20w}, other parental attributes at midlife, $\bar{p}_i^o$, household attributes at midlife, $\bar{x}_i$, housing market outcomes h_i, and other factors influencing household wealth ϵ_i.

$$\bar{w}_i = \alpha_0 + \alpha_1 p_i^{w20} + \alpha_2 \bar{p}_i^o + \alpha_3 \bar{x}_i + \alpha_4 h_i + \epsilon_i \tag{7}$$

Using equation (7) gives us an expression for the covariance between household wealth and parental wealth, which we can express as in equation (8). Note that the left hand side is simply the regression coefficient from regressing household wealth $\bar{w}_i$ on parental wealth p_i^{w20}. This term captures the impact of parental wealth on household wealth, and we use it as our measure of inter-generational wealth persistence.

$$\frac{cov(\bar{w}_i, p_i^{w20})}{var(p_i^{w20})} = \alpha_1 + \alpha_2 \frac{cov(p_i^o, p_i^{w20})}{var(p_i^{w20})} + \alpha_3 \frac{cov(x_i, p_i^{w20})}{var(p_i^{w20})} + \alpha_4 \frac{cov(h_i, p_i^{w20})}{var(p_i^{w20})} + \frac{cov(\epsilon, p_i^{w20})}{var(p_i^{w20})} \quad (8)$$

Inter-generational wealth persistence as defined in equation (8) is made up of five terms. The first term, α_1, is the "pure parental wealth" component. The second term is $\alpha_2 \frac{cov(\bar{p}_i^o, p_i^{w20})}{var(p_i^{w20})}$, which is the "other parental attributes" component. This component depends of two parts; the impact of other parental attributes on household wealth, and the impact of parental wealth on other parental attributes. The third term, $\alpha_3 \frac{cov(\bar{x}_i, p_i^{w20})}{var(p_i^{w20})}$, captures the household attributes component. This component again depends on two effects; the direct impact of household attributes on household wealth, as well as the correlation between parental wealth and household attributes.

The housing market component is captured by the fourth term, $\alpha_4 \frac{cov(h_i, p_i^{w20})}{var(p_i^{w20})}$. The housing market component will be important in explaining inter-generational wealth persistence if housing market outcomes are strongly correlated with parental wealth – as documented in Section 4.1 – *and* housing market outcomes have a sizable direct impact on household wealth *and*. Finally, $\frac{cov(\epsilon_i, p_i^{w20})}{var(p_i^{w20})}$ captures the possible correlation between parental wealth and variables omitted from equation (7). As this term is unobservable, we are implicitly assuming that the correlation between parental wealth and the error term is zero when decomposing inter-generational wealth persistence.

6.2 Estimation

As discussed in the data section, $\bar{w}_i = 1$ if household i has net wealth above the year-specific median in it's early 40s, and zero otherwise. p^{w20} if average parental financial wealth is above the year-specific median when the (child) household is aged 20±1, and zero otherwise. With these measures, inter-generational wealth persistence as defined in equation (8) is found by simply regressing $\bar{w}_i$ on $p_i^{w20} = 1$. Doing this, we find that households with richer parents have a 0.15 percentage point higher probability of themselves having above median wealth at midlife. In other words, households with richer parents are about 35% more likely to themselves have above median wealth.

To decompose the inter-generational wealth persistence into our four components, we first estimate equation (7) to get $\hat{\alpha}_1$, $\hat{\alpha}_2$, $\hat{\alpha}_3$ and $\hat{\alpha}_4$.[12] We use two different measures of housing market outcomes h_i. First, we consider age of entry and purchase price upon entry. However, these variables are only defined for those who we observe enter the housing market. That is, it excludes those who enter before our sample starts, and – importantly – those who never enter. To address this, we also consider homeownership indicators at ages 27, 30, 33 and 36. These indicator variables are defined for all individuals who are observed at these ages, thereby also capturing the extensive margin of potentially never entering the housing market.

After obtaining the α-estimates, we regress p_i^o, x_i and h_i on p_i^{w20} one-by-one, to get the covariance-terms in equation (8). We then have what we need to calculate the distinct components of inter-generational wealth persistence. Table B.2 in the appendix contains all the regression estimates, while the main results are summarized in Table 5. Note that the components sum to the left hand side of equation (8), i.e. the coefficient obtained from regressing midlife wealth on parental wealth.

	Housing market measures	
Inter-generational wealth components	Age of entry & Purchase price	Homeownership at 27, 30, 33, 36
Parental wealth	0.10 (66%)	0.08 (55%)
Parental attributes	0.01 (3%)	0.01 (5%)
Household attributes	0.01 (9%)	0.02 (13%)
Housing outcome	0.03 (22%)	0.04 (27%)
Sum	0.15 (100%)	0.15 (100%)

Table 5: Components of inter-generational wealth persistence as defined in equation (8).

Notes: Parental wealth is p^{w20}. Parental attributes are education, income, location and number of children Household attributes are education, income, location and number of adult household members. Housing market measures are either age of entry and purchase price upon entry (1st column) or homeownership indicators at age 27, 30, 33 and 36 (2nd column).

As seen from the top row of Table 5, the pure parental wealth component accounts for more than 50% of inter-generational wealth persistence. This means that around 40% of the correlation between parental wealth and child wealth can be explained by other observable factors. As seen from the second row, other parental attributes – such as parental income,

[12]For expositional reasons, we let $\bar{p}_i^o$. $\bar{x}_i$ and h_i be single variables in the main text. However, in the estimation we include multiple characteristics as outlined in Appendix D. Conceptually, the only difference is that α_2, α_3 and α_4 in equation (7) actually consists of multiple α-terms each, all of which must be multiplied with the appropriate covariance-term in equation (8).

education, location and number of children – do *not* account for a large share of the observed inter-generational persistence. Household attributes, are somewhat more important, explaining roughly 10% of the correlation between parental wealth and child wealth. Of these, education and co-habitation status are the most important attributes.

Quite strikingly, housing outcomes are substantially more important than both parental attributes and other household attributes in explaining inter-generational wealth persistence – see the last row of Table 5. In fact, around 1/4 of the correlation between parental wealth and child wealth is explained by the housing market outcomes of the child household. The housing market channel is somewhat larger when using the homeownership-indicators as our measure rather than age of entry and purchase price. This is likely driven by the importance of the extensive margin, as using homeownership-indicators means that we also include households who never enter the housing market in our sample.

The results reported in Table 5 are sample averages, and we explore two heterogeneity dimensions. Specifically, we redo the analysis on i) a sample of individuals who reside in big cities, and ii) a sample of households with maximum one sibling (averaging over the household members). The former sample makes up 19% of the full sample at midlife, while the latter makes up 46%.

Table B.3 reports results for the sample living in big cities. Interestingly, the findings when using age of entry and purchase price to capture the housing market channel are similar for the big city-sample, while the findings when using homeownership indicators are much larger. That is, in the latter case, the housing market component increases from 27% for the full sample to 37% for the big city-sample. This implies that the housing market component of inter-generational wealth persistence is much stronger for households residing in big cities, *if* the extensive margin of housing is included. While there are several differences between the full sample and the big-city sample, one striking difference is house price growth, which has been much larger in big cities.[13] The results in Table B.3 are therefore consistent with housing being more important for inter-generational wealth persistence in a setting of high house price growth.

The results for the sample with maximum one sibling are reported in Table B.4. The results are quite similar to those for the full sample, suggesting that inter-generational wealth persistence does not depend crucially on family size. That is, having richer parents is about as beneficial in a setting where all couples have few children as in a setting where all couples have several children.

[13] Going back to the example from the introduction, elaborated on in Appendix C, the difference between Norway in general and Oslo is substantial. The $100 invested in the Norwegian housing market grows to $6,000 over a 25-year period, compared to an astonishing $9,000 in Oslo.

To summarize, we have shown that households with above median wealthy parents are 15 percentage points more likely to themselves be wealthy. Around 1/4 of this inter-generational wealth persistence can be explained by the housing market, and the housing market channel is larger than both the household attributes channel and the other parental attributes channel. We now move on to building a life-cycle model with housing, in which we match the housing channel of inter-generational wealth persistence. We use the model to study the sensitivity of our results to house price growth and mortgage market regulation.

7 Model

We now describe the standard life-cycle model of housing we use to study the sensitivity of our results to house price growth and the effects of borrowing constraints in the mortgage market. In the model, parental support is exogenous and takes the form of an initial cash transfer, an annual cash transfer, or an increased preference for homeownership.

7.1 Model set-up

We first describe the model without parental support in Sections 7.1.1 and 7.1.2. This baseline version of the model can be interpreted to capture households with non-wealthy parents. In Section 7.1.3, we add parental support to the model.

7.1.1 Environment

Demographics A household is born at age T^s, retires at age T^r, and dies at age T^d. Each period constitutes one year, and we do not consider mortality risk or bequest motives for the (child) household.

Preferences The expected lifetime utility of a household is given by

$$\mathbb{E}\left[\sum_{a=T^s}^{T^d} \beta^a u\left(c_a, h_a, s_a\right)\right], \tag{9}$$

where $\beta > 0$ is the discount factor, $c > 0$ is non-housing consumption, $h \in \mathcal{H}(s) \subset \mathbb{R}^2$ is housing consumption, and $s \in \{0, 1\}$ is the ownership status and equals 0 for renters and 1 for owners. The expectation $\mathbb{E}$ is taken over sequences of idiosyncratic shocks that we specify below. In what follows, we omit the dependence of variables on age a except in cases where its omission is misleading.

We assume that households have CRRA-preferences, where consumption and housing is aggregated with a Cobb-Douglas aggregator

$$u(c,h,s) = \frac{\left(c^{1-\eta}h^{\eta}\chi(s)\right)^{1-\gamma}}{1-\gamma}, \tag{10}$$

where $0 < \eta < 1$ is the weight on housing, γ denotes the risk aversion parameter, and $\chi(s)$ the homeownership premium. We set the ownership premium equal to 1 for renters and $1+\chi$ for owners.

Endowments Households are endowed with an uncertain labor income stream during working age

$$\log y_{i,a} = f(a) + \nu_{i,a} + \varepsilon_{i,a},\ a = T^s, \ldots, T^r. \tag{11}$$

We let $f(a)$ denote the deterministic component. ν is a persistent productivity shock, and $\varepsilon \sim \mathcal{N}\left(0, \sigma_\varepsilon^2\right)$ a transitory shock. The persistent shock follows an AR(1) process

$$\nu_{i,a} = \rho\nu_{i,a-1} + u_{i,a}, \tag{12}$$

where ρ is the persistence parameter and $u \sim \mathcal{N}\left(0, \sigma_\nu^2\right)$.

In retirement, income is constant and equal to a fixed proportion (ϕ_{ret}) of the household's income in the last period of working life ($a = T^r$)

$$\log(y_{i,a}) = \log(\phi_{ret}) + f(a = T^r) + \nu_{i,T^r},\ a = T^r + 1, \ldots, T^d. \tag{13}$$

Moreover, households are endowed with an initial level of net worth x_T^s.

Housing Market In the model, the market value of a house is linear in house size h. The per unit house price follow a stochastic process with drift μ_h and volatility ε^h

$$\log(p_{a+1}) = \log(p_a) + \epsilon_{a+1}^h, \epsilon \sim \mathcal{N}(\mu_h, \sigma_h^2). \tag{14}$$

The rental price is assumed to be a constant fraction κ of the market value ph.

Households have the option between renting $s = 0$ or owning $s = 1$ in order to consume housing services. Houses are characterized by their sizes, which belong to discrete finite sets $\mathcal{H}(s)$, which depend on the ownership status.

Buying and selling owner-occupied housing entails adjustment costs that are proportional to the market value of the house and we denote these proportional costs by m_b and m_s, respectively. We let $tc(p, s, h, s', h')$ denote the total adjustment cost. For example, a current renter ($s = 0$) living in a rental unit of size h who buys ($s' = 1$) house h' when the price is p is $tc(p, 0, h, 1, h') = (1 + m_b)ph'$. Moreover, homeowners must pay depreciation δ, e.g., maintenance and taxes.

Financial Market All households can save in a one-period risk-free bond with a return r^f. Borrowing against collateral (owner-occupied housing) is allowed, but households must satisfy a loan-to-value (LTV) and a loan-to-income (LTI) constraint. We model borrowing as a one-period mortgage that is rolled over each period. The mortgage has an interest rate of $r + r^m$, where $r^m \geq 0$ is the mortgage premium.

Since the mortgage premium is positive, households will never simultaneously hold both a mortgage and save in the risk-free bond. We let b denote the net position in bonds. The effective interest rate is

$$r(b) = \begin{cases} r^f & \text{if } b \geq 0, \\ r^f + r^m & \text{if } b < 0. \end{cases} \tag{15}$$

7.1.2 Household optimization

We now outline the decision problem for households with non-wealty parents. For readability, we recast the model to a recursive form and denote one-period-ahead variables with primes $'$ instead of $a + 1$.

Budget Equation All households choose consumption c and their net bond position b. Renters pay rent while homeowners keep the house on the balance sheet. Changing housing status incurs adjustment costs. For a household with wealth x and income y the budget equation is

$$x + y = c + b + ac(p, s, h, s', h') + (1 - s')\kappa ph' + s'ph'. \tag{16}$$

Evolution of Wealth Next-period wealth is given by the net position in bonds and the market value of owner-occupied housing net of depreciation

$$x' = b(1 + r(b)) + s'p'h'(s' - \delta). \tag{17}$$

Decision Problems Effectively, there are five discrete choices in the model. Current renters choose to rent or own. Current owners choose to rent, continue to own the same house, or change the house size. Renters who keep renting and owners who stay in the same house do not incur transactions costs. All other transitions do entail transaction costs.

A household solves

$$V(x,h,s,\nu,p,a) = \max_{c,h',b',s'} \{u(c,h') + \beta \mathbb{E}\left[V(x',h',s',\nu;,p',a+1)\right]\}, \tag{18}$$

subject to

$$c > 0, \tag{19}$$
$$s' \in \{0,1\}, \tag{20}$$
$$h' \in \mathcal{H}(s'), \tag{21}$$
$$b' \geq -LTVph's', \tag{22}$$
$$\frac{b'}{y} \geq -LTIs', \tag{23}$$

and the budget constraint and the law of motion (equations (16) and (17)). The constraints ensure that the household must choose to rent or own (equation (20)), that the feasible set of housing options depend on whether the household rents or buys (equation (21)), and that renters cannot borrow at all while current and new owners are bound by the LTV and LTI constraints (equations (22) and (23)).

7.1.3 Modelling parental support

To match our empirical definition, exactly 1/2 of the households are assumed to have wealthy parents. Parental support is exogenous in the model and takes the form of an initial transfer, an annual transfer, or a higher preference for homeownership. This is consistent with the literature on inter-generational wealth persistence, which has found support both of monetary support and persistence in preferences/norms.

Initial transfer Our first strategy to capture parental support is simply to provide households with richer parents with a one-time transfer at the beginning of adulthood, $\tau^{PW}_{T^s}$. For households with non-wealthy parents this parameter is set to zero. In this case the income process from equation (11) instead becomes

$$y_{i,a} = \exp(f(a) + \nu_{i,a} + \varepsilon_{i,a}) + \tau^{PW}_{T^s}, \quad a = T^s, T^s+1, \ldots, T^s+20. \tag{24}$$

Annual transfer Our second strategy to capture parental support assumes instead an annual transfer τ^{PW} every year from $t = T^s$ to $t = T^s + 20$. As before, this parameter is set to zero for households with non-wealthy parents. In this case the income process from equation (11) instead becomes

$$y_{i,a} = \exp(f(a) + \nu_{i,a} + \varepsilon_{i,a}) + \tau^{PW}, \quad a = T^s, T^s + 1, \ldots, T^s + 20. \tag{25}$$

Homeownership preference Finally, we also consider the possibility that parents matter not through their financial transfers, but rather through their impact on preferences. Specifically, we assume that households with wealthy parents receive an additional benefit from owning a house, such that the housing preference in equation (10) becomes $\chi + \chi^{PW}$. The parameter χ^{PW} is set to zero for those with non-wealthy parents.

7.2 Parameterization

Our parameterization strategy consists of three steps. First, we fix the external parameters, i.e. parameters we can set without relying on model dynamics and that are common across all types of households. These parameters are set to match the Norwegian economy when relevant, in order to match our empirical results. Second, we fix internal parameters, i.e. parameters used to match homeownership and financial wealth at different ages. We do this by matching moments for households with non-wealthy parents. Third, we pick the parental support parameters to match the housing channel of inter-generational wealth persistence as documented in Section 6.2. All model parameters are reported in Table 6.[14]

7.2.1 External Calibration

Adjustment costs In Norway, home buyers pay a transaction tax ('document fee') of 2.5% of the purchase price. We therefore set $m_b = 0.025$. The main cost of selling is the real estate agent commission, which averages 2% (Yao et al., 2015). We therefore set the cost to be $m_s = 0.020$, to capture that sellers usually pay for advertisement, sales insurance, and other costs associated with home sales.

Income Process For the stochastic component we use the parameter values from Fagereng et al. (2017). They estimate $\sigma^2_\nu = 0.012$, $\sigma^2_\varepsilon = 0.023$, and $\phi_{ret} = 0.842$. We report their estimated income profile $f(a)$ in Figure E.1d. Their estimates do not account for any correlations between parental wealth and income, however. We adjust the income profile $f(a)$ by the income gap between households with poor parents and the average income of all households in our data. Figure E.1d plots the results. For simplicity, we assume that income risk does

[14] Numerical parameters such as grid sizes are discussed in Appendix E.1

not depend on parental wealth.[15]

Housing Parameters To find the growth rate and volatility of house prices we use existing home price indices. We deflate the nominal index by median household income, after tax, since income is stationary in the model. We then use the observed mean growth and standard deviation to set $\mu_h = 0.0288$ and standard deviation $\sigma_h = 0.0468$. Figure E.1b plots the time trends of nominal, real, and income deflated house prices in Norway, as well as the mean growth rates and standard deviations.

We calibrate house sizes to match the 5th, 25th, 50th, and 75th percentile of square footage of residential units, which corresponds to 44, 77, 100, and 143, respectively. We normalize the smallest unit to have a size of 1. We assume that the two smallest units can be rented, so that $\mathcal{H}(0) = [1.0, 1.75]$. We then assume that only the 3 largest units can be owned, such that $\mathcal{H}(1) = [1.75, 2.27, 3.25]$.

We estimate rent-to-price ratios κ in Norway in two steps. First, we use statistics on yearly rent, per square meter, by rooms in the unit and price per square meter, by type (single-family, small multifamily, and multifamily). We then divide the rent per square meter for units with 5 rooms by the single-family square meter price, the 4 room rental price by the small multi-family price, and the 3 and 2 rooms prices by the multifamily price. In the years we have data, 2012-2022, the ratios are relatively stable. We set κ equal to 0.044, the average rent-to-price ratios of these four units series over all years, see Figure E.1e.[16]

Preference Parameters We set the preference weight on housing η to 0.35, roughly equal to the average for households aged 27-45 in Yao et al. (2015). We set the risk aversion parameter γ to 2.0, a standard value in life-cycle models.

Initial Conditions To find a households initial financial wealth, we draw from the empirical distribution of households with non-wealthy parents, estimated non-parametrically (see Figure E.1c). We sort the net worth of households aged 20-23 with non-wealthy parents and divide them into 10 equally sized bins by gross financial wealth. Households are randomly allocated a bin and receive an initial endowment equal to the average of their bin.

We draw the households initial productivity shock from the stationary distribution implied by equation (12). All households start as renters, but are allowed to choose to become

[15] Fagereng et al. (2017) find that income risk is almost independent of education. Since education is strongly correlated with parental wealth, this suggests that any difference based on parental wealth is limited in size.

[16] For similar models calibrated to the United States, a standard value is 0.05, based on Davis et al. (2008). Our somewhat lower estimate could be driven by difference in tax regulation—rental income in duplexes are tax exempt if the owner lives in one unit—and other institutional differences.

homeowners in the first period.

Households draw the initial house price p_s from a uniform distribution. We calibrate the mean of the initial price in the following way. In the early 1990s, the average market value of a 'starter home', was about 3.5 times the average household income. Using our calibrated income process, the average income for households aged 20-80 is NOK 449,000 and so we set the average initial price 89.78 for one unit of housing, so that the price of the smallest owner-occupied unit is 3.5 times the average income (NOK 1,571,000). The edges of the distribution is set at $\pm 20\%$, so that $p_s \sim \mathcal{U}_{[0.8\times 89.78, 1,2\times 89.78]}$.

Remaining External Parameters We set most of the remaining parameters following Yao et al. (2015). The risk-free rate r^f is 0.016, the maximum leverage d is 0.9, the maximum debt-to-income level is 5.0, and housing depreciation δ is 0.02. We set the mortgage premium r^m to 0.039, the average spread since 1990, similar to what is found in Erard (2014).

7.2.2 Internal Calibration

In the second step we choose the remaining preference parameters to match life-cycle moments on wealth and homeownership for households with non-wealthy parents. Specifically, we set the discount factor β and the utility shifter for homeownership χ by targeting the homeownership rate and financial wealth at *each* age between 20 and 45. The moments are calculated as the average across our sample of households with non-wealthy parents. Figure 9 shows the empirical moments along with the model fit for both wealth and homeownership for households aged 20-40. We see that the calibrated model is able to match the empirical moments quite well, although it over-predicts homeownership at older ages somewhat.

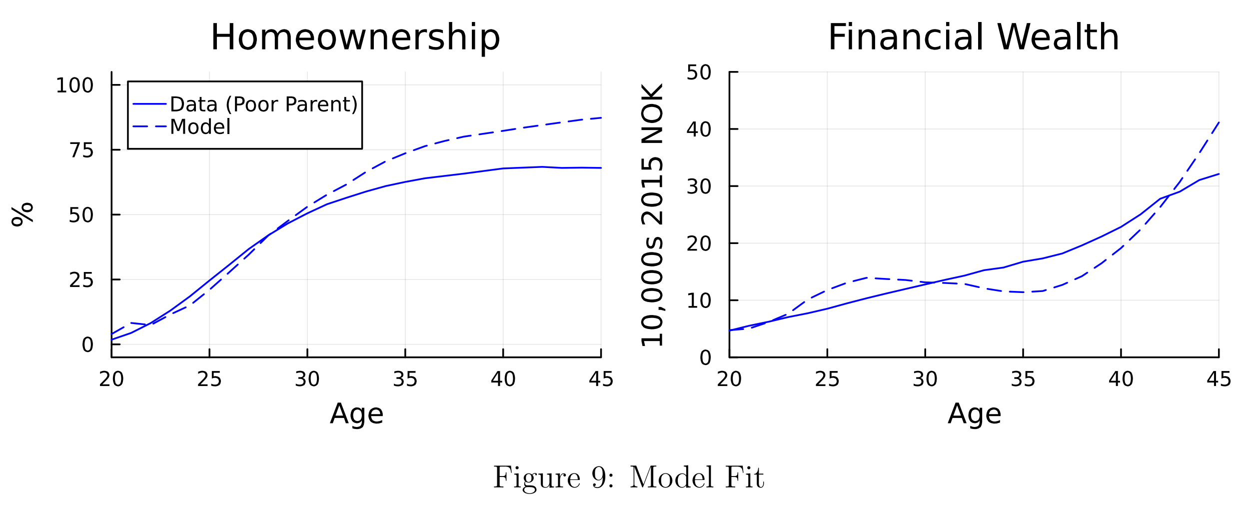


Figure 9: Model Fit

Parameter		Value	Source
Externally Calibrated			
σ^2_ν	Var. pers. inc. shock	0.012	Fagereng et al. (2017)
σ^2_ν	Var. trans. inc. shock	0.023	Fagereng et al. (2017)
ρ	Shock persistence	0.95	Std
ϕ_{ret}	Replacement Ratio	0.842	Fagereng et al. (2017)
$f(a)$	Life-cycle income	Fig. E.1d	Fagereng et al. (2017)
n/a	Initial Wealth	Fig. E.1c	Fagereng et al. (2017)
p_{ini}	Initial house price	89.78	Own calculation
T^s	Starting age	22	
T^r	Retirement age	67	Fagereng et al. (2017)
T^d	Final age	100	
m_b	Purchase cost	0.025	Yao et al. (2015)
m_s	Sales cost	0.020	Yao et al. (2015)
κ	Rent-to-price ratio	0.044	Own calculation
r^f	Risk-free rate	0.016	Yao et al. (2015)
r^m	Mortgage premium	0.039	Own calculation
LTV	Maximum loan-to-value	0.9	Regulation
LTI	Maximum loan-to-income	5.0	Regulation
δ	Depreciation	0.02	Yao et al. (2015)
μ_h	Price growth	0.0288	Own calculation
σ_h	Price std dev	0.0468	Own calculation
$\mathcal{H}(0)$	Rental sizes	$[1.0, 1.75]$	Own calculation
$\mathcal{H}(1)$	Owner-occupied sizes	$[1.75, 2.27, 3.25]$	Own calculation
η	Weight on housing	0.35	Standard
γ	Risk Aversion	2.0	Standard
Internally Calibrated			
β	Discount factor	0.986	Internal estimation (7.2.2)
χ	Ownership utility shift	0.008	Internal estimation (7.2.2)
Parental Parameters			
$\tau^{PW}_{T^s}$	Initial transfer	37	Internal estimation (7.2.3)
τ^{PW}	Annual transfer	2.6	Internal estimation (7.2.3)
χ^{PW}	Ownership preference	0.028	Internal estimation (7.2.3)

Table 6: Calibrated Parameter Values

7.2.3 Calibrating parental parameters

Finally, we choose our parental parameters, $\tau_{T^s}^{PW}$, τ^{PW} and χ^{PW} to match the housing channel of inter-generational wealth persistence from Column 1 in Table 5 in Section 6.2. To do this, we perform the exact same calculations on model data as we did on the actual data. That is, we estimate the components in equation (8), and calculate the housing channel as $\hat{\alpha}_4 \frac{cov(h_i, p_i^{w20})}{var(p_i^{w20})}$, where $\bar{w}_i$ equals one if the household has above median wealth at age 43, p_i^{w20} equals one if the household has wealthy parents, $\bar{x}_i$ includes dummies for the persistent and transitory income shocks as well as the price level at age 43, and h_i includes age of first purchase and the purchase value. There is no need to control for other parental attributes, as these do not exist in the model.

We pick the parental parameters so that the housing channel in the model exactly matches the housing channel in the data, i.e. 0.03. The interpretation being that households with richer parents are three percentage points more likely to themselves be rich at midlife, *due* to housing outcomes.

7.3 Results

In this section we first show to what extent our model is able to match the non-targeted housing gaps between those with richer and poorer parents. Second, we evaluate how the housing channel of inter-generational wealth persistence varies with house price growth and downpayment requirements.

Matching the non-targeted ownership gap Because we have three different strategies to capture parental support, we also have three implied homeownership gaps between those with richer and poorer parents. These are illustrated in Figure 10. The black, solid line captures the homeownership gap in the data, after removing the impact of household attributes and other parental attributes.

Modelling parental support as an early-in-life transfer results in the poorest fit with regard to homeownership gaps. Not only is the model gap substantially smaller than that observed in the data, it also has the wrong life-cycle profile, as the ownership gap peaks too early in life. The annual transfer does a better job, and matches the size of the ownership gap in the data well. However, the timing is a little bit off, with the housing gap from the model lagging that of the data with roughly five years. Modelling parental support as a preference shifter, however, provides a homeownership gap very close to that observed in the data. Not only is the size of the gap correct, the timing of the model is also just 1-2 years behind that in the data.

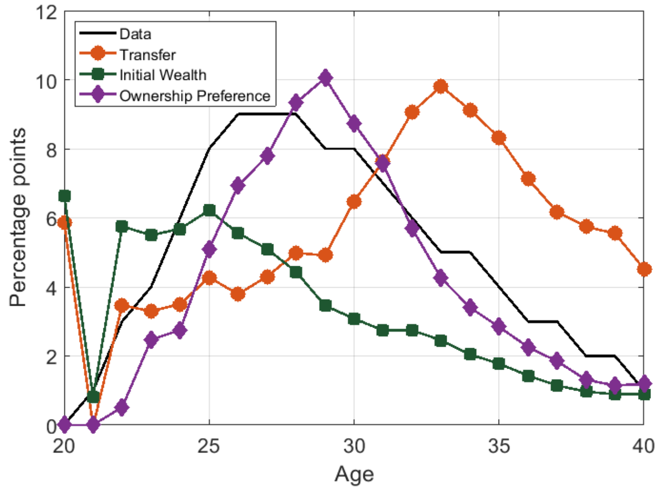


Figure 10: Homeownership rate gaps by age in model and data.

Notes: This figure shows the gap in homeownership between low and high parental wealth households in the data, as well as in the model for different parametrizations. "Transfer" refers to the housing gap in the model when we have used annual transfers, i.e. τ^{PW}, to match the housing channel of intergenerational wealth persistence. "Initial Wealth" refers to the housing gap in the model when we have used initial wealth, i.e. $\tau^{PW}_{T^s}$, to match the housing channel of intergenerational wealth persistence. Finally, "Ownership Prefernces" refers to the housing gap in the model when we have used the ownership preference, i.e. χ^{PW}, to match the housing channel of intergenerational wealth persistence.

The effect of house price growth Next, we use our model to understand how the housing channel of inter-generational wealth persistence varies with house price growth. Specifically, we change average house price growth to $\mu = 0.015$, the estimated value in Cocco (2005) for the United States – almost halving price growth from 0.0288.

We do two experiments. First, we keep policy functions unchanged, and only alter realized house price growth. This does not give households the opportunity to adjust their behavior in response to the change in house prices, and can be interpreted to capture the impact of unanticipated lower house price growth. Second, we change average house price growth, and re-solve the model to obtain new policy functions. In this case, households are allowed to adjust their behavior, and both realized *and* expected house prices change.

The results are illustrated in Figure 11. When house price growth is nearly halved – but expectations are left unchanged – the housing channel of inter-generational wealth persistence falls by a moderate 20%. However, when expectations are allowed to adjust, the effect is much larger, reducing the housing channel of inter-generational wealth persistence by roughly 70%. This suggests that – perhaps surprisingly – it is not the actual price growth that matters the most, but how households respond to this growth.

The effect of mortgage regulation Finally, we use the model to quantify the impact of downpayment requirements on the effect of parental wealth on children's wealth and housing outcomes. Our policy experiment is motivated by the clear link between LTV requirements and parental housing support (e.g., Blickle and Brown (2019)) and a growing understanding of the unintended consequences of LTV regulation (e.g., Aastveit, Juelsrud, and Wold (2022)).

We consider a scenario where the LTV requirement changes from 90 % to 70 %. A tightening of the LTV constraint of this magnitude leads to a 16 % increase in the housing channel, suggesting that LTV constraints can amplify inter-generational wealth persistence and thereby have substantial distributional effects.[17] The intuition being that tighter mortgage regulation increases the barriers to entry in the housing market, creating a larger role for the support of affluent parents.

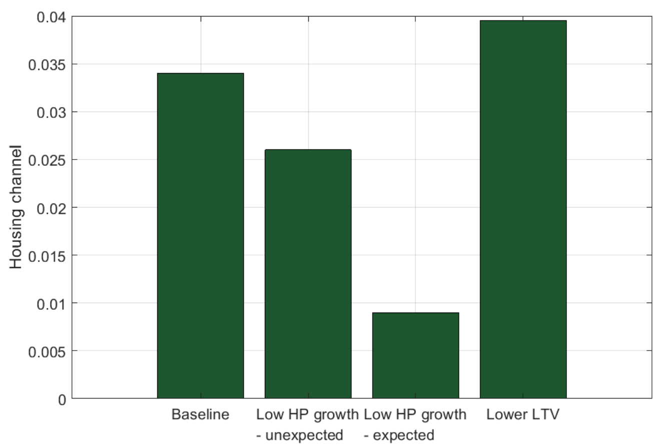


Figure 11: The housing channel of inter-generational wealth persistence

Notes: The figure shows the housing channel of inter-generational wealth persistence as defined in equation (8). In the low HP growth scenarios, we set the mean growth to $\mu = 0.015$. In the "unexpected" scenario, households assume that the house price process is unchanged. In the "expected" scenario, households internalize the change in house price growth. Lower LTV refers to a scenario where we assume an LTV constraint of 0.7 instead of 0.9.

In sum, the results in this section illustrate that the housing channel of inter-generational wealth persistence depends on both house price growth and LTV restrictions. In the former case, the impact is substantially larger if households internalize the lower house price growth, highlighting the importance of expected house price growth.

[17] This finding is consistent with evidence from Brandsaas (2021), who uses a more complicated model calibrated to the United States and finds similar results.

8 Conclusion

We have documented large gaps in housing outcomes by parental wealth. Roughly half of these gaps can be explained by household attributes, while other parental attributes play a minor role. Even after controlling for a rich set of observables, we still find that households with richer parents have a 21% higher entry probability, buy homes worth 20% more when entering the housing market, and are 13% more likely to be homeowners by age 30. Using plausibly exogenous variation in parental wealth resulting from grandparent death or international stock market returns support a causal impact of parental wealth. In terms of mechanisms, we document support for traditional transfers, parental equity withdrawal, co-purchasing and direct sales from parent to child at substantial price discounts. Using a structural mediation framework, we find that housing outcomes is an important driver of wealth persistence across generations. In fact, roughly 1/4 of the inter-generational wealth persistence in our data is attributed to housing outcomes.

Our results are based on Norwegian data for the past decades, a period with relatively high house price growth. A natural question is how our results would change with lower house price growth. To get a sense of this we built a life-cycle model with housing, showing that while lower realized house price growth reduces the housing channel of inter-generational wealth persistence somewhat, what really matters is house price *expectations*. Understanding peoples expectations for house price growth going forward is therefore key for determining how large the housing channel of inter-generational wealth persistence will be in the future.

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A Additional figures

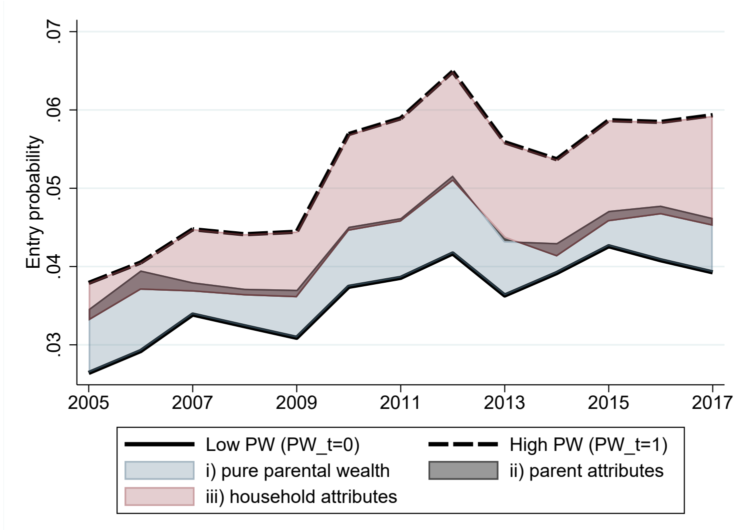


Figure A.1: Entry probability by parental wealth: decomposed into channels i)-iii) as in equation (2)

Notes: $h_{i,t}$ is an indicator variable for entering the housing market. $p^w_{i,t-1} = 1$ if average parental financial wealth in year $t-1$ is above the year-specific threshold, p^o_i is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of hh members. Sample consists of potential entrants and entrants in the housing market.

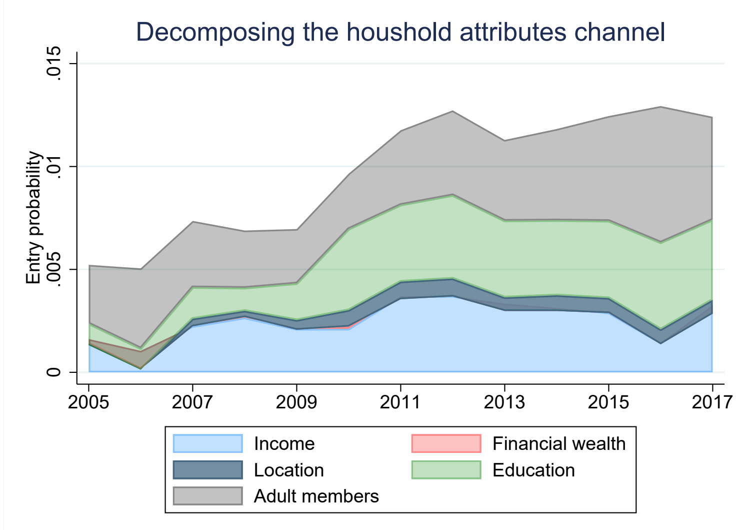


Figure A.2: Entry probability by parental wealth: the household attributes channel

Notes: $h_{i,t}$ is an indicator variable for entering the housing market. $p_i^{w20} = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of hh members. Sample consists of potential entrants and entrants in the housing market.

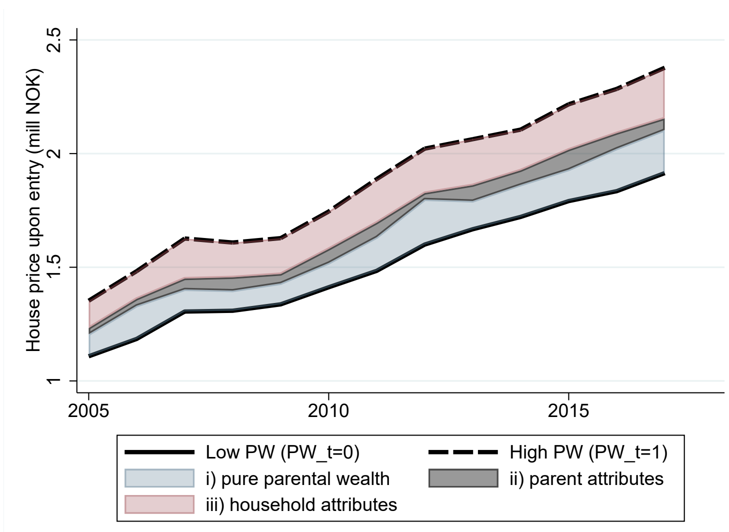


Figure A.3: Purchase price by parental wealth: decomposed into channels i)-iii) as in equation (2)

Notes: h_i is the purchase price upon entering the housing market. $p_{i,t-1}^{w} = 1$ if average parental financial wealth in year $t-1$ is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of hh members. Sample consists of households entering housing market.

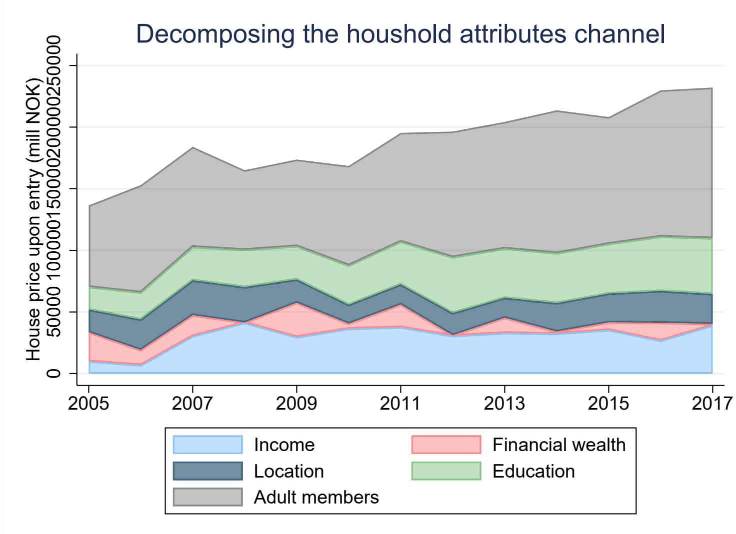


Figure A.4: Purchase price by parental wealth: the household attributes channel

Notes: h_i is the purchase price upon entering the housing market. $p_i^{w20} = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of hh members. Sample consists of households entering the housing market.

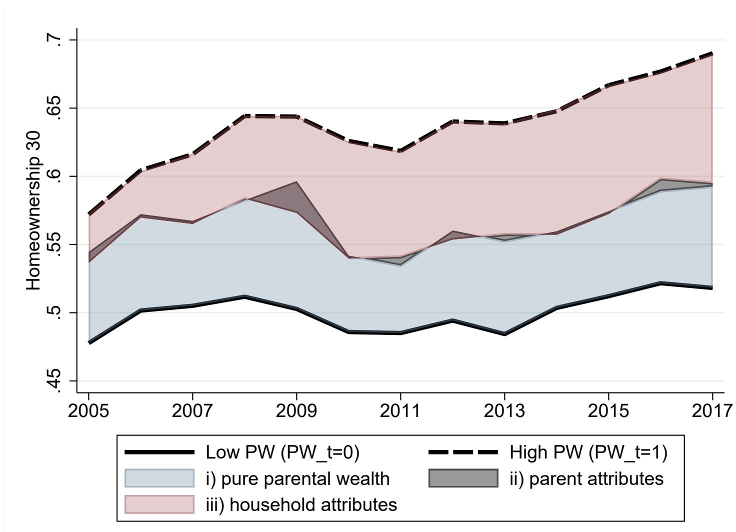


Figure A.5: Homeownership at 30 by parental wealth: decomposed into channels i)-iii) as in equation (2)

Notes: h_i is the purchase price upon entering the housing market. $p_{i,t-1}^w = 1$ if average parental financial wealth in year $t-1$ is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of hh members. Sample consists of 30-year olds.

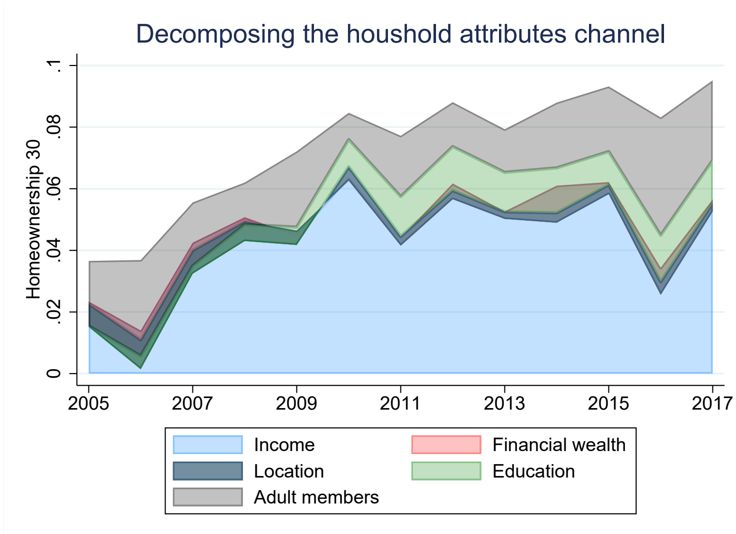
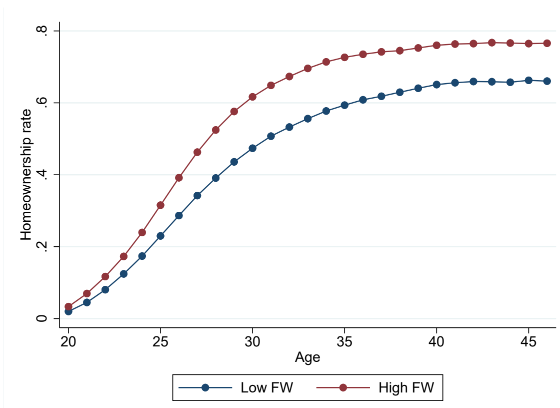
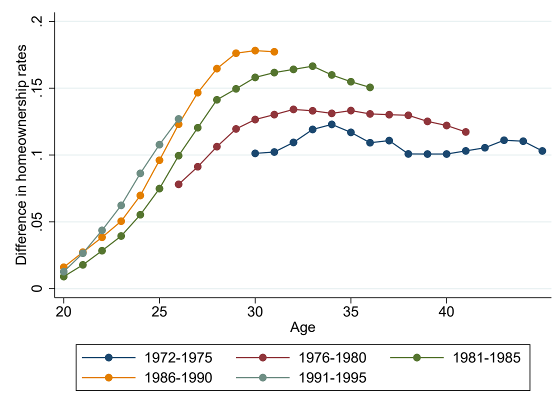


Figure A.6: Homeownership at 30 by parental wealth: the household attributes channel (2)

Notes: h_i is the purchase price upon entering the housing market. $p_i^{w20} = 1$ if average parental financial wealth when household is aged 19-21 is above the year-specific threshold, p_i^o is parent income, education, location and number of children, x_i is hh income, financial wealth, education, location and number of hh members. Sample consists of 30-year olds the housing market.



(a) Homeownership rate by parental wealth



(b) Homeownership gap by cohort

Figure A.7: Homeownership over the life cycle

Notes: Households are divided into two groups; those whose parents have below median financial wealth in the year the household is 20 (Low FW) and those whose parents have above median financial wealth in the year the household is 20 (High FW). The homeownership gap is defined as the difference in homeownership rates between these two groups. Because not all cohorts are observed at all ages, the homeownership gap for different cohorts is depicted for different age intervals.

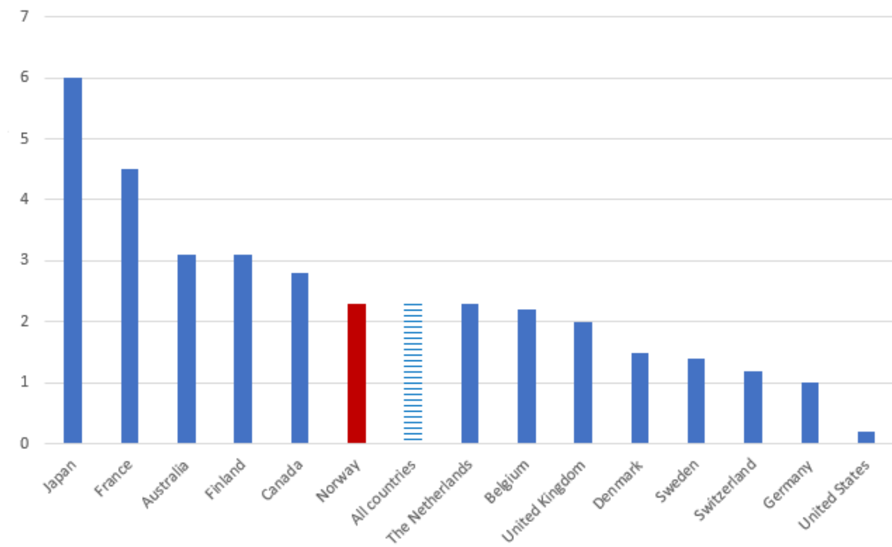


Figure A.8: Average real annual house price growth from Online Appendix Table A.5 in Knoll, Schularick, and Steger (2017) (%) post-Wold War II.

B Additional tables

	(1) House purchase price
Square meters	13,224***
	(131)
Number of rooms	105,549***
	(4,023)
Number of bathrooms	337,375***
	(13,165)
N	98,759
Municipality FE	Yes
Year FE	Yes
R^2	0.29

Table B.1: Predicting house prices based on equation (6).

Notes: Estimates from regressing the house purchase price on household attributes. Sample: only houses reportedly sold at market value and excluding sales from parent to child.

	(1) $\bar{w}_i$	(2) $city^p$	(3) $income^p$	(4) $educ^p$	(5) $children^p$	(6) entry-age	(7) hprice	(8) income	(9) educ	(10) city	(11) members
p_i^{20w}	0.0967***	0.0348***	370376.9***	0.114***	-0.0438***	-0.270***	790181.1***	177537.6***	0.150***	0.0708***	0.145***
	(0.00744)	(0.00338)	(13992.6)	(0.00697)	(0.0135)	(0.0590)	(31148.7)	(7807.1)	(0.00724)	(0.00618)	(0.00489)
$city^p$	0.0625***										
	(0.0159)										
$income^p$	4.51e-09										
	(4.03e-09)										
$educ^p$	0.00147										
	(0.00815)										
$children^p$	-0.0240***										
	(0.00388)										
enry-age	-0.0165***										
	(0.000910)										
hprice	3.53e-08***										
	(1.92e-09)										
income	-2.47e-08***										
	(7.60e-09)										
educ	0.0817***										
	(0.00774)										
city	0.113***										
	(0.00906)										
members	-0.0198										
	(0.0123)										
N	18,294	18,294	18,294	18,294	18,294	18,294	18,294	18,294	18,294	18,294	18,294

Table B.2: Regression results from estimating equation (7) (Col.1) and the covariance-terms in equation (8) (Col.2-11).

	Housing market measures	
Inter-generational wealth components	Age of entry & Purchase price	Homeownership at 27, 30, 33, 36
Parental wealth	0.10 (66%)	0.08 (55%)
Parental attributes	0.01 (3%)	0.01 (5%)
Household attributes	0.01 (9%)	0.02 (13%)
Housing outcomes	0.03 (22%)	0.04 (27%)
Sum	0.15 (100%)	0.15 (100%)

Table B.3: Big-city sample: Components of inter-generational wealth persistence as defined in equation (8).

Notes: Households are divided into two groups; those whose parents have below median financial wealth in the year the household is 20 (Low FW) and those whose parents have above median financial wealth in the year the household is 20 (High FW). The homeownership rate gap at age 30 is decomposed into the four channels outlined in equation (2). Only individuals who reside in a big city are included in the sample.

	Housing market measures	
Inter-generational wealth components	Age of entry & Purchase price	Homeownership at 27, 30, 33, 36
Parental wealth	0.10 (67%)	0.07 (57%)
Parental attributes	0.01 (4%)	0.01 (4%)
Household attributes	0.01 (9%)	0.03 (16%)
Housing outcome	0.03 (20%)	0.04 (24%)
Sum	0.14 (100%)	0.13 (100%)

Table B.4: Maximum one sibling sample: Components of inter-generational wealth persistence as defined in equation (8).

Notes: Households are divided into two groups; those whose parents have below median financial wealth in the year the household is 20 (Low FW) and those whose parents have above median financial wealth in the year the household is 20 (High FW). The homeownership rate gap at age 30 is decomposed into the four channels outlined in equation (2). Only households with an average maximum of one sibling are included.

C Simple example: investing in housing vs. stocks

In this appendix we provide some simple calculations meant to illustrate housing market returns in different countries. We make two main points. First, housing market returns have been especially high in Norway compared to other countries. Second, with realistic assumptions about leverage, the housing market is found to outperform the stock market for all countries considered here.

Figure C.1 depicts nominal house price indices for different countries[18], as well as a nominal stock price index, here captured by the NASDAQ. Two points are worth highlighting. First, the stock market index has grown faster than house prices in all countries considered. Second, house price growth has been higher in Norway than in the other countries considered, i.e. the US, the UK and Sweden.

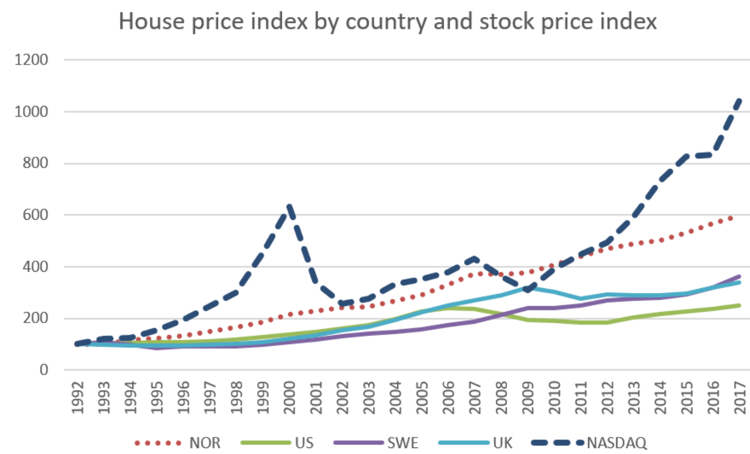


Figure C.1: Price indices for housing (by country) and stocks.

Simply looking at price indices ignores the important role of leverage. The average household is highly leveraged when investing in housing, and not leveraged when investing in stocks. To capture the importance of leverage we do some simple calculations. Specifically, we compare the following two investments:

1. Invest \$100 in 1992 as a downpayment on a house worth \$1,000, implying an initial leverage of 0.9. Pay an annual interest rate on the mortgage, and pay down 1/25 of the mortgage each year over the next 25 years.

2. Invest \$100 in stocks in 1992, at zero leverage. Each year, invest an additional amount equal to the interest rate cost in 1.

Figure C.2 depicts equity from investment 1. in different countries, and equity from investment 2. Note that the Norwegian housing market now outperforms the stock market. This is due to an average leverage ratio of 0.26 in the housing market, which is below the

[18]The Norwegian house price index is from Statistics Norway, the US house price index is the S&P/Case-Shiller U.S. National Home Price Index from FRED, while the house price indeces from Sweden and the UK are from the OECD.

average observed leverage ratio in the data. For the other countries in the sample, the stock market still outperforms the housing market.

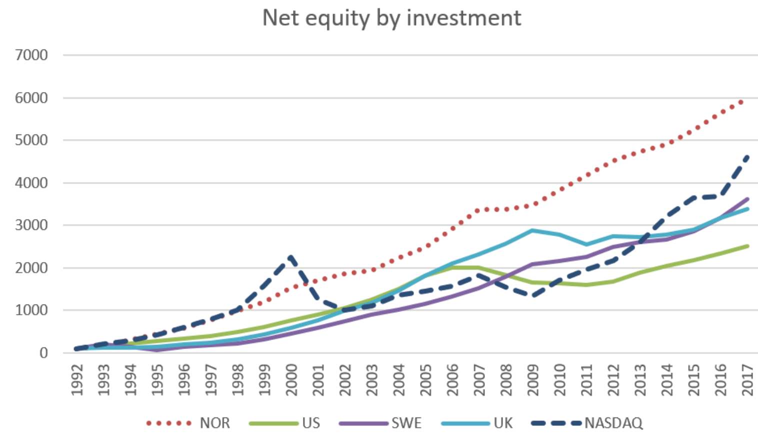


Figure C.2: Equity by investment in housing (by country) or stocks.

Are there realistic assumptions which can make the housing market outperform the stock market in other countries as well? Yes, for instance, consider changing the investment strategy in 1. so that mortgage is re-financed every ten years. Specifically, we assume an initial leverage ratio of 0.8, allowing for an initial gross housing investment of \$500. Every ten years (i.e. in 2002 and 2012), we let housing wealth and debt adjust so that the leverage is again 0.8. Of course, this also implies higher mortgage payments, so that the additional stock market investments under strategy 2 also adjusts. Given this alternative investment strategy, which increases the average leverage to roughly 0.5, the return on the housing investment exceeds the return in the stock market for all countries in the sample – see Table C.1.

The above calculations ignore the riskiness of the investment. While the stock market has the highest realized return, is also has a substantially higher volatility. Table C.1 reports Sharpe ratios for the different housing markets and the stock market. Again, the Norwegian housing market stands out by offering the lowest volatility and the highest Sharpe ratio. The Sharpe ratio for housing investments in similar to that in the stock market in the UK and Sweden. In the US, the stock market provides a higher Sharpe ratio than the housing market.

	Housing					
	Norway	US	Portland-US	Sweden	UK	Stocks
Equity	6,000	2,500	3,500	3,600	3,400	4,600
Avg. leverage	0.26	0.34	0.29	0.39	0.35	0
Avg. price growth (nominal, %)	7.5	3.9	5.4	5.5	5.2	12
Standard deviation (nominal, %)	4.3	5.8	6.9	5.9	6.6	20
Sharpe ratio (nominal)	1.3	0.3	0.5	0.6	0.5	0.5
With re-leveraging:						
Housing equity - stock equity	9,000	500	4,700	2,900	1,100	-
Average leverage	0.50	0.53	0.49	0.57	0.55	0

Table C.1: Investing in housing vs. stocks.

Notes: The upper panel compares the return from investment strategy 1. and 2. as described in the text. The Sharpe ratio is calculated assuming a risk-free return of 2%. The lower panel ("With re-leveraging") assumes an initial LTV-ratio of 0.8, and a refinancing back to 0.8 leverage every ten years.

D Decomposition of different channels with multiple parental and household attributes

Suppose now that we relax the assumption of a single parental attribute p_i^o or household attribute x_i when decomposing housing gaps (Section 3.1) or inter-generational wealth persistence (Section 6.1), and instead assume that the outcomes considered depend on a vector of attributes. Specifically, we consider a vector of household attributes $x_{1,i}, \cdots, x_{m,i}$ with m elements, and a vector of parental attributes $p_{1,i}, \cdots, p_{n,i}$ with n elements.

In this case, we can write

$$y_i = \beta_0 + \beta_1 p_i^w + \delta_1^p p_{1,i}^o + \cdots + \delta_n^p p_{n,i}^o + \delta_1^x x_{1,i} + \cdots + \delta_m^x x_{m,i} + \eta_i \tag{26}$$

where $y_i \in \{\bar{w}_i, h_i\}$.

Taking the covariance and scaling by the variance of parental wealth, yields

$$\frac{cov(h_i, p_i^w)}{var(p_i^w)} = \underbrace{\beta_1}_{\text{i)parental wealth}} + \underbrace{\left[\delta_1^p \frac{cov(p_{1,i}^o, p_i^w)}{var(p_i^w)} + \cdots + \delta_n^p \frac{cov(p_{n,i}^o, p_i^w)}{var(p_i^w)}\right]}_{\text{ii)parental attributes}}$$
$$+ \underbrace{\delta_1^x \frac{cov(x_{1,i}, p_i^w)}{var(p_i^w)} + \cdots + \delta_m^x \frac{cov(x_{m,i}, p_i^w)}{var(p_i^w)}}_{\text{iii)hh attributes}} + \underbrace{\frac{cov(\eta_i, p_i^w)}{var(p_i^w)}}_{\text{iv)unobservables}} \tag{27}$$

E Model Appendix

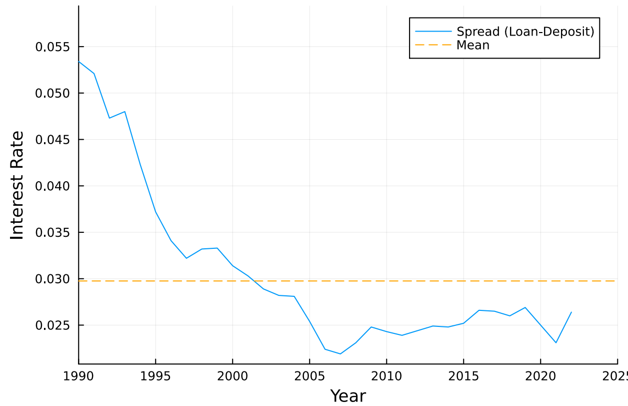
E.1 Numerical Details

The problem is solved backwards, by first solving the value function of a retiree at age T, when death is certain. For each discrete choice, we solve for optimal consumption choice using Brent's root-finding algorithm. The optimal policy is then given by the discrete choice, and it's associated consumption choice, that maximizes utility. This process is repeated backwards, until age $a = T^s$.

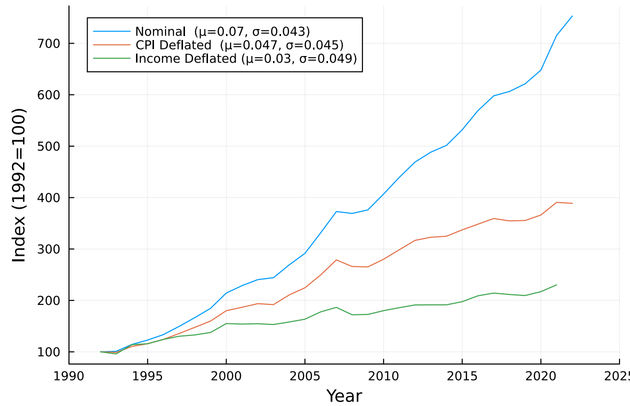
The persistent income shock is discretized following Rouwenhorst (1995), while other shocks are discretized on equal probability basis. That is, for n grid points, the probably of each outcome is $1/n$ and the values of the shock at each grid point is equal to the midpoints of the $n - 1$ quantiles of the underlying distribution.

The persistent income shock ν follows a 4-state Markov chain process, and the transitory income shock is discretized to 2states, while The house price shock has discretized to 5states. The net worth x and price p grids are both unevenly spaced, with higher density for lower values with 63and 7grid points, respectively. For values not the grids we use linear interpolation.

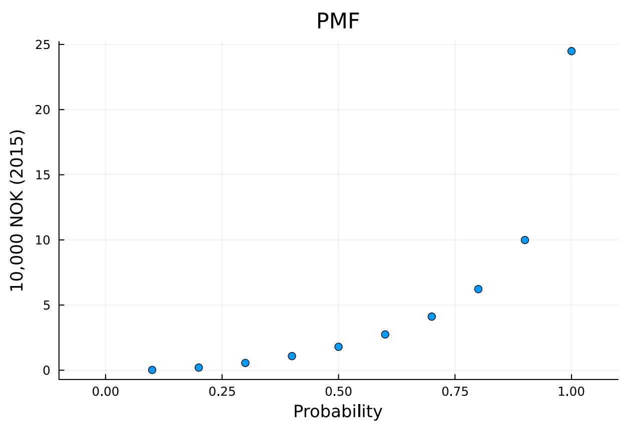
The model is solved in Julia `1.8.5`, and in addition to standard packages we use `Interpolations.jl v0.14.7` and `Optim v1.7.4` for interpolation and optimization routines.



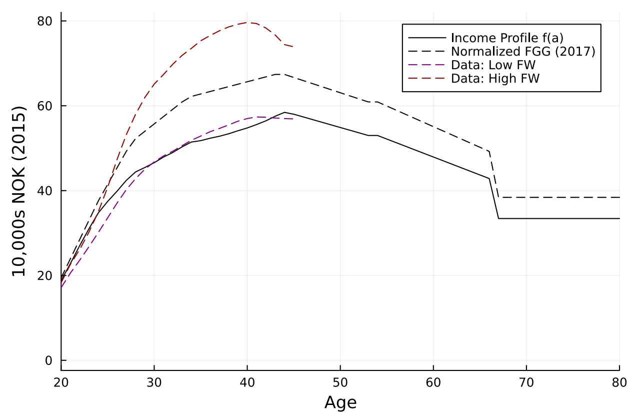
(a) Mortgage Premium r_m



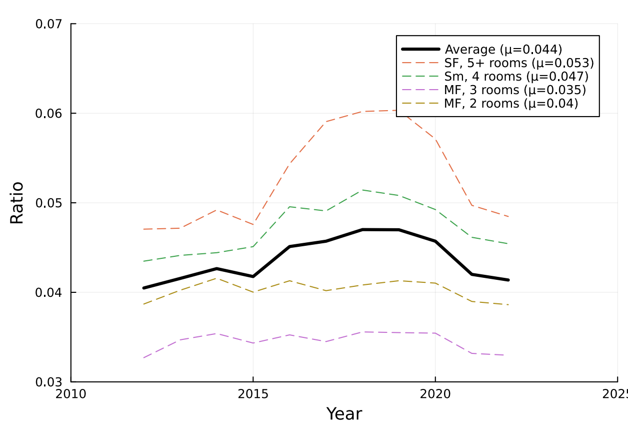
(b) House Prices



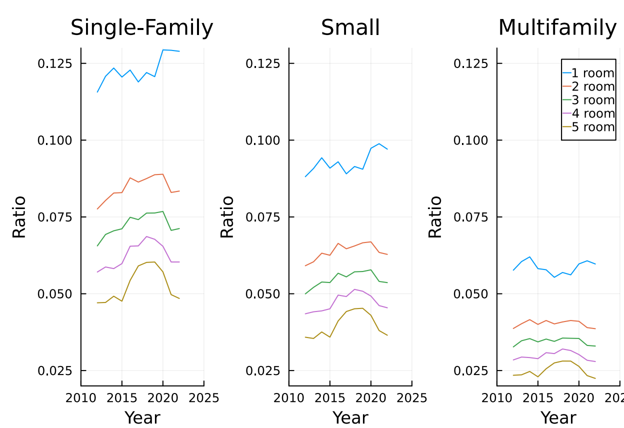
(c) Initial Wealth



(d) Calibrated Income Process



(e) Rent-to-Price Ratios, Select Sizes and Units



(f) Rent-to-Price Ratios, All Sizes and Units

Figure E.1: Calibration Figures