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Lofty pine and clinging vine

The educational 'Great Gatsby Curve' and the role of house prices

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Abstract: We investigate the heterogeneous and nonlinear intergenerational transmission channels of education and the impact on this of house price appreciation. Using the China Household Finance Survey 2011, we construct household history of property purchases and educational investment over the past 16 years with current filial educational achievement. Using quantile instrumental regressions, we find that through tightening households' credit constraints, rising house prices weaken the paternal intergenerational educational correlation by 38 per cent (from 0.366 to 0.226) but enhance the maternal correlation by 84 per cent (from 0.165 to 0.303). Decomposition analysis indicates the existence of glass-ceiling effects for females and rural offspring aiming to achieve high educational attainment due to narrower opportunities, and also glass-floor effects for urban offspring due to more endowment, which in turn leads to gender and urban–rural educational gaps across generations. The opportunity effect drives increasing intergenerational persistence of education over time.

Keywords: quantile instrumental regressions, decomposition, housing, intergenerational mobility, education
JEL classification: D31, D63, R31, I24

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1 Introduction

The literature of intergenerational mobility has thoroughly documented a positive parent–child association in income (Chetty et al. 2014a, 2014b; Lefgren et al. 2012), wealth (Boserup et al. 2013), occupation (Long and Ferrie 2013), health (Eriksson et al. 2014) and education (Qin et al. 2014), socioeconomic status (proxied by surnames, in Clark 2014), and even habits (Schmidt and Tauchmann 2011), attitudes (Dohmen et al. 2012), and criminal conviction (Hjalmarsson and Lindquist 2012). The persistence crosses as many as three to four generations e.g. the UK (Chan and Boliver 2013), Sweden (Hällsten 2014), and the US and Germany (Hertel and Groh-Samberg 2014). The cross-country studies suggest that the higher the cross-sectional inequality, the more likely it is to be transmitted as an intergenerational phenomenon (Corak 2013), even when nonlinearly as in Nordic countries (Bratsberg et al. 2007).

The existing empirical literature has focused disproportionately on income in industrialized countries e.g. Sweden (Björklund et al. 2012).[1] Strong income and class solidarity have also appeared in emerging markets witnessing fast and rising inequality along with economic growth such as China (Deng et al. 2012; Chen 2013), India (Hnatkovska et al. 2013), Brazil (Dunn 2007), and Chile (Nunez and Miranda 2010).[2] In the absence of well-functioning markets and social protection systems, populations are likely to experience dual inequalities—during the course of their lifetime and extending to the next generation—constituting an intergenerational vicious circle.

By exploiting a recent nationally representative survey in China, this paper investigates what has been hitherto a relatively neglected subject in the intergenerational inequality literature in the context of transition economies, albeit one that is growing in importance over time and becoming the main cause of intergenerational persistence in other dimensions, namely the intergenerational transmission of human capital in terms of educational attainment. Our empirical analysis pays particular attention to heterogeneity in educational transmission and the underlying mechanism of persistence through the lens of housing assets, given recent concern with rising wealth inequality.

Specifically, there are two forms of heterogeneity in educational transmission. First, gender effects between parents and children can be heterogeneous. The father–son income link is found to be stronger than the mother–daughter one (see e.g. Chadwick and Solon 2002). However, mothers' IQ seems to have a slightly stronger intergenerational link than fathers' IQ, and the mother–daughter transmission of cognitive skills is reported to be stronger than that between fathers and sons (see e.g. Anger and Heineck 2009).

Intergenerational transmissions of education can be nonlinear, resulting in the second form of heterogeneity. Nonlinearity depends not only on children's observables such as age, which captures the lifecycle bias (Grawe 2006), health and nutrition (Carvalho 2012), and children's unobservables such as innate ability or heritability (Dardanoni et al. 2008), but also on parents' and families' characteristics such as household assets (Huang 2013), credit constraints (Grawe

[1] See Causa and Johansson (2010) for a review of intergenerational social mobility in OECD countries.

[2] See Hertz et al. (2007) for 42 developed and developing countries. They calculated the intergenerational correlation coefficient: it is 0.2 in rural China in 1995, 0.4 in Western Europe, 0.46 in the US, 0.55 in Indonesia, 0.59 in Brazil, and 0.6 in South America. India shows a coefficient of 0.443 in 2006 (Emran and Shilpi 2015). It seems that China is more mobile across generations, but their dataset is early and the present study further focuses on housing.

2004), family structure (Martin 2012), social capital (Heath et al. 2010), and social environment (Patacchini and Zenou 2011).

Wealth, among other household characteristics, further confounds the heterogeneously intergenerational transmissions of education. Elliott et al. (2011) review a generally positive impact of household assets (financial resources) on children's academic achievement. Nevertheless, if considering the distribution of wealth, which is one source of aforementioned heterogeneity, the intergenerational transfer would vary across households faced with different constraints and opportunities (Atkinson 2015). Indeed, wealth inequality has surpassed unequal income and become a major concern in both industrialized (as reviewed by Piketty and Saez 2014) and developing economies e.g. India (Zacharias and Vakulabharanam 2011). We pay particular attention to housing wealth, which constitutes the largest element of household net worth (Cowell and Van Kerm 2015 for 15 European countries; Xie and Jin 2015 for China) and the rise in aggregate wealth comes almost entirely from appreciation in housing capital (Liu et al. 2015 for urban China; Rognlie 2014 for eight developed countries except the US).

On the one hand, if regarding the house property value as a proxy for parents' lifetime income and/or offspring's inheritance (Karagiannaki 2012), one may expect that house price appreciation promotes household consumption through loosening either the household's lifetime budget constraint (pure wealth effect as in Johnson 2014) and/or the household's borrowing constraint in the consumption Euler equation (borrowing collateral effect as in Cooper 2013). Micro panel data in Denmark do not support the former (Browning et al. 2013). However, based on the US data, it appears that the positive wealth effect on household consumption stemming from rising house prices is substantially larger than that from shocks to financial wealth (Carroll et al. 2011). As a result of increased wealth, parents increase human capital investment in children and thus, filial education relates positively to house prices (Cooper and Luengo-Prado 2015). Increases in house prices in children's early life also push up their income in adulthood with an elasticity of 0.9 in the US (Cooper and Luengo-Prado 2015). If better-educated parents invest more in child education in the presence of either effect, house price appreciation will suggest a positive relationship with intergenerational transmission of education and this relationship becomes stronger with parents' higher educational levels, which provides a source of nonlinearities.

On the other hand, however, if households are not able to divest assets easily in bad times, which is typically the case in transition economies with market imperfections or when simultaneous selling behaviour supresses prices (Fafchamps 2003),[3] or if they regard housing as a consumption/status good in addition to its role of asset, i.e. dual functions in urban China, (Liu et al. 2015; Li and Wu 2015), one may envision tightened budget constraints and a cost burden faced by parents, e.g. Italy, Germany, UK, Spain, and France (Deidda 2015). House price appreciation also directly affects credit markets and thus reduces credit availability for households within a region (Ramcharan and Crowe 2013). Therefore, those parents without credit constraints can borrow from their children's future income and invest optimally in their

[3] It is worth noting that households may not be willing to refinance out of housing equity. Since housing is a necessity, the utility consequences of the risk of refinancing out of housing equity might be large. This is particularly the case in transition economies such as China where the majority own one residential property. In the absence of suitable financial products to insure this risk, the life-cycle model with UK and US data predicts that individuals would invest in housing early in the life cycle as a way of insuring future price fluctuations (Banks et al. 2004). This leads to higher owner-occupation rates, more housing wealth, and less propensity to realise capital gains on housing through refinancing to fund non-housing consumption.

children's human capital, while the credit-constrained families would invest optimally in activities other than child education (Grawe 2004). Rising house prices would then result in less intergenerational transmission for credit-constrained parents, which in turn also provides a source of nonlinearities. Indeed, there is no consensus on the impact of credit constraints on intergenerational mobility, e.g. income mobility (Black and Devereux 2011).

House price appreciation may also change the distribution of wealth and income through its impact on the property value (Xie and Jin 2015). In the presence of nonlinear intergenerational transmission, the consequences of these distributional changes on filial educational attainment remain unclear. Moreover, house prices on both counts are likely to affect households' decision-making nonlinearly (e.g. Campbell and Cocco 2007), which further adds to heterogeneity in intergenerational transmission of education.

This paper contributes to the literature on intergenerational mobility in the following three ways. First, it adds to existing knowledge on the nonlinear and heterogeneous intergenerational transmission of education, especially in transition economies. Taking individual and household heterogeneity into account, we use quantile regression to estimate an educational 'Great Gatsby Curve', in the language of Alan Krueger (Corak 2013), on the entire distribution of filial education. We also dissect this curve between fathers' and mothers' transfer and between various demographic groups based on urban–rural divide, child gender, birth cohorts and timing of purchasing properties relative to that of investing in child education. Second, the above analysis reveals the role of housing in intergenerational transmission of education by examining separately the credit-constraint and wealth effects and their interaction terms with parents' education and household wealth in quantile estimation. Third, this paper further investigates the (nonlinear and heterogeneous) sources of differences in house-price-adjusted intergenerational educational transmission between demographic groups (defined in our first contribution) by decomposing conditional quantile functions. Not only can the distribution of parents' education, house prices, household wealth and other socioeconomic factors affect filial educational attainment, but also the differences of these distributions between groups would incur intergenerational inequality in education.

Our analysis points to significant mother–child educational association, which is likely to be driven by urban families and the '90s cohort, and the magnitude is larger for daughters than for sons. The later the family bought the first residential property during their children's schooling, the stronger the maternal transmission of education. The largest increase in intergenerational persistence is realized when the purchase happens after the children's secondary education. The maternal transmission of education suggests nonlinearities along with higher education of mothers, parents' income, and household wealth. House prices change the maternal transfer, but this impact is subject to substantial heterogeneity between demographic groups and within the distribution of parents' and household characteristics within a group. The endowment effects drive urban–rural differences in intergenerational transmission of education, while the opportunity effects explain much of the increasing persistence of intergenerational inequality of education over time.

The remainder of this paper unfolds as follows. The next section describes the data and explorative statistics. Section 3 spells out the empirical model and decomposition. Section 4 continues with discussion of the results. Section 5 concludes with implications for policy-making in education as well as in real-estate markets to weaken the transfer of educational inequality from one generation to the next.

2 Data

2.1 Data source

The present study uses the China Household Finance Survey (CHFS) collected by the Survey and Research Centre for China Household Finance at the Southwestern University of Finance and Economics in 2011. It is nationally representative and includes individual and household level information, particularly assets and debts.

The CHFS adopted stratified sampling, selecting units with probability proportional to size. It includes 29,324 individuals out of 8,438 households spread across 320 communities in 80 counties of 25 provinces.[4] We further select sample offspring according to the following two criteria: (1) they were aged 20 or below when the household purchased its first residential property (actually those who were born after the Cultural Revolution (1966–1976)); and (2) the household acquired its first residential property with non-zero expenditure after 1994 when China implemented major reforms to housing and property markets (Liu et al. 2015)—'subsidized housing' in terms of allocation of free housing in the socialist egalitarian era was abandoned and households had to purchase properties from property markets. The motivation for the above selection was to focus on parents who confronted educational and house ownership decisions simultaneously. House prices faced by households at the time of purchase could play a role in the family's coordinated decision-making process and thus would affect their children's educational achievement in adolescence. Nevertheless, one may be concerned with endogeneity caused by this simultaneous decision-making. There is actually a trade-off between using the full or our selected samples. The former is less affected by endogeneity in simultaneous decisions than the latter, but it suffers from radical institutional changes in both housing (i.e. the reform in 1994 as stated above) and education—education services, especially college/university education, were severely interrupted or even stopped during the Cultural Revolution. These institutional interventions invalidated individual optimal decision-making. Thus, it is unable to test for two channels of house prices in education as reviewed in Section 1. Considering this and the possibility of instrumenting house purchases and thus house prices, we chose the selected sample in the present study.

1,776 individuals (aged between 15 and 32 in 2011), out of 1,341 households in all 25 sample provinces, remained after excluding missing values. Of these, 57 per cent (43 per cent) were male (female) and 53 per cent (47 per cent) lived in urban (rural) areas. We also checked the balances between our selected samples and the original dataset by testing the mean of various socioeconomic indicators. There are no statistically significant differences in parents' education, household per adult equivalent income/wealth, the number of residential properties, total expenditure on the first residential property, or house prices measured by the expenditure per square metre on the purchase of the family's first residential property.[5]

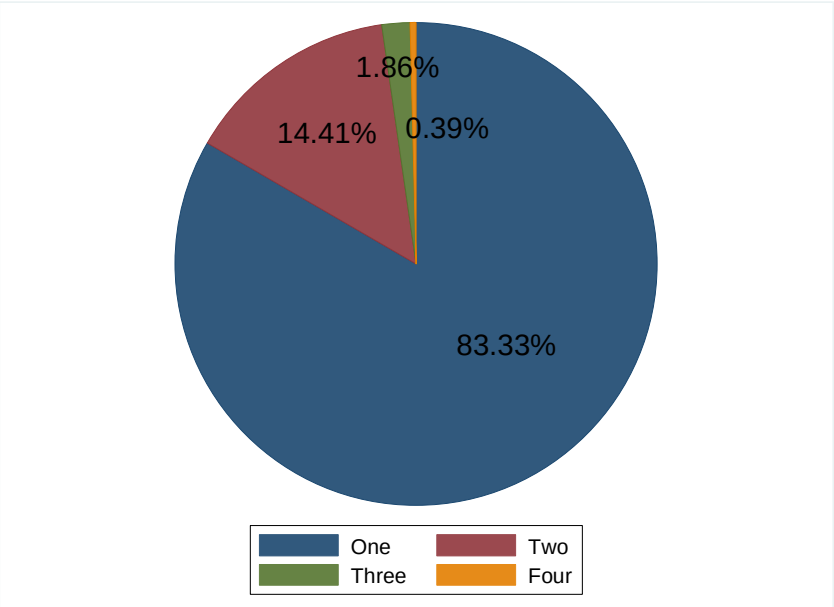
Our selection process ensures that all sample households have owned at least one property. The constructed dataset is representative in different ways. 27 per cent of sample individuals have siblings who are also selected samples and used in estimation. 20 per cent of sample individuals

[4] See http://www.chfsdata.org/ for detailed description of the CHFS (accessed on 10 January 2016).

[5] Filial age and education are different at 1 per cent significance level. This is predictable given our sample selection: only those aged between 15 and 35 in the 2011 survey were kept (aged 0–20 when their families bought the first property), and those aged 36 or above were excluded. The excluded individuals had lower educational attainment owing to the very low development level of the country or the influences of the Cultural Revolution.

did not live with parents at the time of the survey.[6] About 17 per cent of the selected sample households own more than one property (Figure 1). Nearly 70 per cent of households have full ownership of their properties (Figure 2), while other kinds co-exist due to transitioning property markets and concurrent social welfare reforms.

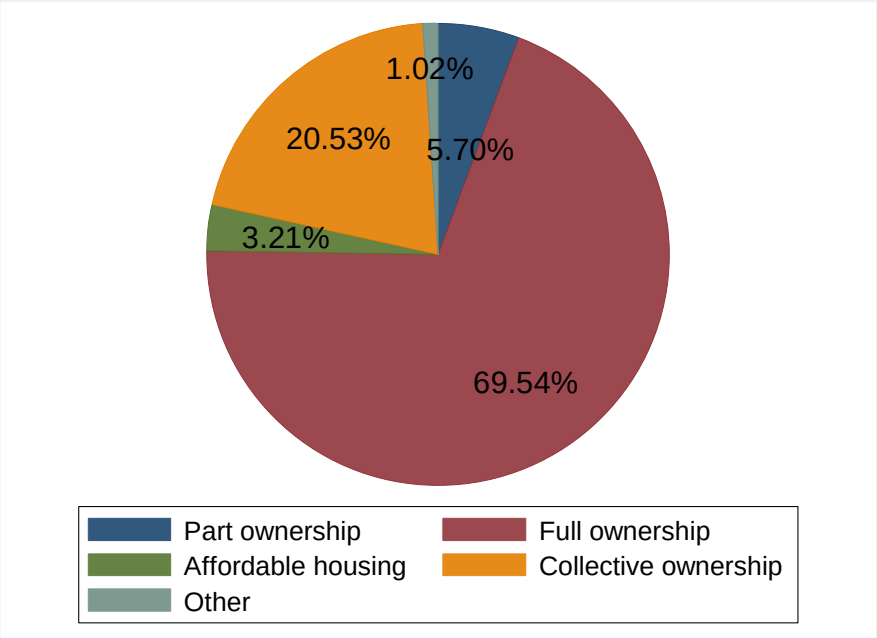
Figure 1: Distribution of the number of properties owned by the household



Source: Authors' calculation based on the CHFS.

[6] One may be concerned with endogeneity in living arrangement caused by high house prices. Given our sample selection, 77 per cent (72 per cent) of samples co-residing (not living) with parents in 2011 are aged 15–23, indicating that living arrangement is largely determined by educational requirements rather than house prices.

Figure 2: Structure of property ownership

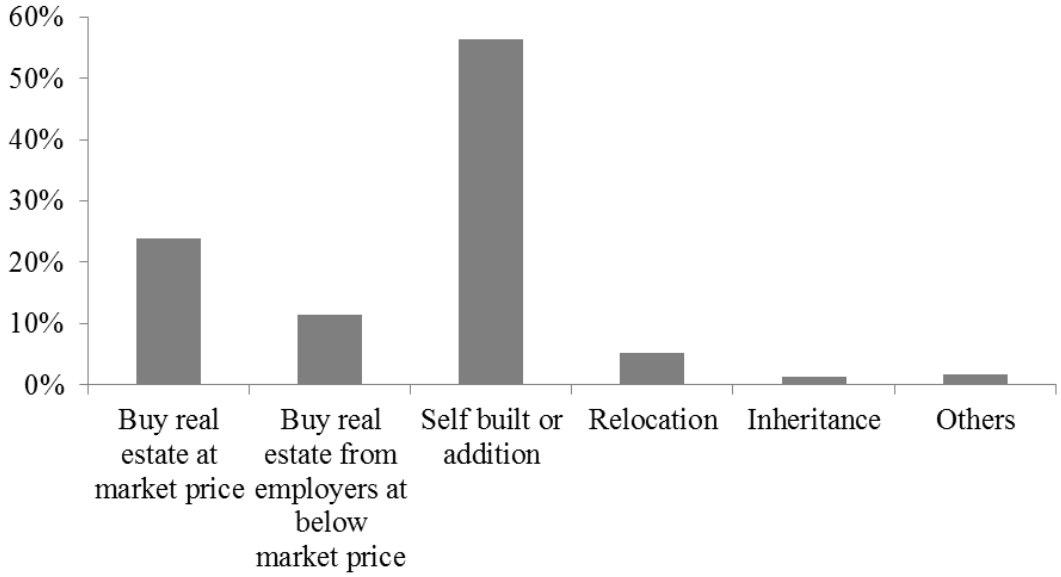


Source: Authors' calculation based on the CHFS.

We define the house price as the unit price (*yuan* per square metre) paid by the household for their first residential property. The housing and social welfare reforms of 1994 caused a range of house prices. As shown in Figure 3, a quarter bought properties from markets and paid market prices. As a 'holdover' from the socialist social welfare institution, 11.5 per cent paid partial market prices as they bought properties from employers who provided subsidies to make up the price difference. Nearly 60 per cent built their properties by paying market costs for labour and material. This typically happened among rural households—68 per cent of households constructing their properties lived in rural areas. Irrespective of how households acquired their first property, our sample selection criteria ensure that every household incurred non-zero payment for housing and thus faced non-zero house prices, either at or below market levels. It is worth noting that the purpose of this paper is to examine the role of house prices *experienced* by households when they have to make decisions on human capital investment in the next generation. The mechanism forcing different house prices, structure of real-estate markets, or the comparison of welfare consequences between different kinds of house price are beyond the scope of this paper.[7] We will separately examine subgroups (such as urban–rural divide) to account for different kinds of house prices and restrict samples to the market prices in the robustness check.

[7] The real average price of the first property (at 2010 price level) was 1,298.99 yuan for urban households and 602.58 yuan for rural households (which is consistent with 673.4 yuan in 2010 based on the Rural Household Survey conducted by the NBS). Nevertheless, cost per square metre has increased proportionately faster for rural than for urban households (Figure 4). The burden of house expenditure (house price-income ratio) is equivalently high between rural and urban households (Table 1). We included households' residential places and registration types as covariates to control for urban–rural differences and used weighted regressions to correct for any possible sampling bias. The weights are sampling weights (probabilities of being sampled) calculated by the CHFS team.

Figure 3: Methods of acquiring the first property



Note: 'Relocation' means households relocate due to government planning. According to the official documents, they can obtain monetary subsidies from the government based on the size of their previous property and buy a new one somewhere else. They have to pay the price difference if the subsidy is not enough for the new purchase.

Source: Authors' calculation based on the CHFS.

2.2 Income, wealth, and educational portfolios

We describe sample households' livelihood in Table 1. A rural household's annual net income is only 57 per cent of an urban household's. The gap in wealth is much more severe—the former's total wealth is only 30 per cent of the latter's, as a result of 79 per cent less housing and 73 per cent less financial assets than the latter's.

Table 1: Household livelihood profile

	Full sample	Urban	Rural
Household size (adult equivalent)	2.649	2.508	2.809
No. of properties	1.196	1.232	1.147
Size of the first property (use, m^2)	128.240	118.378	141.485
Unit (m^2) price of the first residential property (*yuan*)	1,014.648	1327.397	588.477
Net annual income per adult equivalent	13,952	17,032	9,694
Wealth per adult equivalent	237,109	334,957	101,894
Housing assets per adult equivalent	187,370	280,180	59,118
Financial assets per adult equivalent	21,267	30,688	8,248
Share of hhs borrowing loans for housing[a]	35.12	32.78%	38.37%
(Total housing loans[b])	(54,804)	(73,919)	(32,237)
of which:			
Share of hhs borrowing from bank[c]	11.46%	14.12%	8.33%
(amount, *yuan*)	(128,455)	(164,074)	(57,216)
Share of hhs borrowing from other sources, including relatives, friends, and other institutions (amount, *yuan*)	82.38% (50,832)	78.43% (65,933)	87.04% (34,767)
Share of hhs borrowing from both sources (amount, *yuan*)	6.16% (91,254)	7.45% (117,611)	4.63% (41,173)
Share of hhs having not completed repayment	100%	100%	100%
Ratio of total housing loans over household net annual income[d]	23.718	30.527	16.157
Ratio of total house price over household net income per annum	20.360	21.850	18.756
Share of hhs borrowing educational loans[a]	11.26%	7.97%	15.81%
(Total educational loans, *yuan*[b])	(9,821)	(13,196)	(7,470)
of which:			
Share of hhs borrowing from bank	11.92%	16.13%	8.99%
(amount, *yuan*)	(11,123)	(12,424)	(9,497)
Share of hhs borrowing from other sources, including relatives, friends, and other institutions (amount, *yuan*)	81.46% (8,430)	79.03% (11,719)	83.14% (6,253)
Share of hhs borrowing from both sources (amount, *yuan*)	6.62% (22,538)	4.84% (38,482)	7.87% (15,704)
Share of hhs having not completed repayment	100%	100%	100%
Ratio of total educational loans over household net annual income[d]	2.088	3.921	0.888

Note: a. The shares are calculated based on the sample size of each column.

b. Average amount of loans is calculated based on those who borrowed loans.

c. The shares are calculated among those who borrowed.

d. The average ratio is calculated among those who borrowed loans.

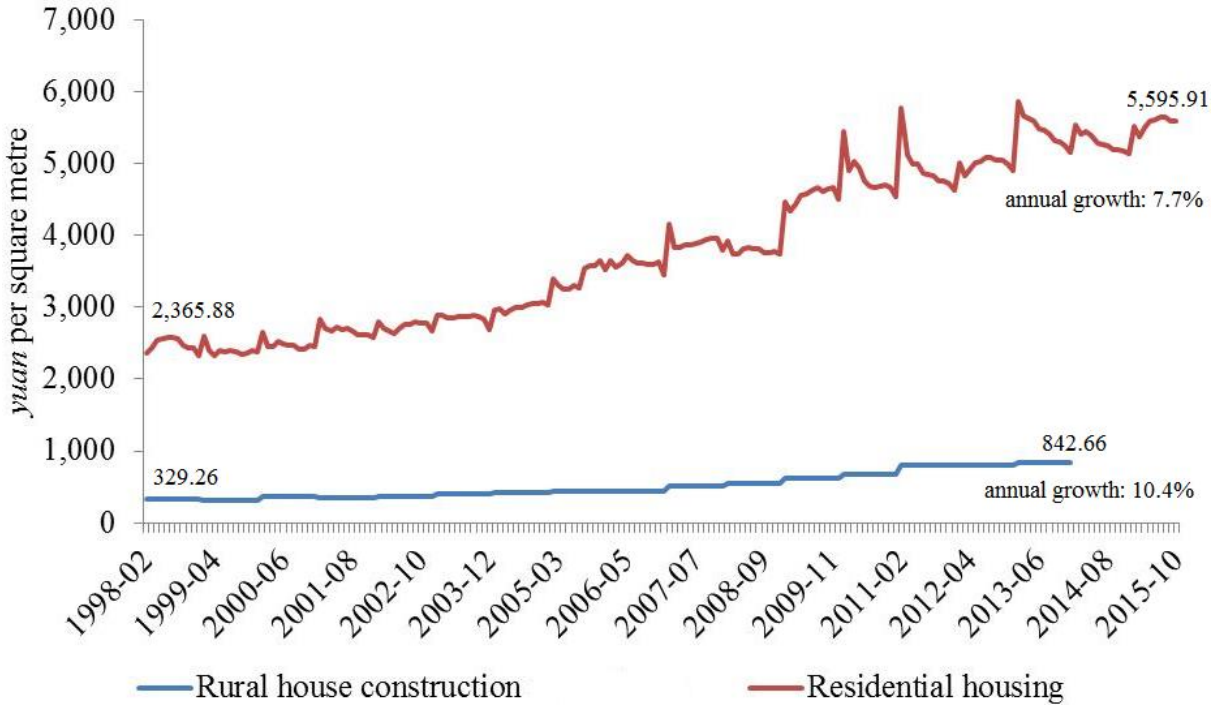
e. All monetary variables are in real terms at the 2010 price level. Deflators (2010=1) are consumer prices indices at the national, urban, and rural levels, separately.

Source: Authors' calculation based on the CHFS and price data compiled from China Statistical Yearbooks published by the NBS.

Since the reform in 1994 legalized privatization of housing, individuals have been responsible for obtaining their own properties. As shown in Figure 4, residential house prices have kept increasing and have more than doubled over the past 15 years. The annual growth rate has hit 7.7 per cent. Rural households, many of whom constructed their residential properties, suffered from an even quicker growth rate of costs (10.4 per cent). The average appreciation rate of house prices in our samples has a similar record of 9.4 per cent per annum since purchase. Rising house prices result in high house price-income ratios for both urban and rural households (around 20 in Table 1), which is likely to impose credit constraints on households. More than one-third of households borrowed formal and/or informal loans to purchase their first property. Borrowing happens more frequently among rural (38 per cent) than urban households (33 per cent) even though the house price experienced by the former is only 44 per cent that of the latter. Roughly, 82 per cent of borrowers had informal loans and this proportion was higher for rural households

(87 per cent). However, formal loans accounted for the main source of funding because of the large amounts required. Among those who had housing loans, on average 45.7 per cent (26.4 per cent) of the total price of urban (rural) households' first property relied on formal loans. The total loans are 30 (16) times as large as the urban (rural) household's net income per annum (Table 1).

Figure 4: Average selling/construction price of residential properties (1998–2015)



Note: Selling prices of residential housing are at the monthly level, while rural house construction prices are annual figures. We translated nominal monthly selling prices into real terms by using the monthly Consumer Price Index with the price in June 2010 being 1. Rural house construction prices are translated into real terms at the 2010 price level by using the Rural Housing Construction Price Index (2010=1).

Source: Authors' calculation based on data from Monthly Macroeconomic Report and China Statistical Yearbooks published by the NBS.

As shown by the household wealth portfolio in Table 2, housing assets have become the most important component of household wealth. Housing constitutes 84 per cent of the household's non-financial assets and 77 per cent (=92%×84% in Column 1 of Table 2) of its total assets. Urban households have a higher proportion of housing assets (92%×90%=83% in column 2 of Table 2) than do rural families (93%×65.4%=61% in Column 3 of Table 2). Urban households also own proportionally more financial assets (particularly bonds and equity security) and less debt than their rural counterparts. Despite low levels of debt for both rural and urban households, the former's debt–asset ratio is more than twice as high as the latter's.

Table 2: Household wealth portfolio

Assets	Full (%)	Urban (%)	Rural (%)
Non-financial assets	91.87	91.67	92.65
of which:			
Housing assets	84.17	89.96	65.40
Non-housing assets	15.03	10.04	34.60
Financial assets	8.13	8.33	7.35
Total assets	100.00	100.00	100.00
Debts	1.50	1.22	2.62
No. of households	1,341	778	563

Source: Authors' calculation based on the CHFS.

Inequality emerges with rising income and wealth. The Lorenz curves in Figure 5 suggest that wealth inequality is driven by unequal distribution of financial assets and housing, and is wider than income inequality. This is further demonstrated by the Gini coefficients in Table 3. The Gini coefficient of wealth has approached 0.6. Housing and financial assets suggest even higher Gini coefficients exceeding 0.7. Moreover, both urban and rural Gini coefficients are lower than that for the full sample (except financial assets), indicating a deeper cleavage between than within rural and urban groups.

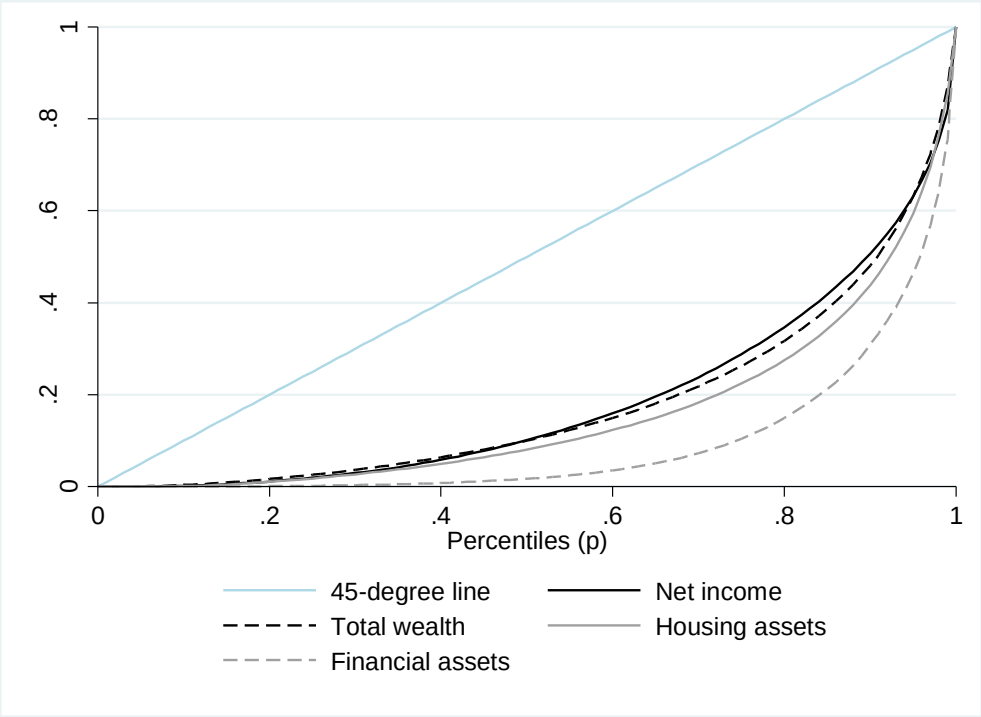
Table 3: Gini coefficients

Economic status	Full sample	Urban	Rural
Household net income per adult equivalent	0.565	0.540	0.536
Household wealth per adult equivalent	0.598	0.547	0.533
of which:			
Housing assets per adult equivalent	0.623	0.552	0.532
Financial assets per adult equivalent	0.767	0.728	0.787

Note: Considering the outliers, we trim off the highest and the lowest 1 per cent of households in the distribution of each indicator.

Source: Authors' calculation based on the CHFS.

Figure 5: Lorenz curves of household income and wealth per adult equivalent



Source: Authors' calculation based on the CHFS.

Education is categorized into seven levels—pre-school, primary school, junior high school, senior high or professional school, undergraduate or college, master's degree, and doctoral degree.[8] 15.8 per cent (8 per cent) of rural (urban) households have taken educational loans mainly from informal sources like their housing loans. Despite more rural borrowers, the size of educational loans is much larger for urban households than for rural families, being four times as large as the urban household's net income per annum or 89 per cent of their annual net income (Table 1). This is consistent with higher (and thus more costly) educational achievement observed among urban households (for both parents and offspring) than among rural households. The distribution of offspring's education in Table 4 points to proportionally more females receiving undergraduate degrees than males,[9] but the average educational achievement does not relate to gender. An average individual has obtained secondary education in senior high school and has an average father's and mother's education at junior high school and primary school levels, respectively. The offspring's generation appears to obtain higher educational achievement by, on average, one category than their parents'. The intergenerational educational correlation coefficient is 0.49 for mothers and 0.44 for fathers. This pattern holds in both urban and rural households, while the correlation coefficients are always higher for the former. Rural offspring, compared with their urban peers, are as likely to continue suffering educational disadvantage as their parents' generation.

Table 4: Distribution of educational levels

Education	Offspring		Parents	
	Male (%)	Female (%)	Father (%)	Mother (%)
Never attended school	0.49	0.53	4.00	10.53
Primary school	5.29	4.50	22.41	32.49
Junior high school	35.78	28.70	41.61	33.67
Senior high school or vocational school	33.63	31.08	21.73	16.61
Undergraduate/college	23.53	33.60	9.85	6.64
Master's degree	0.98	1.32	0.34	0.06
Doctoral degree	0.29	0.26	0.06	0.00
Total	100	100	100	100

Source: Authors' calculation based on the CHFS.

Overall, it appears that the purchase of property (house prices) faced by parents imposes a heavy financial burden on households though this is subject to substantial urban–rural differences. Households' educational borrowing and investment in children cannot be isolated from their house ownership decisions.

3 Model

3.1 Distribution-dependent determinants of filial education

The classic model of Becker and Tomes (1979, 1986) predicts strong dependence of child income on that of parents with limited funds for investing in their children. Solon (2004) adapts the model to account for the intergenerational transmission of education. The parents' utility function is derived from their own consumption and their children's. The steady-state intergenerational persistence hinges positively on parents' investment in their children's human

[8] We use years of education in estimation given that the model specification is for continuous variables. See Table A.1 in the Appendix for a complete list of variable definition and descriptive statistics.

[9] Females perform better than males in schools.

capital and parents' favourable endowments passed onto children through genetic and/or cultural inheritance. Parents' investment in their children's human capital is further determined by parents' income (borrowing constraints), altruism, expected returns to human capital investment, and available public resources in education supposing progressivity of education spending. Overall, the higher the pay-offs from investing in children's human capital, the more the parents are inclined to make that investment.

Motivated by the above theoretical models, we begin by estimating a benchmark education determination regression. The individual i's educational attainment in adulthood (in 2011) e_i is determined presumably by individual characteristics, family (including parental) background, and aggregated factors:

$$\begin{aligned} e_i = {} & \alpha + \boldsymbol{\beta}_1 \mathbf{X}_i + \theta_1 e_i^f + \theta_2 e_i^m + \theta_3 \ln H_h + \theta_4 e_i^f \ln H_h + \theta_5 e_i^m \ln H_h \\ & + \theta_6 A_h + \theta_7 e_i^f A_h + \theta_8 e_i^m A_h + \boldsymbol{\beta}_2 \mathbf{X}_h + \boldsymbol{\beta}_3 \mathbf{X}_p + \varepsilon_i \end{aligned} \quad (1)$$

Where $\mathbf{X}_i$ is a vector including i's own demographic characteristics such as gender and age.[10] e_i^f and e_i^m denote father's and mother's education, respectively, and reflect the parent–child educational association. $\mathbf{X}_h$ includes family characteristics such as the number of children in the family, controlling for competition for limited resources within a family where there is more than one child and the increased investment in child human capital because of lower childcare costs due to the one-child policy (Zhu et al. 2013), natural logarithmic family wealth per adult equivalent transmitting education through a pure wealth effect (Björklund and Jäntti 2009), the number of all residential properties owned by the household helping control for the wealth effect and decision-making on livelihood, the household's residential place (rural or urban areas) and registration type (rural or urban *Hukou*) which may affect the house price and educational services faced by the household. As reviewed in Section 1, $\ln H_h$ and A_h represent respectively two roles of housing in filial education—the house price paid by the household when their children were of school age (≤20 years old) and the annual appreciation rate of this house price since purchase. Interactions between these two housing-related variables and parents' education and household wealth per adult equivalent are also controlled for, in order to investigate the channels by which house prices play a role in household livelihood. The aggregated correlates at the province level are in $\mathbf{X}_p$, including the public investment in education, natural logarithmic GDP per capita in 2010, and other unobservables in provincial dummies. The disturbance ε_i follows the *i.i.d.* normal distribution. Considering heterogeneity between various demographic groups, we estimate Equation (1), by the standard (sampling-weighted) two-stage least square instrumental variable (2SLS-IV) approach to mitigate possible sampling bias and endogeneity in house prices. Standard errors are clustered at the household level throughout our analyses, given that 27 per cent of (finally selected) sample individuals have siblings who are also included in the final sample for estimation. Excluded instruments are the growth rate of provincial average house price, the growth rate of provincial urbanization, and natural logarithmic provincial GDP per capita, all of which were in the year immediately before the household purchased its first

[10] See Table A.1 in the Appendix for detailed definition and descriptive statistics of all variables.

residential property. We estimate Equation (1) for the full sample as well as different subsamples that are susceptible to having inter-group heterogeneity.

To allow for (intra-group) heterogeneity in distribution of filial education, we re-estimate Equation (1) in a two-step conditional quantile IV specification (Lee 2007):

$$\begin{aligned} Q_{e|\mathbf{e}^f,\mathbf{e}^m,\mathbf{A},\mathbf{X}}\left(u \mid \mathbf{e}^f,\mathbf{e}^m,\mathbf{A},\mathbf{X}\right) = {} & \alpha(\tau)+\boldsymbol{\beta}_1(\tau)\mathbf{X}_i+\theta_1(\tau)e_i^f+\theta_2(\tau)e_i^m+\theta_3(\tau)\ln H_h \\ & +\theta_4(\tau)e_i^f\ln H_h+\theta_5(\tau)e_i^m\ln H_h+\theta_6(\tau)A_h+\theta_7(\tau)e_i^f A_h \\ & +\theta_8(\tau)e_i^m A_h+\boldsymbol{\beta}_2(\tau)\mathbf{X}_h+\boldsymbol{\beta}_3(\tau)\mathbf{X}_p+\hat{v}_i(\tau)+u_i \end{aligned} \quad (2)$$

where τ denotes the quantile of filial education, ranging from 0.01 to 0.99 with an increment of 0.01; the disturbances follow $\mathbf{U}\sim U(0,1)$ independent of $\left(\mathbf{e}^f,\mathbf{e}^m,\mathbf{A},\mathbf{X}\right)'$. $\hat{v}_i(\tau)$ is the residual from the first-stage quantile regression of house prices with variables in Equation (2) and three excluded instruments as in 2SLS-IV. Consistent estimators are defined by

$$\left(\hat{\boldsymbol{\alpha}},\hat{\boldsymbol{\beta}},\hat{\boldsymbol{\theta}}\right)(\tau)\equiv\underset{\boldsymbol{\alpha},\boldsymbol{\beta},\boldsymbol{\theta}\in\Theta}{\arg\min}\,\mathrm{E}_n\left[\rho_\tau\begin{pmatrix} e_i-\hat{\alpha}-\hat{\boldsymbol{\beta}}_1\mathbf{X}_i-\hat{\theta}_1(\tau)e_i^f-\hat{\theta}_2(\tau)e_i^m-\hat{\theta}_3(\tau)\ln H_h \\ -\hat{\theta}_4(\tau)e_i^f\ln H_h-\hat{\theta}_5(\tau)e_i^m\ln H_h-\hat{\theta}_6(\tau)A_h \\ -\hat{\theta}_7(\tau)e_i^f A_h-\hat{\theta}_8(\tau)e_i^m A_h-\hat{\boldsymbol{\beta}}_2\mathbf{X}_h-\hat{\boldsymbol{\beta}}_3\mathbf{X}_p-\hat{v}_i(\tau)\end{pmatrix}\right] \quad (3)$$

$\hat{\theta}_1(\tau)$ and $\hat{\theta}_2(\tau)$ pick up heterogeneous transmission of education from parents to offspring at each quantile τ, unconditional on house prices. $\hat{\theta}_3(\tau)$ and $\hat{\theta}_6(\tau)$ point to which role house prices played in transmitting education across generations, while the estimates of interaction terms ($\hat{\theta}_4(\tau)$, $\hat{\theta}_5(\tau)$, $\hat{\theta}_7(\tau)$ and $\hat{\theta}_8(\tau)$) indicate through which channel this role was realized.

3.2 Counterfactual inferences and quantile decomposition of offspring education

We further decompose the differences in offspring education on its entire distribution between various demographic groups. Chernozhukov et al. (2013) develop a framework, in the spirit of Blinder-Oaxaca decomposition, based on counterfactual inferences to conditional quantile functions. According to them, this method allows covariates to change not only the location of filial education, but also the entire shape of its distribution. A quantile specification also better approximates the genuine conditional quantile function of filial education, especially when it has smooth conditional density.

We are interested in comparing a pair of demographic groups j and k, say urban and rural offspring. We first obtain the covariate distribution for each group, say k, by the empirical distribution function

$$\hat{F}_{\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k\right)=\frac{1}{n_k}\sum_{i=1}^{n_k}1\left\{\left(\mathbf{e}_{ik}^f,\mathbf{e}_{ik}^m,\mathbf{H}_{ik},\mathbf{A}_{ik},\mathbf{X}_{ik}\right)'\le\left(\mathbf{e}^f,\mathbf{e}^m,\mathbf{H},\mathbf{A},\mathbf{X}\right)'\right\} \quad (4)$$

Where n_k is the group size; the member of group k can only be observed if his/her observed characteristics are smaller than certain values $\left(\mathbf{e}^f, \mathbf{e}^m, \mathbf{H}, \mathbf{A}, \mathbf{X}\right)'$, i.e. individuals are categorized in this group k because they share certain observed traits. Then, we can define the conditional quantile function of offspring education in group j given covariates as below:

$$\mathbf{e}_j = Q_{e_j|\mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j}\left(u \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right) = P\left(\mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right)'\left(\hat{\boldsymbol{\alpha}}_j, \hat{\boldsymbol{\beta}}_j, \hat{\boldsymbol{\theta}}_j\right)(\tau) \qquad (5)$$

Where $\mathbf{U} \sim U(0,1)$; $P(\cdot)'$ is the linear combination of observed characteristics as the right-hand side of Equation (2); $\left(\hat{\boldsymbol{\alpha}}_j, \hat{\boldsymbol{\beta}}_j, \hat{\boldsymbol{\theta}}_j\right)(\tau)$ denotes the conditional quantile estimator for group j and is obtained as Equation (3). The corresponding conditional distribution is expressed by

$$\begin{aligned} &F_{e_j|\mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right) \\ &= \delta + \int_{\delta}^{1-\delta} 1\left\{P\left(\mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right)'\left(\hat{\boldsymbol{\alpha}}_j, \hat{\boldsymbol{\beta}}_j, \hat{\boldsymbol{\theta}}_j\right)(\tau) \le e_j\right\} \mathrm{d}u \end{aligned} \qquad (6)$$

Where $\delta \in (0,1)$ is a small constant and means trimming off the tail quantiles to avoid extreme values. Using urban households (group j) and their offspring as the status quo, the observed difference in the distribution of offspring education between urban and rural groups given their own observed characteristics is

$$F_{e_j|\mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right) - F_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_k \mid \mathbf{e}_k^f, \mathbf{e}_k^m, \mathbf{H}_k, \mathbf{A}_k, \mathbf{X}_k\right) \qquad (7)$$

Equation (7) can be broken down into two components:

$$\begin{aligned} &\underbrace{\left[F_{e_j|\mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right) - F_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right)\right]}_{Coefficients} \\ &+\underbrace{\left[F_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right) - F_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_k \mid \mathbf{e}_k^f, \mathbf{e}_k^m, \mathbf{H}_k, \mathbf{A}_k, \mathbf{X}_k\right)\right]}_{Characteristics} \\ &\underbrace{\left[F_{e_j|\mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right) - F_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right)\right]}_{Coefficients} \\ &+\underbrace{\left[F_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right) - F_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_k \mid \mathbf{e}_k^f, \mathbf{e}_k^m, \mathbf{H}_k, \mathbf{A}_k, \mathbf{X}_k\right)\right]}_{Characteristics} \end{aligned} \qquad (8)$$

where the counterfactual conditional distribution (i.e. the second and third terms in Equation (8)) is obtained by integrating an estimator of the conditional distribution $\hat{F}_{e_j|\mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j}\left(e_j \mid \mathbf{e}_j^f, \mathbf{e}_j^m, \mathbf{H}_j, \mathbf{A}_j, \mathbf{X}_j\right)$ with respect to an estimator of the covariate distribution in Equation (4):

$$\hat{F}_{e_k|\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(e_j \mid \mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j\right)$$
$$=\int_{\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\hat{F}_{e_j|\mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j}\left(e_j \mid \mathbf{e}_j^f,\mathbf{e}_j^m,\mathbf{H}_j,\mathbf{A}_j,\mathbf{X}_j\right)\mathrm{d}\,\hat{F}_{\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k}\left(\mathbf{e}_k^f,\mathbf{e}_k^m,\mathbf{H}_k,\mathbf{A}_k,\mathbf{X}_k\right) \quad (9)$$

As such, the effect of *coefficients* (opportunities) in Equation (8) is the change in filial education by holding urban households' observed characteristics but sequentially changing the structure of urban filial education to the rural one. By contrast, the effect of *characteristics* (endowments) is the change in filial education by holding the structure of rural filial education but sequentially changing the components of rural households' covariate distribution. Empirically, we will estimate and decompose filial education with and without housing-relevant variables. Comparison of results will inform the importance of housing in studying inheritance and accumulation of filial human capital.

4 Estimation results

4.1 Benchmark regressions

Tables 5–6 present the 2SLS-IV estimates for the full sample and subgroups. Over-identification tests and the overall statistical significance of the first-stage regression manifest satisfying instruments. We are interested in groups based on the urban–rural divide, gender and birth cohorts of the offspring, and the timing of buying the first property compared with filial education at the time of purchase. In particular, the latter could affect the role of house prices in intergenerational educational transmission given higher costs and returns at higher educational levels—a tug-of-war between these two forces influences parents' coordinated decision-making on housing and human capital investment at different stages of child education even when they face the same house prices and credit constraints.

Table 5: 2SLS-IV estimation (full sample and by urban–rural divide, gender and birth)

Independent variable	Full sample	Urban–rural Divide		Gender		Birth cohort	
		Urban	Rural	Male	Female	’80	’90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Housing							
Ln(House price)	-0.345	-1.304	0.711	-0.525	-0.187	-1.047	-1.000
	(0.539)	(1.092)	(0.881)	(0.656)	(0.742)	(0.911)	(0.634)
Annual appreciation of house price	0.0001	0.0001	0.0001	0.00002	0.000002	0.00003	0.00001
	(1.208)	(7.140)	(39.703)	(6.480)	(3.169)	(13.781)	(4.218)
Parents’ characteristics							
Father’s education	-0.121	-0.663	0.937	-0.298	0.247	0.190	-0.541
	(0.308)	(0.425)	(0.803)	(0.392)	(0.600)	(0.540)	(0.294)*
Ln(House price) ×father’s education	0.046	0.112	-0.117	0.082	-0.041	-0.006	0.110
	(0.050)	(0.073)	(0.156)	(0.070)	(0.110)	(0.110)	(0.042)***
Annual appreciation ×father’s education	-0.005	0.159	0.081	0.117	0.038	-0.409	0.052
	(0.367)	(0.319)	(3.282)	(0.513)	(0.575)	(1.193)	(0.512)
Mother’s education	0.298	0.237	-0.088	0.390	-0.035	-0.484	0.306
	(0.248)	(0.691)	(0.598)	(0.268)	(0.262)	(0.250)*	(0.253)
Ln(House price) ×mother’s education	-0.018	0.003	0.035	-0.042	0.076	0.107	-0.010
	(0.043)	(0.099)	(0.043)	(0.046)	(0.061)	(0.043)**	(0.046)
Annual appreciation ×mother’s education	-0.086	-0.194	-0.552	-0.128	-0.347	0.371	-0.179
	(0.242)	(0.622)	(1.619)	(0.452)	(0.520)	(0.457)	(0.220)
Father’s average return to education	0.392	0.569	-1.118	-0.730	2.947	1.517	-0.388
	(1.303)	(4.284)	(12.925)	(2.079)	(2.696)	(3.332)	(1.573)
Mother’s average return to education	-0.793	-1.139	1.280	0.412	-3.675	-0.643	-1.782
	(4.495)	(2.922)	(9.954)	(5.549)	(12.744)	(7.139)	(3.373)
Individual demographics							
Age	0.913	1.144	0.578	0.667	1.255	0.998	3.135
	(0.463)**	(0.894)	(0.378)	(0.355)*	(0.922)	(5.435)	(3.319)
Age square	-0.020	-0.023	-0.014	-0.015	-0.027	-0.022	-0.084
	(0.009)**	(0.019)	(0.008)	(0.006)***	(0.018)	(0.106)	(0.089)
Gender	-0.503	-0.176	-0.708	–	–	-0.565	-0.330
	(0.592)	(0.541)	(0.338)**			(0.676)	(1.182)
Household characteristics							
No. of children in family	-0.189	0.240	-0.222	-0.114	-0.265	-0.222	-0.216
	(0.209)	(1.433)	(0.294)	(0.499)	(0.650)	(0.314)	(0.259)
Ln(wealth (excluding housing) per adult equivalent)	0.243	0.226	0.227	0.074	0.459	0.250	0.267
	(0.152)	(0.415)	(0.160)	(0.707)	(0.236)*	(0.182)	(0.101)***
Ln(House price)× Ln(wealth (excluding housing) per adult equivalent)	-0.00000002	-0.0000003	-0.0000003	0.0000002	-0.0000004	-0.00000004	-0.0000002
	(0.0000003)	(0.000001)	(0.0000002)	(0.0000005)	(0.0000003)	(0.000001)	(0.0000004)
Annual appreciation × Ln(wealth (excluding housing) adult equivalent)	0.000001	0.00001	0.00005	0.000004	0.00001	0.00001	0.00001
	(0.000003)	(0.000006)*	(0.00002)**	0.00001	0.00001	(0.00001)	0.00001
No. of properties	-0.290	-0.504	0.107	0.001	-0.820	-0.176	-0.290
	(0.460)	(0.289)*	(0.614)	(0.253)	(0.596)	(1.044)	(0.569)

House size	0.001	-0.002	0.002	0.001	-0.002	-0.002	0.000
	(0.002)	(0.010)	(0.004)	(0.006)	(0.002)	(0.005)	(0.002)
Loan for housing	-0.296	-0.479	0.146	-0.157	-0.473	0.206	-0.465
	(0.294)	(1.964)	(0.443)	(0.588)	(0.419)	(0.379)	(0.254)*
Loan for production	0.007	0.215	-0.147	0.158	-0.008	-0.241	0.035
	(0.254)	(0.630)	(0.293)	(1.085)	(0.771)	(3.080)	(0.516)
Household residence	-0.769	–	–	-1.087	-0.189	-1.644	-0.406
	(0.844)			(0.412)***	(1.877)	(0.393)***	(0.684)
Household registration	0.763	0.925	1.257	0.595	1.023	0.481	0.770
	(0.989)	(0.532)*	(2.123)	(1.136)	(2.384)	(0.506)	(1.030)
Provincial control							
Fiscal budget on education	0.00001	0.0001	0.00002	0.00001	0.00003	0.00004	0.00002
	(17.777)	(15.822)	(14.193)	(61.181)	(5.449)	(4.057)	(7.711)
Ln(GDP per capita) in 2010	0.330	0.694	-0.439	0.758	-0.060	-0.453	0.514
	(1.082)	(0.384)*	(0.734)	(2.387)	(1.293)	(1.050)	(1.571)
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	1,776	946	830	1,020	756	697	1,079
R^2	0.379	0.344	0.352	0.394	0.444	0.519	0.311
First-stage *F*-statistic (*p*-value)	4.406	7.932	2.066	4.469	2.070	9.336	4.021
	(0.004)	(0.005)	(0.104)	(0.004)	(0.103)	(0.002)	(0.008)
Hansen's *J* statistic (over-identification test of instruments), χ^2 (*p*-value)	0.240	0.989	1.951	0.611	3.228	7.004	1.281
	(0.887)	(0.610)	(0.377)	(0.737)	(0.199)	(0.030)	(0.527)

Note: ***, ** and * denote separately 1 per cent, 5 per cent and 10 per cent significance levels. 38 individuals who were born in the 1970s were included in the subsample of the '80 cohort. Sampling weights are used in estimation in every column. Household-clustered standard errors are in parentheses.

Source: Authors' calculation based on the CHFS.

Table 6: 2SLS-IV estimation (by timing of purchasing the first property)

Independent variable	Pre-school	Primary school	Junior high school	Senior high school	College
	(1)	(2)	(3)	(4)	(5)
Housing					
Ln(House price)	-0.040	0.175	1.754	2.477	0.903
	(0.858)	(0.618)	(1.538)	(1.266)*	(0.933)
Annual appreciation of house price	0.000001	0.00002	0.00002	-3.227	0.000001
	(0.724)	(5.842)	(65.809)	(6.000)	(9.894)
Parents' characteristics					
Father's education	-0.505	0.369	0.681	0.385	1.375
	(0.561)	(0.416)	(1.028)	(0.638)	(0.782)*
Ln(House price)×father's education	0.102	-0.033	-0.073	0.008	-0.241
	(0.115)	(0.082)	(0.192)	(0.108)	(0.330)
Annual appreciation×father's education	-0.083	-0.087	-0.143	0.299	-1.126
	(1.059)	(0.391)	(7.311)	(0.717)	(1.484)
Mother's education	0.758	0.125	0.480	1.274	-0.905
	(0.511)	(0.249)	(0.397)	(0.756)*	(0.412)**
Ln(House price)×mother's education	-0.092	0.015	-0.069	-0.208	0.143
	(0.150)	(0.053)	(0.087)	(0.123)*	(0.238)
Annual appreciation×mother's education	-0.494	-0.062	0.164	0.356	1.262**
	(1.136)	(0.329)	(0.410)	(0.433)	(0.608)
Father's return to education	-0.937	0.788	-1.994	-2.350	7.093
	(7.484)	(2.501)	(7.288)	(6.364)	(21.415)
Mother's return to education	0.00005	-1.082	1.317	2.160	0.000
	(61.109)	(9.604)	(1.873)	(8.063)	(6.366)
Individual demographics					
Age	1.249	0.654	0.775	0.537	-2.741
	(11.704)	(0.591)	(2.101)	(4.809)	(8.836)
Age square	-0.028	-0.012	-0.017	-0.009	0.047
	(0.327)	(0.014)	(0.041)	(0.092)	(0.164)
Gender	-1.208	-0.501	-0.511	-0.713	-0.696
	(0.406)***	(0.492)	(1.402)	(0.432)*	(1.541)
Household characteristics					
No. of children in family	-0.290	-0.227	-0.272	-0.157	-1.057
	(0.299)	(0.241)	(2.353)	(0.430)	(1.108)
Ln(wealth (excluding housing) per adult equivalent)	0.207	0.286	0.170	0.106	0.300
	(0.249)	(0.148)*	(0.121)	(0.354)	(1.379)
Ln(House price)×Ln(wealth (excluding housing) per adult equivalent)	-0.0000001	-0.0000001	-0.0000002	0.000001	-0.0000004
	(0.0000002)	(0.0000004)	(0.000002)	(0.000001)	(0.000003)
Annual appreciation×Ln(wealth (excluding housing) adult equivalent)	0.000001	-0.000001	0.000001	-0.00001	0.00002
	(0.00001)	(0.00001)	(0.0001)	(0.00003)	(0.00002)

No. of properties	-0.152	-0.364	-0.203	-0.103	-1.837
	(0.401)	(0.345)	(1.741)	(0.419)	(0.818)**
House size	0.005	0.001	0.002	0.004	-0.005
	(0.007)	(0.002)	(0.008)	(0.011)	(0.016)
Loan for housing	0.142	-0.097	-0.296	-0.592	-1.069
	(1.528)	(1.180)	(1.852)	(0.942)	(3.010)
Loan for production	0.032	0.299	-0.506	0.480	-1.268
	(1.690)	(0.911)	(1.125)	(0.937)	(1.215)
Household residence	-0.386	-0.606	-1.322	-0.089	-1.285
	(1.410)	(0.906)	(0.725)*	(1.302)	(2.871)
Household registration	0.835	0.409	0.833	0.990	0.773
	(2.051)	(1.818)	(0.935)	(2.420)	(0.651)
Provincial control					
Fiscal budget on education	0.00002	0.00003	0.00001	0.00001	0.00002
	(6.709)	(0.354)	(1.158)	(100.963)	(1.378)
Ln(GDP per capita) in 2010	0.431	0.093	-0.245	-1.409	-2.146
	(1.314)	(0.859)	(0.775)	(1.336)	(0.935)**
Provincial dummies	Yes	Yes	Yes	Yes	Yes
No. of obs.	330	667	354	333	92
R^2	0.437	0.392	0.518	0.466	0.843
First-stage *F* statistic (*p*-value)	1.977 (0.118)	3.039 (0.029)	9.227 (0.004)	5.681 (0.019)	–
Hansen's *J* statistic (over-identification test of instruments), χ^2 (*p*-value)	1.346 (0.510)	1.485 (0.476)	1.186 (0.553)	2.049 (0.359)	0.084 (0.959)

Note: See Table 5.

Source: Authors' calculation based on the CHFS.

The conventional nature–nurture hypothesis only appears in the OLS estimation of Equation (1) without controlling for any housing-related variables; there are marginal transmission rates of 0.191 and 0.203 of paternal and maternal years of education, respectively, at the 1 per cent statistically significant level.[11] Not only does inclusion of housing oppress education handed down (Column 1 of Table 5), but there is negative mother–child (father–child) correlation for the '80 ('90) cohort (Columns 6 and 7 of Table 5). These results should be read with inter-group heterogeneity. Father's marginal intergenerational effect on children's education is 1.375 years in families that bought properties during the period in which their children were enrolled in tertiary education, while the interactions between father's education and house price and its appreciation are all insignificant (Column 5 of Table 6). This reflects father's pure support to bear the increasing costs of college, rather than the wealth effect of housing. House-price appreciation tended to raise children's college educational attainment by mother's education (1.262 in Column 5 of Table 6), while mother's education *per se* relates negatively to children's (mainly the '80 cohort's) tertiary education (Column 5 of Table 6 and Column 6 of Table 5). Mother's effect seemed more important during the period of senior high school with a marginal effect of 1.274 years (Column 4 of Table 6), which may conform to the conventional nature–nurture hypothesis considering the importance of nurture during long and tough preparation for national exams to college. Nevertheless, the credit-constraint effect of rising house prices offset this transmission (-0.208 in Column 4 of Table 6).

It seems that neither the level nor appreciation of house prices per se is relevant to filial education, except a positive impact of the level of house prices when the property was purchased during children's attendance at senior high schools—a 1 per cent increase in house prices is associated with 0.02 additional years of filial education (Column 4 of Table 6). Conditional on parents' education, high house prices can promote father–child transmission in the '90 cohort (Column 7 of Table 5) and mother–child transmission for the '80 cohort (Column 6 of Table 5). Nevertheless, the latter can be weakened if buying the property during filial senior-high education (Column 4 of Table 6). These findings indicate that fathers' possibly strengthened economic position in the family in the presence of high house prices in recent times is crucial to moderate educational transmission. However, during costly tertiary education, which is typically faced by the '80 cohort, it is the house-price appreciation (i.e. the wealth effect) that strengthens maternal transmission (Column 5 of Table 6).

House-price appreciation is largely insignificant and there is only a tiny positive impact of house-price appreciation on filial education, conditional on household wealth (Columns 2–3 of Table 5). Together with insignificant household wealth and its interaction with the level of house prices, these call into question the wealth effect of housing reviewed in Section 1.[12] We will delineate two roles of house prices in Section 4.2 after taking heterogeneity into account.

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[11] OLS results are available upon request.

[12] One may be concerned about particularly high house prices in mega cities such as Beijing, Shanghai, and Guangzhou (Wu et al. 2015) and price difference between urban and rural areas because there are many self-built properties and limited real-estate markets in rural areas. We restricted our samples to market-based purchases and re-estimated Tables 5–6. The appreciation and its interaction terms remain insignificant. We also excluded provinces with exceptionally high house prices and this does not alter the conclusion. These provinces are those having a high annual growth rate of real house prices (≥10 per cent) over the period 2004–14 in Wu et al.'s (2015) calculations, including Beijing, Shanghai, Anhui, Zhejiang, and Guangdong. Results hold qualitatively as the full sample. We will return to this sort of robustness check in quantile regressions in Section 4.2.

4.2 Quantile estimation and nonlinear intergenerational transmission of education

We precede highlighting (within-group) heterogeneity across the distribution of filial education by quantile estimation in Table 7.[13] The tests for intra-household correlation and heteroskedasticity reject the null hypotheses in most cases, justifying the use of household-clustered standard errors and quantile regressions. Statistically significant residuals from the first-stage quantile regression of house prices point to the existence of endogeneity and justify the use of quantile IV specification.

[13] Table 7 reports the results of the full sample and the urban and rural subgroups, considering the huge urban-rural inequality as discussed in Section 2.2. Figures A.1–2 in the Appendix illustrate other subgroups.

Table 7: Quantile IV estimation

Independent variable	Full sample			Urban			Rural		
	10th	50th	90th	10th	50th	90th	10th	50th	90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Housing									
Ln(House price)	-1.114	-0.276	0.174	-0.252	0.210	-0.021	-1.406	-1.248	-0.344
	(0.395)***	(0.439)	(0.416)	(1.001)	(0.427)	(0.669)	(0.639)**	(0.483)***	(1.076)
Annual appreciation of house price	0.791	-2.044	-6.715	5.105	0.450	-8.398	-8.195	-11.493	-12.063
	(1.783)	(1.753)	(2.266)***	(3.736)	(2.195)	(2.424)***	(4.603)*	(5.192)**	(7.221)*
Parent's characteristics									
Father's education	-0.232	0.455	0.618	0.169	0.257	0.678	-0.811	0.039	1.015
	(0.223)	(0.187)**	(0.242)**	(0.596)	(0.189)	(0.482)	(0.386)**	(0.282)	(0.385)***
Ln(House price)×father's education	0.067	-0.020	-0.073	-0.017	-0.017	-0.090	0.098	0.001	-0.112
	(0.040)*	(0.029)	(0.041)*	(0.099)	(0.026)	(0.067)	(0.052)*	(0.033)	(0.067)*
Annual appreciation ×father's education	-0.407	-0.143	0.324	0.051	0.088	0.183	0.390	0.858	1.035
	(0.117)***	(0.120)	(0.119)***	(0.477)	(0.097)	(0.286)	(0.443)	(0.495)*	(0.997)
Mother's education	0.231	0.197	0.167	0.381	0.177	-0.096	0.214	-0.246	-0.310
	(0.201)	(0.168)	(0.162)	(0.461)	(0.203)	(0.349)	(0.317)	(0.238)	(0.247)
Ln(House price)×mother's education	-0.017	0.012	-0.012	0.020	0.014	0.023	-0.027	0.033	0.101
	(0.034)	(0.027)	(0.025)	(0.069)	(0.031)	(0.050)	(0.042)	(0.032)	(0.044)**
Annual appreciation ×mother's education	0.122	0.194	0.191	-0.688	-0.121	0.512	0.144	0.024	-0.251
	(0.151)	(0.155)	(0.217)	(0.322)**	(0.187)	(0.233)**	(0.441)	(0.394)	(0.554)
Father's average return to education	0.207	-1.998	-0.965	1.161	-0.912	-0.487	7.393	2.253	-4.009
	(1.529)	(0.933)**	(1.183)	(2.451)	(0.960)	(1.739)	(3.879)*	(3.130)	(2.106)*
Mother's average return to education	-0.189	-1.615	0.053	-1.821	-1.473	-0.173	0.470	5.281	-0.916
	(0.761)	(0.636)**	(0.739)	(1.337)	(0.705)**	(0.916)	(3.313)	(1.782)***	(1.436)
Individual demographics									
Age	0.605	0.985	1.269	1.168	1.621	1.528	0.531	0.318	1.364
	(0.211)***	(0.179)***	(0.201)***	(0.477)**	(0.211)***	(0.158)***	(0.272)*	(0.217)	(0.286)***
Age square	-0.015	-0.021	-0.025	-0.025	-0.033	-0.029	-0.015	-0.008	-0.030***
	(0.005)***	(0.004)***	(0.005)***	(0.011)**	(0.005)***	(0.003)***	(0.006)**	(0.005)*	(0.006)
Gender	-0.150	-0.645	-0.433	0.130	-0.398	-0.076	-0.181	-0.457	-0.350
	(0.170)	(0.138)***	(0.139)***	(0.324)	(0.150)***	(0.193)	(0.199)	(0.193)**	(0.230)
Household characteristics									
No. of children in family	-0.468	-0.324	-0.032	-0.357	-0.187	0.020	-0.176	-0.082	-0.155
	(0.110)***	(0.145)**	(0.120)	(0.291)	(0.231)	(0.142)	(0.141)	(0.187)	(0.154)
Ln(wealth (excluding housing) per adult equivalent)	0.167	0.203	0.072	0.333	0.154	0.041	0.144	0.266	0.290
	(0.065)**	(0.072)***	(0.060)	(0.158)**	(0.071)**	(0.088)	(0.124)	(0.092)***	(0.087)***
Ln(House price)×Ln(wealth (excluding housing) per adult equivalent)	-0.0000001	-0.0000001	0.0000004	-0.0000004	-0.0000001	0.0000005	-0.0000001	-0.0000004	-0.0000003
	(0.0000001)	(0.0000002)	(0.0000005)	(0.0000005)	(0.0000001)	(0.0000003)	(0.0000002)	(0.0000001)***	(0.0000001)**
Annual appreciation × Ln(wealth	0.00001	0.000002	-0.000004	0.00001	0.000003	-0.000002	0.00001	0.00003	0.000001

(excluding housing) adult equivalent)	(0.00001)	(0.000004)	(0.00002)	(0.00001)	(0.000003)	(0.000005)	(0.00003)	(0.00003)	(0.00001)
No. of properties	0.024	-0.029	0.069	-0.522	-0.202	-0.110	0.363	0.220	0.205
	(0.183)	(0.170)	(0.130)	(0.310)*	(0.177)	(0.197)	(0.254)	(0.333)	(0.303)
Property size	-0.002	-0.001	-0.001	-0.006	-0.000	-0.002	-0.001	-0.002	-0.000
	(0.001)*	(0.001)	(0.001)	(0.005)	(0.001)	(0.001)***	(0.001)	(0.002)	(0.002)
Loan for housing	-0.037	-0.203	-0.220	-0.116	-0.103	-0.098	0.074	0.412	-0.399
	(0.229)	(0.184)	(0.164)	(0.369)	(0.200)	(0.209)	(0.277)	(0.231)*	(0.335)
Loan for production	-0.141	0.105	0.290	-0.357	-0.053	0.701	0.045	0.016	0.181
	(0.254)	(0.262)	(0.270)	(0.823)	(0.556)	(0.330)**	(0.228)	(0.251)	(0.378)
Household residence	-0.680	-1.248	-1.099						
	(0.203)***	(0.335)***	(0.275)***						
Household registration	0.728	0.785	0.264	0.413	0.959	0.097	-0.463	0.336	1.092
	(0.320)**	(0.317)**	(0.269)	(0.514)	(0.425)**	(0.322)	(1.039)	(0.951)	(0.555)**
Provincial control									
Fiscal budget on education when	-7.282	-1.849	-7.002	-3.325	-0.412	-7.610	-7.001	1.745	-1.624
purchasing the property	(3.277)**	(3.017)	(3.427)**	(5.933)	(3.378)	(4.985)	(5.980)	(4.140)	(5.520)
Ln(GDP per capita) in 2010	-0.152	-1.044	0.610	0.679	-0.514	1.541	0.180	-0.668	-1.450
	(0.579)	(0.297)***	(0.726)	(1.182)	(0.682)	(0.901)*	(0.910)	(0.371)*	(0.712)**
Provincial dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage residual	0.797	0.479	0.789	0.352	-0.013	0.925	0.849	1.045	0.566
	(0.322)**	(0.368)	(0.338)**	(0.585)	(0.272)	(0.413)**	(0.568)	(0.492)**	(0.869)
No. of obs.	1,776	1,776	1,776	946	946	946	830	830	830
Pseudo R^2	0.307	0.378	0.278	0.272	0.310	0.192	0.207	0.308	0.232
Parente-Santos Silva test for intra-cluster	3.369	4.916	0.884	0.623	2.443	1.622	2.170	2.467	0.344
correlation, *T* statistic (*p*-value)	(0.001)	(0.000)	(0.377)	(0.534)	(0.015)	(0.105)	(0.030)	(0.014)	(0.731)
Machado-Santos Silva test for	76.057	114.373	77.069	89.704	89.646	89.438	60.601	62.889	117.083
heteroskedasticity, χ^2 (*p*-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: See Table 5.

Source: Authors' calculation based on the CHFS.

Paternal transmission surfaces for higher filial education with increasing magnitude (Columns 2–3 of Table 7), especially for rural offspring (Column 9 of Table 7) and sons (0.552 at the 50th percentile of filial education).[14] Mother–daughter association appears regardless of the daughter's position in their educational distribution at 5 per cent—10 per cent significance levels. The magnitude of association decreases at daughters' higher educational attainments, from 0.744 at the 10th percentile to 0.59 at the median and 0.349 at the 90th percentile of filial education. Mothers' transmission is also important (0.266 at 10 per cent significance level) for the '90 cohort to achieve high educational attainment (at their 90th percentile), indicating the more important role of the child-raising/nurturing method in recent times. By contrast, fathers' transmission is crucial (1.947 at 1 per cent significance level) for the '80 cohort to obtain at least the 90th percentile level of filial education. This echoes the finding in benchmark regressions that fathers play important roles in sustaining filial tertiary education—these children largely belonged to the '80 cohort.

There are positive parent–child associations in urban areas but statistical significance disappears after controlling for housing variables (Columns 4–6 of Table 7). It is also worth noting negative paternal transmission of education for the least-educated rural offspring (Column 7 of Table 7), indicating high intergenerational educational mobility. Alarmingly, this is downward mobility—fathers' education is higher than children's locating below the 10th percentile and the father–child educational gap decreases from 0.9 years for the 10th percentile to 0.1 years for the 90th percentile.[15] Positive paternal transfer emerges only in well-educated rural offspring (Column 9 of Table 7).[16] The larger-than-one magnitude of marginal transmission rate (1.015) indicates upward intergenerational mobility for the best educated individuals only. Together, the filial educational gap would be enlarged within rural areas.

In sharp contrast to the 2SLS-IV results, there are significantly negative quantile IV estimates of housing variables. A high level of house prices per se dents filial education at its bottom 10th percentile (Column 1 of Table 7). Negative impact of the level of house prices is also observed among least-educated individuals (at the bottom 10th percentile of filial education) in rural areas (Columns 7–8 of Table 7), male offspring, the '80 cohort, and those whose families purchased their first property during tertiary education. Figure 6(a) further draws the 2SLS-IV and quantile IV estimates of the level of house prices over the entire distribution of filial education for the full sample, while results of subgroups are shown in Figure A.1 in the Appendix. Rising house prices turn to promote filial education at the 90th percentile of filial education, but without statistical significance in the full sample (Column 3 of Table 7 and Figure 6(a)). This positive effect for the well-educated offspring (at the 90th percentile of filial education) is of 1 per cent statistical significance only among households that purchased their first property during children's tertiary

[14] Full sub-group quantile estimation is available upon request.

[15] Using a nationally representative survey, Golley and Kong (2013) also document lower intergenerational persistence of education in rural than in urban China. They find that the majority of rural children complete only junior high school and the youngest cohorts move down the education ladder relative to their parents, while urban children maintain at least their parents' education level. This aggravates rural–urban educational disparity. The high drop-out rate in rural secondary education (especially in senior high schools) is largely due to high opportunity costs (wages earned from rural-to-urban migration) relative to educational costs (Yi et al. 2012).

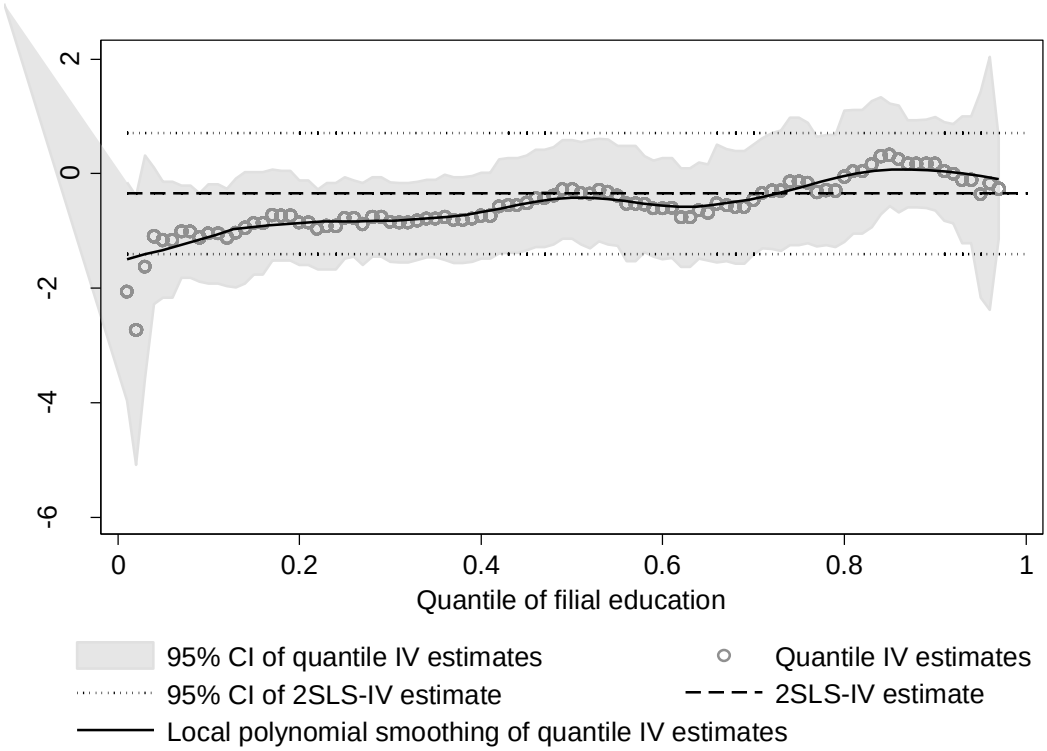
[16] One may also suspect that increasingly, rural children are raised by grandparents because parents work as migrant workers in cities. There might be association between grandparents and grandchildren. Unfortunately, it is impossible to directly test this by re-estimating regressions because of insufficient samples—only 149 (90) out of 1,776 individuals have grandmothers' (grandfathers') educational information. Our data, based on limited matching, can only provide some hints to this conjecture. In rural areas, the pairwise correlation coefficient of mother–child education is 0.36 and 0.43 for the grandmother–child link, both at 1 per cent significance levels, but the grandfather–child correlation coefficient is 0.24 without statistical insignificance.

education (0.984), and correspondingly the '80 cohort (1.663). Together, the pure impact of rising house prices tends to enlarge inequality of filial education.

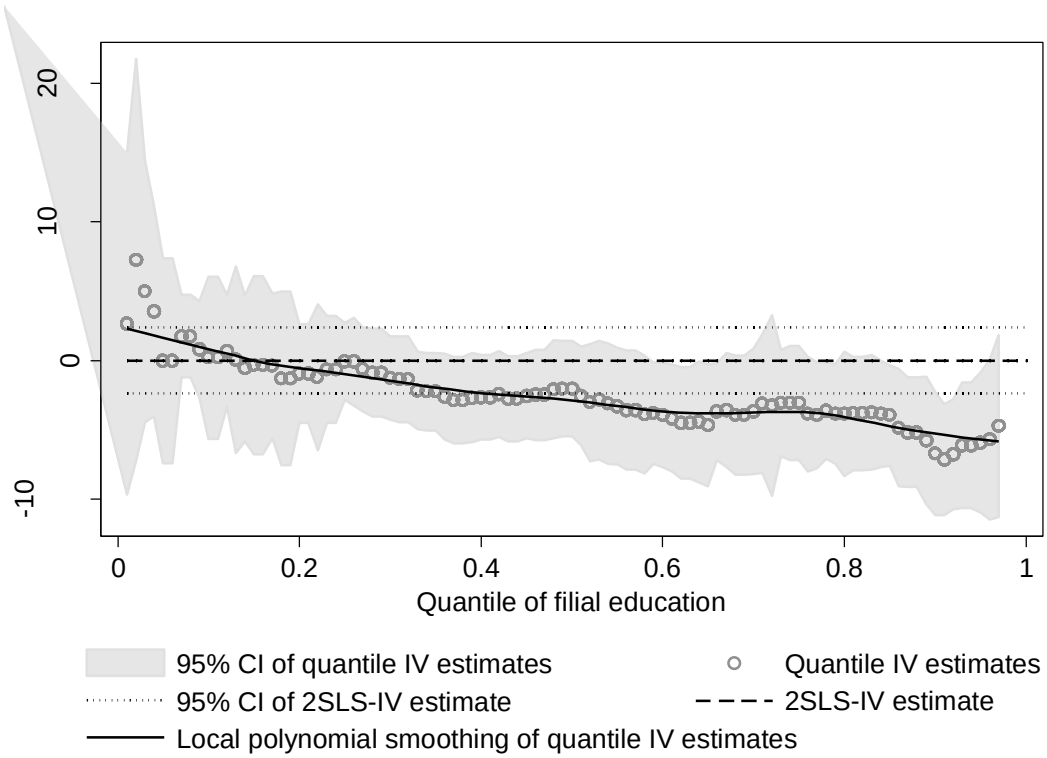
This result can be understood from the credit-constraint role of house prices introduced in Section 1. Those experiencing lower-than-median house prices are less likely to be constrained—only 30 per cent of them borrowed loans for housing and 76 per cent of non-borrowers said they did not need to borrow. By contrast, 40 per cent of those experiencing higher-than-median house prices borrowed loans for housing, while the proportion of those who also borrowed educational loans in this latter group (7 per cent) was less than half of that in the former (16 per cent). It is also worth noting that of all subgroups rural households particularly suffer from credit constraints—as indicated by negative estimates of interactions between household wealth and house prices (Columns 8–9 of Table 7). Thus, rural offspring largely experiences the credit-constraint effect of house prices (Columns 7–8 of Table 7 and Figure A.1(b)).

Figure 6: Quantile effects of housing wealth on filial education

(a) Quantile estimates of house prices (level)



(b) Quantile estimates of house prices (appreciation)



Source: Authors' calculation based on the CHFS.

House-price appreciation per se strongly shortens years of education for offspring at the high end of the distribution of their education (Column 3 of Table 7 and Figure 6(b)), contradicting the theoretical prediction of a wealth effect reviewed in Section 1. This result is driven by urban individuals (Column 6 of Table 7 and Figure A.2(a)) and is observed across the entire distribution of rural individuals (Columns 7–9 of Table 7 and Figure A.2(b)). The inhibiting role played by house-price appreciation in transmitting education across generations is predictable. As stated before, neither benchmark (Column 1 of Table 5) nor quantile estimation (Columns 1–3 of Table 7) yields a significant coefficient of the interaction term between house-price appreciation and household wealth. One reason could be attributed to households' attitudes towards consumption and preferences in investment when experiencing wealth appreciation. We find broadly similar proportions of households who answered 'being willing to spend more when the value of assets increases' for those in the upper (50 per cent) and the bottom (49 per cent) half of the distribution of households' housing wealth.[17] Thus, the correlation coefficient between house-price appreciation and the likelihood of borrowing educational loans is trivial (0.021). Actually, Chinese households show strong inclinations to invest in financial assets (typically in housing and stock markets when there are limited investment channels) rather than education.[18] Another reason may lie in the high volatility of house prices in China, as documented by Wu et al. (2015).

[17] There are no statistically significant differences in risk attitudes or patience between these two groups, either.

[18] The correlation coefficient between household financial assets per adult equivalent and the annual appreciation rate of house prices is 0.22 at the 1 per cent significance level. We also regressed respectively the former and the number of properties owned by the household on the latter, controlling simultaneously for individual demographics (gender, age, and its square) and provincial dummies. Simple OLS estimation with household-clustered standard errors suggests that an additional 1 per cent of appreciation rate is associated with more financial assets per adult equivalent of 60.5k yuan at 5 per cent significance level and 0.31 more properties at 1 per cent significance level.

This would make wealth components relying on house-price appreciation a hedging means of insuring against future uncertainties in livelihood, especially when parents cannot borrow freely from their children's future income (i.e. credit constraints). Overall, house prices appear to affect intergenerational transmission mainly through credit constraint rather than wealth effects.[19] As predicted by the theory, the more credit-constrained, the less transfer of human capital investment from parents and thus less intergenerational association of education.[20]

Interaction terms show that higher house prices enhance paternal (maternal) transfer for the least (well-) educated offspring, especially for rural offspring (Columns 1, 4, and 9 of Table 7), while they counteract paternal positive transmission of education for the well-educated offspring (Columns 3 and 9 of Table 7). House-price appreciation has similar functions but with opposite directions: it weakens parents' transmission among the least-educated offspring (Columns 1 and 4 of Table 7), but enhances intergenerational linkage for the well-educated offspring (Columns 3, 6, and 8 of Table 7). Together, the credit-constraint effect of rising house prices appears to 'smooth' the intergenerational association of education, while the wealth effect tends to consolidate intergenerational unequal transmission of education.

Figure 7 demonstrates the above discussion. At each $\tau \in [0.01, 0.99]$ with a step of 0.01, it draws marginal quantile impact of parents' education on offspring's, unconditional on housing (i.e. $\hat{\theta}_1(\tau)$ and $\hat{\theta}_2(\tau)$) and total marginal quantile impact conditional on gradually the credit-constraint and wealth impact of housing (i.e. Equations 10–11 below) against the quantile of filial education:

$$\frac{\partial e_i}{\partial e_i^f} = \hat{\theta}_1(\tau) + \hat{\theta}_4(\tau) \ln \bar{H}_{h\tau} + \hat{\theta}_7(\tau) \bar{A}_{h\tau} \tag{10}$$

$$\frac{\partial e_i}{\partial e_i^m} = \hat{\theta}_2(\tau) + \hat{\theta}_5(\tau) \ln \bar{H}_{h\tau} + \hat{\theta}_8(\tau) \bar{A}_{h\tau} \tag{11}$$

---

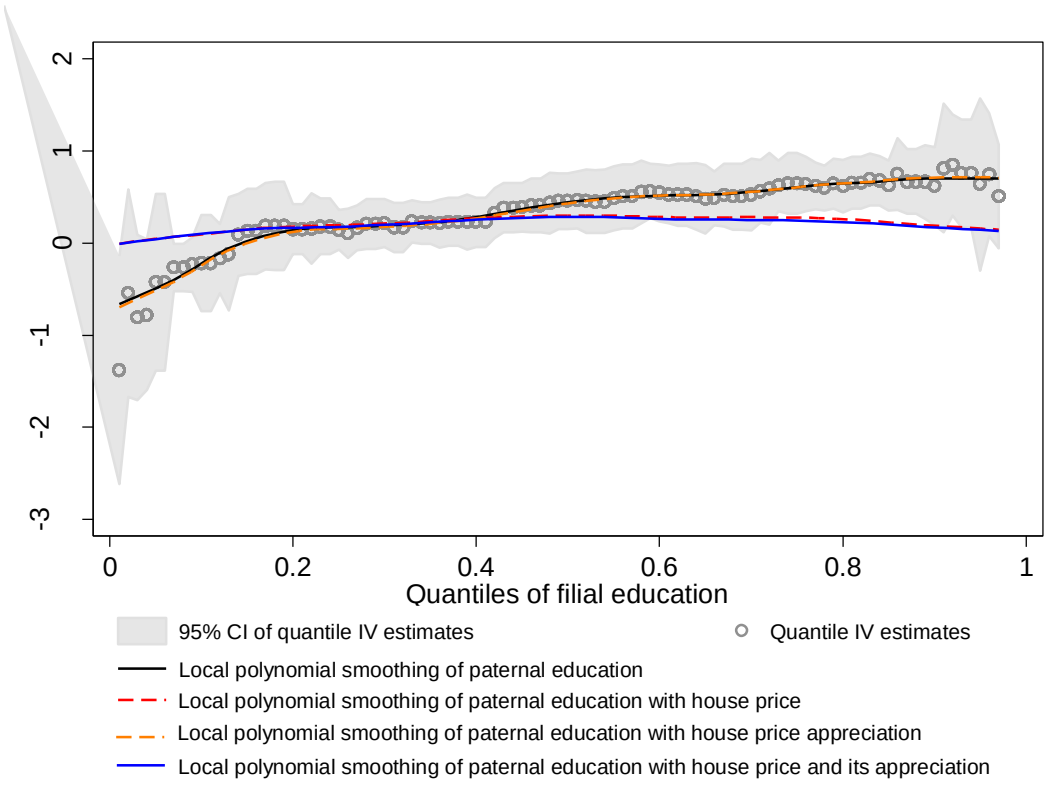
[19] We checked robustness by restricting samples to market-based purchases and re-estimating the first three columns of Table 7. The negative impact of the level of house prices per se lacks statistical significance, but for the highest decile of filial education, its interaction term with paternal education is negative (-0.105 at 5 per cent significance level), discounting the positive paternal transmission (0.99 at 1 per cent significance level). House-price appreciation remains negative with a larger magnitude in absolute terms (-3.705 to -2.457). This indicates that larger wealth effects as a result of soaring market-based house prices may 'squeeze' even more investment into non-educational assets. We also dropped provinces where there were high annual growth rates of real house prices (≥10 per cent) over the period 2004–14 in Wu et al.'s (2015) calculations and re-estimated the first three columns of Table 7. The excluded provinces are Beijing, Shanghai, Anhui, Zhejiang, and Guangdong. Paternal transmission in Column 1 becomes marginally significant (-0.433) at the 10 per cent level, while negative impact of the level of house prices still holds (-1.09 at the 5 per cent significance level). Maternal transmission becomes 0.525 at 1 per cent significance level in Column 3. Other findings hold qualitatively. These imply even stronger credit-constraint effects of (high) market-based house prices.

[20] We also examined other subgroups. The conclusion still holds. The house-price appreciation and its interaction with household wealth are insignificant, except for those who purchased their first property during children's tertiary education. In that case, house-price appreciation per se suggests negative impact, although this effect can be mitigated by household wealth. The weakened effects of parents' education (i.e. negative estimates of interaction between parents' education and house-price appreciation) have been observed in all subgroups, despite statistical insignificance at some quantiles.

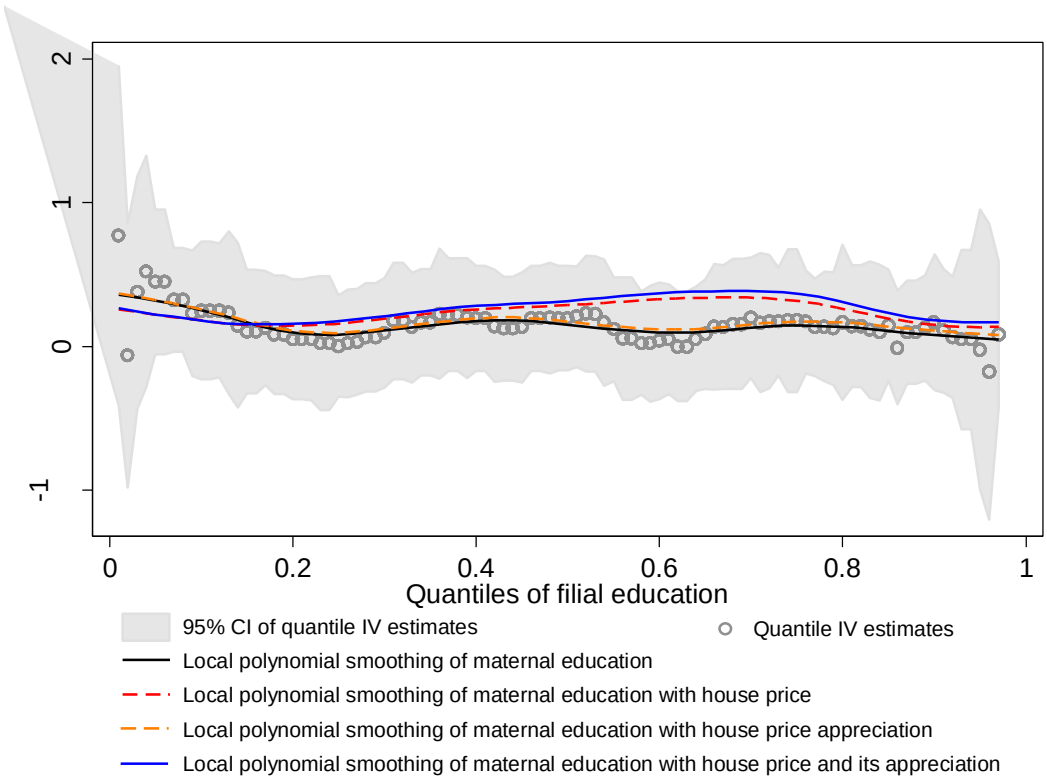
Consistent with previous discussion, Figure 7 shows little wealth impact of house prices on parents' transmission of education throughout the distribution of filial education. The credit-constraint effect of house prices smooths down the increasing paternal transmission along the distribution of filial education (Figure 7(a)), while it pushes up maternal transmission at the moderately high filial education (between the 50th and 80th percentiles in Figure 7(b)). A similar pattern is largely found in different subgroups (Figure A.3 in the Appendix).

Figure 7: Quantile intergenerational transmission of education

(a) Quantile effects of paternal transmission



(b) Quantile effects of maternal education



Source: Authors' calculation based on the CHFS.

The above shifts of marginal effects of parents' education are attributable to different roles played by parents along the distribution of filial education. Fathers may not get involved in nurture as much as mothers typically do, but rather, as Solon's (2004) model predicts, may raise children's educational attainments by increasing human capital investment if their expectations of educational returns are high. The quantile average (wage) return to fathers' education is 6 per cent (26.6 per cent) less for offspring at the lowest quartile of filial education than for their better-educated counterparts in the second (highest) quartile at 1 per cent significance level. The credit-constraint effect of rising house prices attenuates fathers' support for costly higher education and thus pulls the paternal transmission curve at the higher end of filial education. By the same token, fathers' nurture role, albeit weak compared with their economic role, would become relatively prominent under high house prices. Thus, we can observe an upward shift of paternal transmission for the least-educated offspring (at the bottom 10th percentile of distribution of filial education), which was solely driven by rural households who are most credit-constrained (Column 7 of Table 7). As such, fathers' role in child education may be 'nonlinear'—for those least-educated (rural) individuals, fathers work less and thus may have more time to accompany their children. Indeed, fathers of rural individuals at the bottom 10th percentile of filial education work one day (per week) less than fathers of those at the 20th percentile. For higher educational achievement, economic support takes over the role.

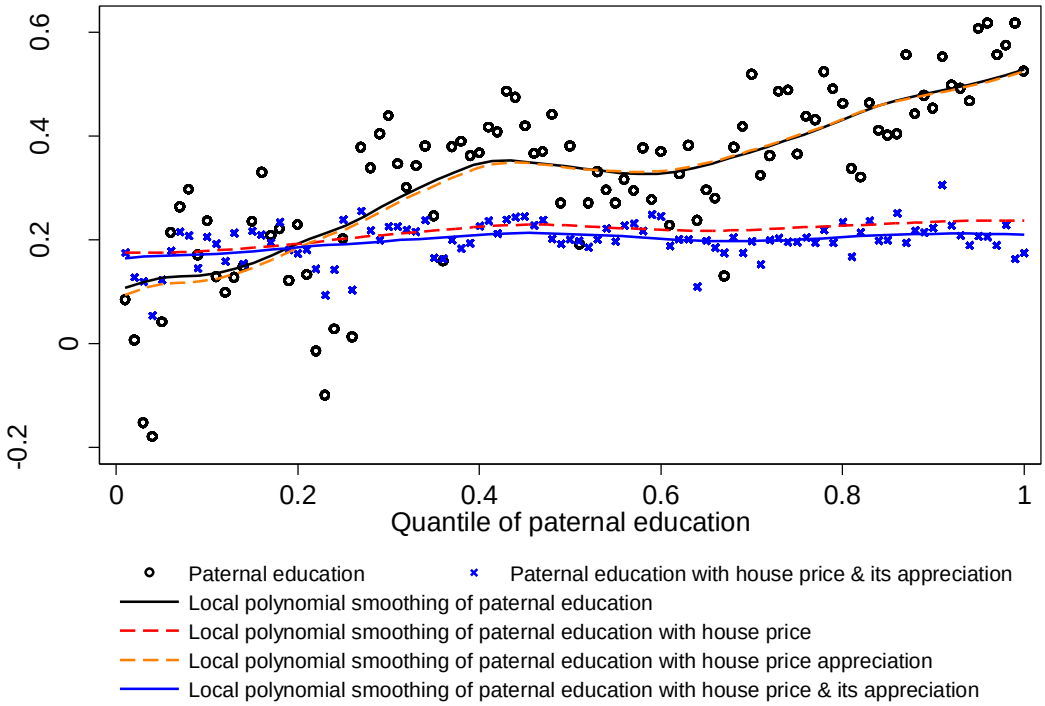
Consistent with this argument, there is enhanced maternal transmission after taking the level of house prices into account, as mothers' primary role is child care (i.e. conventional nature–nurture association) rather than sustaining human capital investment. For those in the upper half of the distribution of filial education, their mothers, on average, work 0.6 fewer hours per day (at the 10

per cent significance level) and one fewer month per year (at the 1 per cent significance level) than mothers of those in the lower half of the distribution.[21] Thus, despite having 60 per cent higher house prices, the former still have more time for child care than the latter. By looking at the subgroups in Figure A.3 in the Appendix, it can be seen that proportionately higher marginal effects of maternal education among moderate to well-educated offspring compared with those in other parts of the distribution is likely to be driven by male offspring and the '80 cohort.

The analysis so far has documented substantial heterogeneity across subgroups and along the distribution of filial education within one group. Together with the credit-constraint effect of house prices, one may suspect nonlinearity in intergenerational transmission of education. Figure 8 draws what we called 'the educational Great Gatsby Curve'—we averaged the previous quantile estimates of parents' education (i.e. the pure parents' transmission, $\hat{\theta}_1(\tau)$ and $\hat{\theta}_2(\tau)$, and the total marginal effects based on Equations 10–11, respectively) according to the distribution (quantile) of parents' education. It clearly shows that housing alters the pattern of nonlinear intergenerational transmission. Paternal and maternal transmissions without considering housing suggest increasing and decreasing trends, respectively. The credit-constraint role of rising house prices presses nonlinear paternal transmission towards (linear) 0.2 (Figure 8(a)) and shifts maternal transmission upwardly and more nonlinearly (Figure 8(b)).

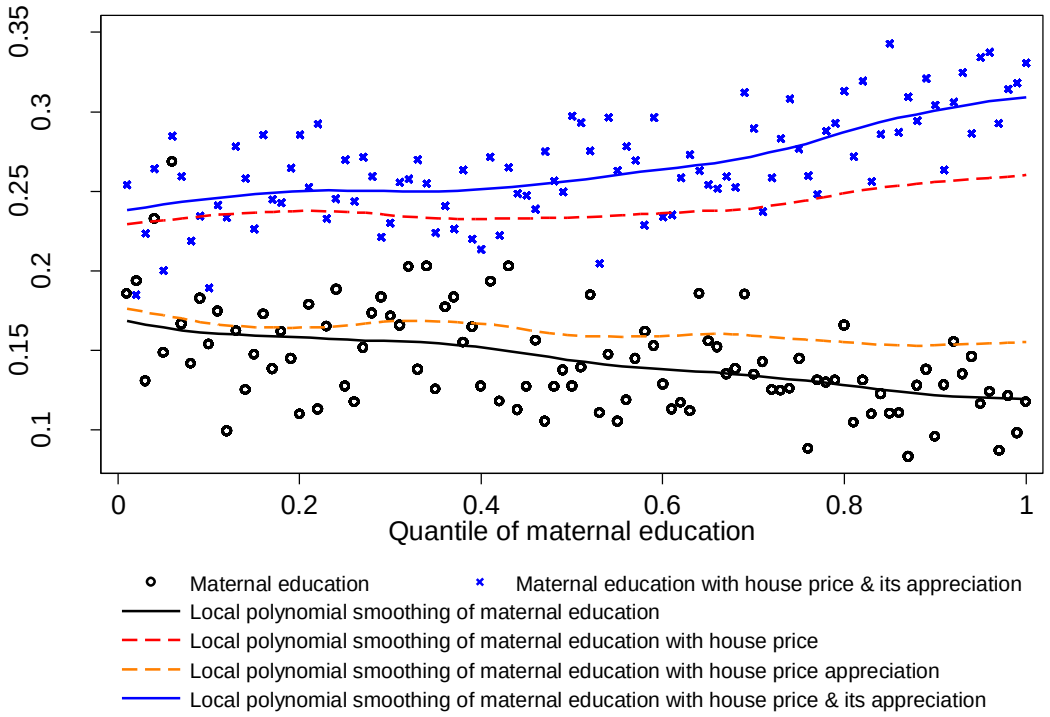
Figure 8: Nonlinear intergenerational transmission of education and the impact of housing on it

(a) Paternal transmission



[21] This is predictable as the former has on average 2.86 more years of education than the latter does at the 1 per cent significance level. Thus the former enjoy a 30 per cent higher educational return without working as intensively as the latter.

(b) Maternal transmission



Note: Dots are quantile estimates of paternal/maternal education, i.e., marginal effects of parents' education *per se*. Crosses are total marginal effects of parents' education filial education considering interaction terms with the level and appreciation of house prices.

Source: Authors' calculation based on the CHFS.

Taking into account housing effects and various heterogeneity and nonlinearity, we further standardized the marginal rates of parents' transmission to the intergenerational correlation coefficient to get rid of influences of marginal distributions in two generations and facilitate cross-comparison as suggested by Björklund and Jäntti (2009).[22] Take paternal transmission for example. We use the standard deviations of fathers (σ^m) and filial education (σ^c) to calculate the average correlation coefficient of paternal transmission *per se*, $\hat{\theta}_1(\tau)\frac{\sigma^m}{\sigma^c}$ for the 2SLS-IV estimate and $\frac{1}{q}\sum_{\tau=0.01}^{0.99}\left(\hat{\theta}_1(\tau)\frac{\sigma^m}{\sigma^c}\right)$ for the quantile IV estimates, and the overall coefficient $\frac{1}{q}\sum_{\tau=0.01}^{0.99}\left[\left(\hat{\theta}_1(\tau)+\hat{\theta}_4(\tau)\ln\bar{H}_{h\tau}+\hat{\theta}_7(\tau)\bar{A}_{h\tau}\right)\frac{\sigma^m}{\sigma^c}\right]$ in the case of quantile IV estimation. Table 8 lists the results.

[22] Note that it is correlation rather than causality as the data limitations do not allow us to disentangle the genuine transmission from the genetic (Currie and Moretti 2007) or 'foetal' origins in terms of mothers' health (Currie and Almond 2011).

Table 8: Coefficients of intergenerational transmission of education

Sample	Parents	2SLS-IV	Quantile IV			
		Without housing effects	Without housing effects	With house price only	With house-price appreciation only	Both house price & its appreciation
		(1)	(2)	(3)	(4)	(5)
Full	Father	-0.138	0.366	0.243	0.361	0.226
	Mother	0.342	0.165	0.274	0.186	0.303
Urban	Father	-0.760	0.415	0.155	0.436	0.142
	Mother	0.271	0.103	0.246	0.095	0.253
Rural	Father	1.073	0.072	0.027	0.114	0.065
	Mother	-0.101	-0.134	0.118	-0.138	0.128
Male	Father	-0.341	0.486	0.320	0.485	0.304
	Mother	0.447	0.131	0.247	0.161	0.283
Female	Father	0.282	-0.228	0.089	-0.223	0.113
	Mother	-0.040	0.558	0.387	0.548	0.366
’80	Father	0.217	0.628	0.257	0.584	0.177
	Mother	-0.554	-0.153	0.237	-0.089	0.329
’90	Father	-0.620	-0.002	0.116	0.015	0.140
	Mother	0.350	0.241	0.241	0.243	0.241
Pre- or primary school	Father	0.106	0.385	0.193	0.354	0.150
	Mother	0.173	0.094	0.248	0.082	0.245
Secondary school or above	Father	0.173	0.399	0.209	0.383	0.175
	Mother	0.978	0.250	0.132	0.297	0.165

Note: The first column is based on the estimates of parents’ education in Tables 5–6. Other columns are based on quantile IV estimates in Table 7 and unreported results for other subgroups.

Source: Authors’ calculation based on the CHFS.

Comparing the first two columns of Table 8, it can be seen that even though considering housing effects in the 2SLS-IV estimation, heterogeneity in filial education and other parents' and households' characteristics reduces the extent of maternal transmission of education by more than a half (from 0.342 to 0.165) for the full sample and even changes the sign of paternal transmission. Taking house prices into account attenuates paternal transmission by 38 per cent (from 0.366 to 0.226), while it strengthens maternal transmission by 84 per cent, from 0.165 back to 0.303. These mean that one standard deviation of father's (mother's) education can explain 0.226 (0.303) standard deviations of filial education. Across subgroups, the highest overall intergenerational correlation coefficient appears in mother–daughter association (0.366 in Column 5 of Table 8). Maternal transmission dominates the paternal one in the full sample as well as in all subgroups except male children and the families that purchased their first property in the later stage of child education.

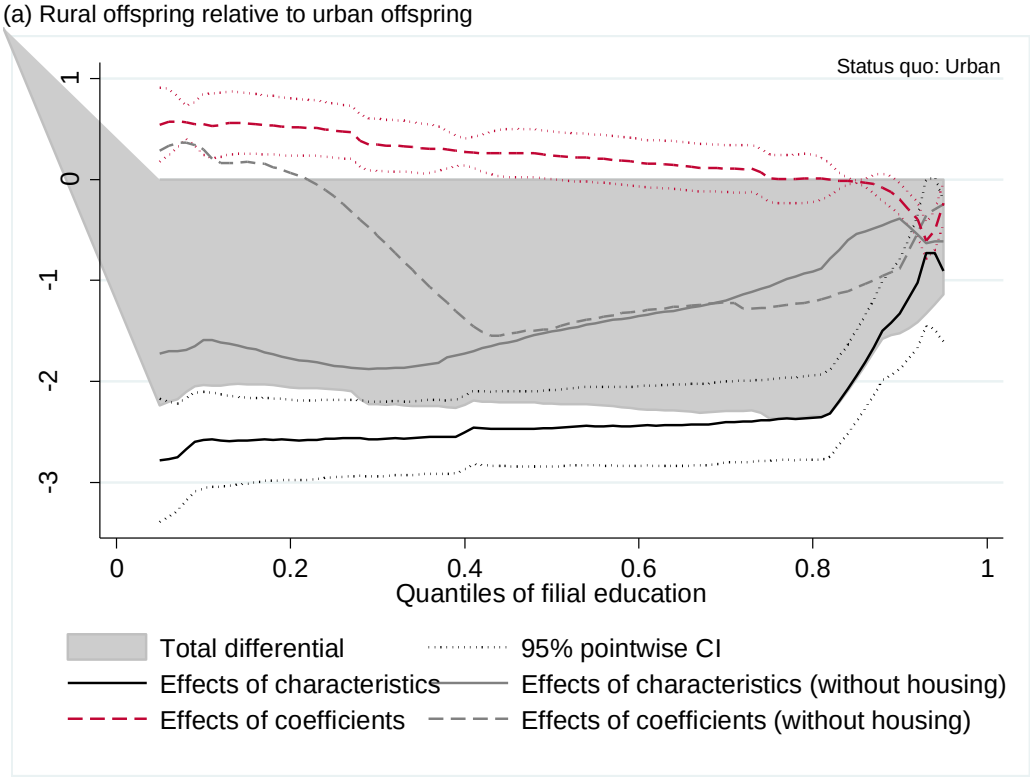
4.3 Sources of different intergenerational transmission of education between urban and rural households

Of the subgroups, we are particularly interested in urban–rural differences given their persistent educational gap and other considerably different socioeconomic status discussed in Section 2. As shown in Column 5 of Table 8, both paternal and maternal intergenerational transmissions are larger in urban than in rural areas, indicating a persistent and widening urban–rural educational gap across generations. Using another large dataset in China (the 2008 Rural–Urban Migration in China and Indonesia Survey), Golley and Kong (2013) also find a lower intergenerational correlation in rural and migrant than in urban populations who were born between 1941 and 1990.

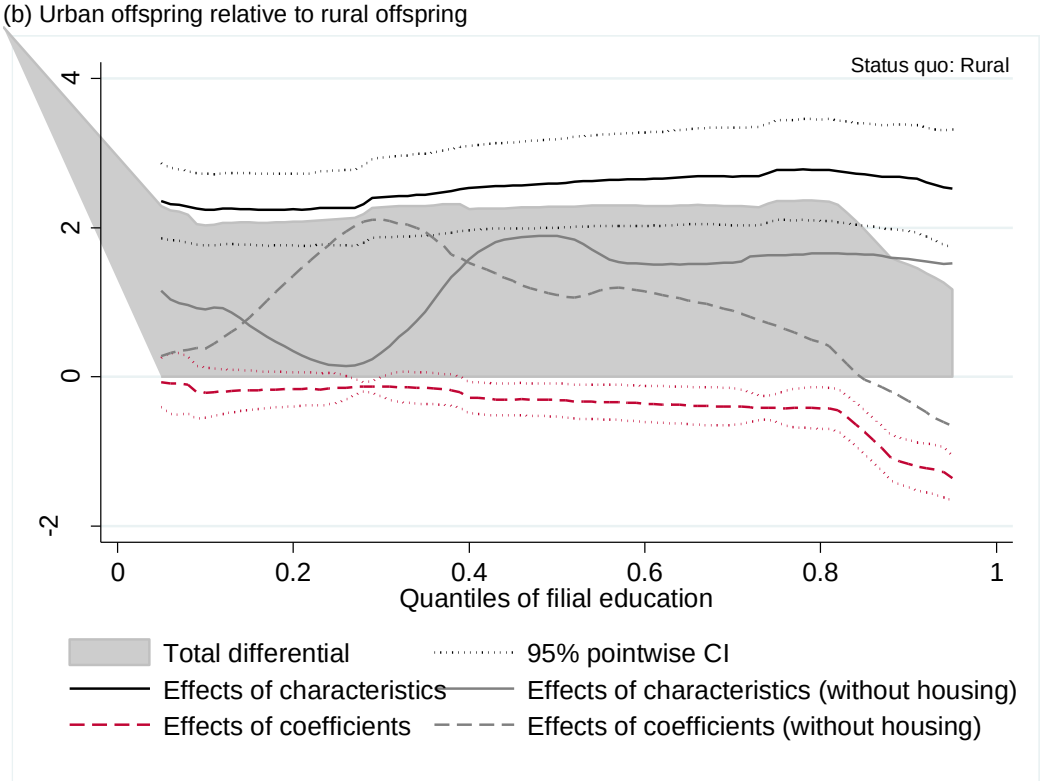
Figure 9 plots the total difference in filial education between urban and rural households along the distribution of filial education (Equation 7) and its two components by decomposition (Equation 8) at all 100 different quantiles from $\tau = 0.01$ to $\tau = 0.99$ with (1,000 times) bootstrapped standard errors. Urban households are first treated as the status quo population in Figure 9(a). The observed urban–rural gap (the shaded areas) in filial education is always negative, indicating lower educational attainment in rural than in urban populations in the entire distribution of filial education. The gap remains broadly the same when we move upwards along the distribution of filial education, but decreases after the 8th decile. Negative effects of characteristics and positive effects of coefficients below the 8th decile imply that at the low or moderate filial educational level, if rural parents raised urban children, filial educational attainment would have been even lower than rural children's. It is rural parents' limited endowment that leads to rural offspring's lower educational attainment than their urban counterparts'. In the highest two deciles of filial education, however, both effects are negative with similar magnitude, indicating that limited opportunities and endowments are equal barriers for rural offspring. In this sense, rural offspring are likely to encounter a 'glass ceiling' in terms of preventing able rural children from progressing to the top. It is worth noting that if decomposition was made without including housing-relevant variables in quantile regressions (i.e. the grey curves in Figure 9(a)), the conclusion could be misleading both quantitatively and qualitatively—both endowment and opportunity effects tend to explain rural offspring's educational disadvantages, and the opportunity effects even change the sign.

Figure 9: Quantile decomposition of urban–rural differences in distribution

(a) Rural offspring relative to urban offspring



(b) Urban offspring relative to rural offspring



Note: The label, 'without housing', indicates estimation and decomposition results of our model without controlling for housing-relevant variables (i.e. the level and appreciation of house prices and their interaction with parents' education and household wealth).

Source: Authors' calculation based on the CHFS.

When rural households are treated as the status quo in Figure 9(b), the total difference becomes positive, which is symmetric to that in Figure 9(a). Urban offspring's educational advantages are driven by their better endowments throughout the distribution.[23] Moreover, inclusion of housing yields negative opportunity effects. This indicates that urban offspring can inherit directly their parents' high endowments and the returns to wealth are higher than the returns to education. The magnitude of negative effects of coefficients is particularly large for offspring in the highest decile: they have an annual wealth income that is 1.6 times what they would get as wages. Thus, urban parents do not necessarily invest in child education and the descendants rely simply on huge wealth effects to inherit their parents' socioeconomic status. Piketty et al. (2014) term those successors whose capital income dominates labour income the '*rentiers*', and the converse 'savers'. They found that Paris was a '*rentier* society' over the years 1872 to 1927—10 per cent of Parisians were *rentiers* and they owned 70 per cent of aggregate wealth. Here we find a similar proportion for China in 2011: the highest decile in the distribution of filial education.

Together with the finding in Figure 9(a), in such a *rentier* society, there is also a 'glass floor' for those who were born in better-off families (typically urban families in Figure 9(b). The glass floor effect means that for urban children (especially the highest two deciles in Figure 9(b)), their parents' endowments would 'insure' their educational attainment by direct endowment effects/transfer regardless of their own capability as the endowment effects are positive and dominate negative opportunity effects along the entire distribution of filial education. Without considering house prices, the magnitude of the glass floor effects will be smaller because of smaller endowment effects and positive opportunity effects (e.g. the grey curves in Figure 9). It is the credit-constraint effect of rising house prices that escalates urban parents' endowment advantages in 'protecting' their (even less able) children from falling down the educational ladder and makes it harder for able children from (less advantaged) rural backgrounds to build on high potential. As such, it is not surprising to observe strong glass floor effects on the highest filial education in families purchasing housing properties in their children's (costly) secondary or tertiary education (i.e. the highest decile in Figures A.4(e) and (f) in the Appendix). Both glass ceiling and glass floor effects inhibit educational mobility and force urban–rural educational inequality to persist into the next generation.

Heterogeneity again affects our finding on the dominant role of endowment effects. Two exceptions are male-female and '80–'90 subgroups—educational advantages of males and the '90 cohort are mainly explained by their better opportunities (Figures A.4(a) and (b) in the Appendix). In particular, this birth cohort decomposition indicates that childcare methods, family environment and/or the opportunities attached to them (or offered by parents) become increasingly important in extending educational advantages across generations rather than parents' endowments per se, i.e. an increasingly large glass ceiling over time spurred by dominant opportunity effects.

[23] The dominant impact of endowments also appears in other countries. In India, 70 per cent of the variation in child education is due to parental education and geographic location (Emran and Shilpi 2015). In the US, two-thirds of the intergenerational earnings elasticity over the period 1968–2005 stems from the endowment effect, but the reverse occurs at low log income of fathers (Cardak et al. 2013), in contrast to no more than 37 per cent in Sweden (Lefgren et al. 2012) where inequality is less marked.

5 Conclusion

This paper estimates the extent of intergenerational transfer of human capital in terms of educational levels in the context of transitioning markets and investigates the impact of house prices on intergenerational transmission of education. We use a nationally representative survey, the China Household Finance Survey 2011, to construct household history of property purchases and educational investment decisions over the past 16 years. Various heterogeneity in and between offspring, their parents, and households is addressed by separately estimating different demographic groups in a quantile model specification.

Rising house prices brings more credit constraints to households' consumption/investment behaviour, compared with wealth effects of price appreciation. There is considerable heterogeneity in intergenerational transmission of education between various demographic groups and nonlinearity within each group depending on the distribution of both generations' education. Inferences on intergenerational transmission of education can be misled substantially without taking into account house prices and heterogeneity. Overall, rising house prices lessens the average paternal intergenerational correlation coefficient by 38 per cent, from 0.366 to 0.226, and enhances the maternal one by 84 per cent, from 0.165 to 0.303. The cross-sectional urban–rural educational gap tends to persist into the next generation due to low endowments in the rural population and limited opportunities (negative discrimination) for those rural offspring to achieve the highest educational attainments compared with their urban counterparts. Higher educational attainment becomes more persistent between gender and across generations over time due to methods of child-raising and/or wider opportunity (positive discrimination) among males and the '90 cohort compared to their female or '80 counterparts. These findings question the existence of meritocratic value and equal opportunity for educational advancement in China.

Policy addressing (cross-sectional) inequality of endowments in parents' generation can reduce intergenerational persistence of the educational gap, while to slow the decreasing trend of intergenerational mobility over time, policy needs to concentrate on reducing discrimination and equalizing opportunities that are now likely to be offered (only) by well-endowed parents. In the presence of heterogeneity and nonlinearity, policy resulting in rising house prices (such as the current 'campaign' of massive urbanization pledged by the Chinese government and 'bubbles' in land or real-estate markets) is likely to incur intergenerational inequality in education through both glass ceiling and glass floor effects.

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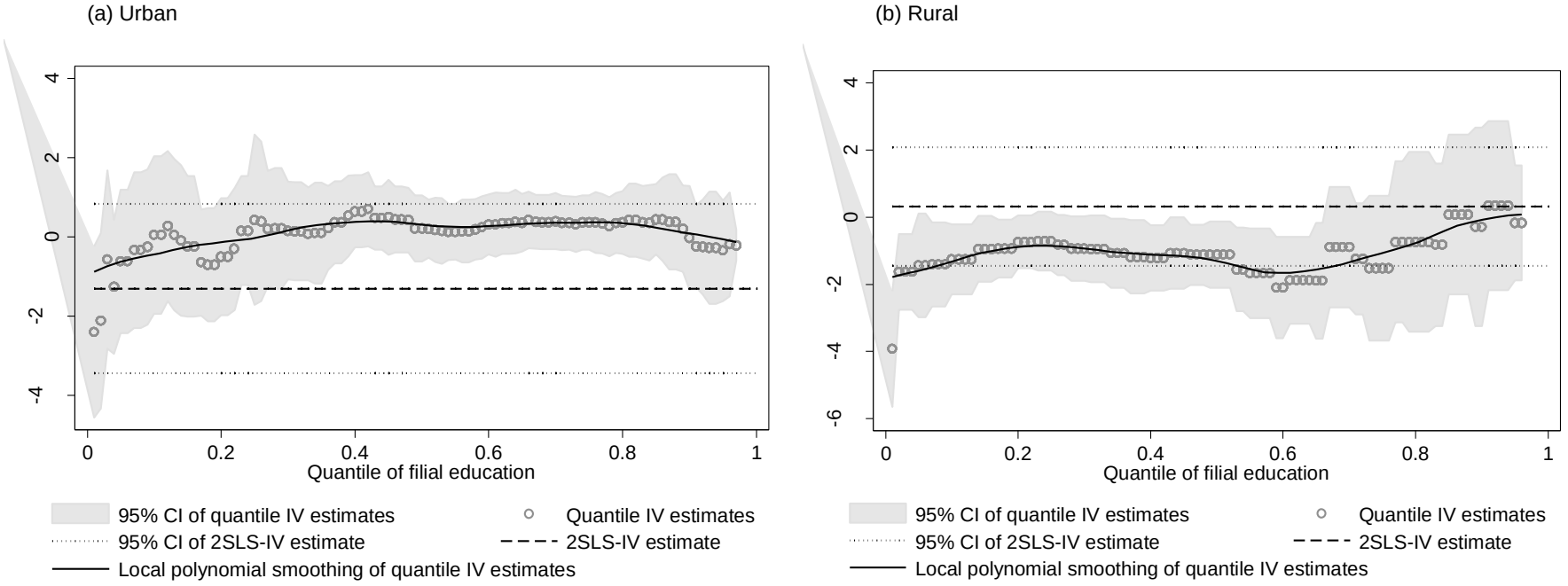
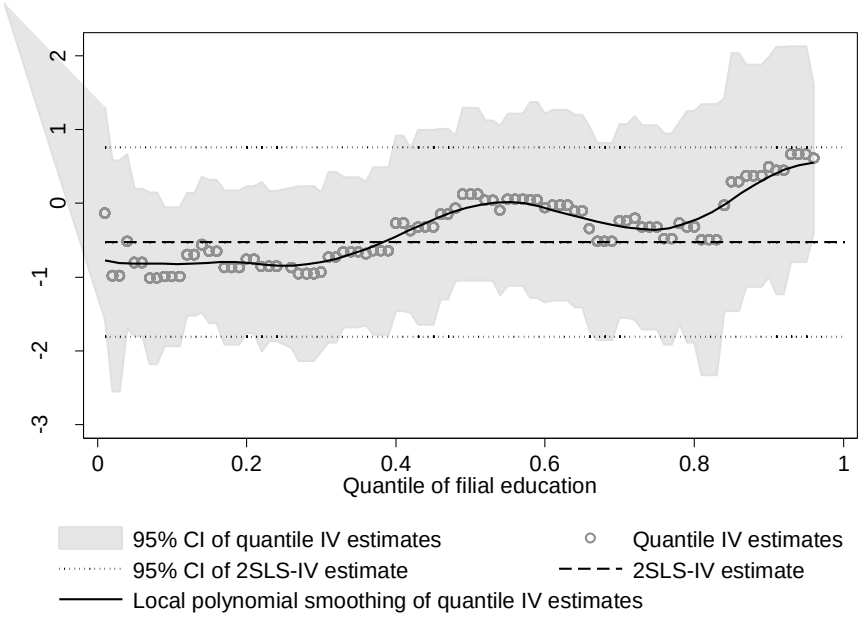
Appendix

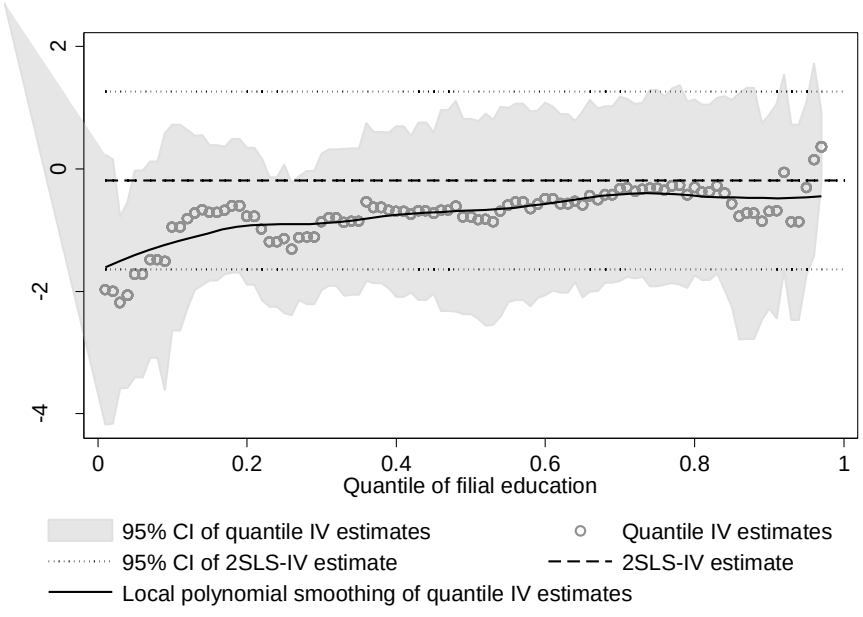
Figure A.1: Quantile estimates of house price



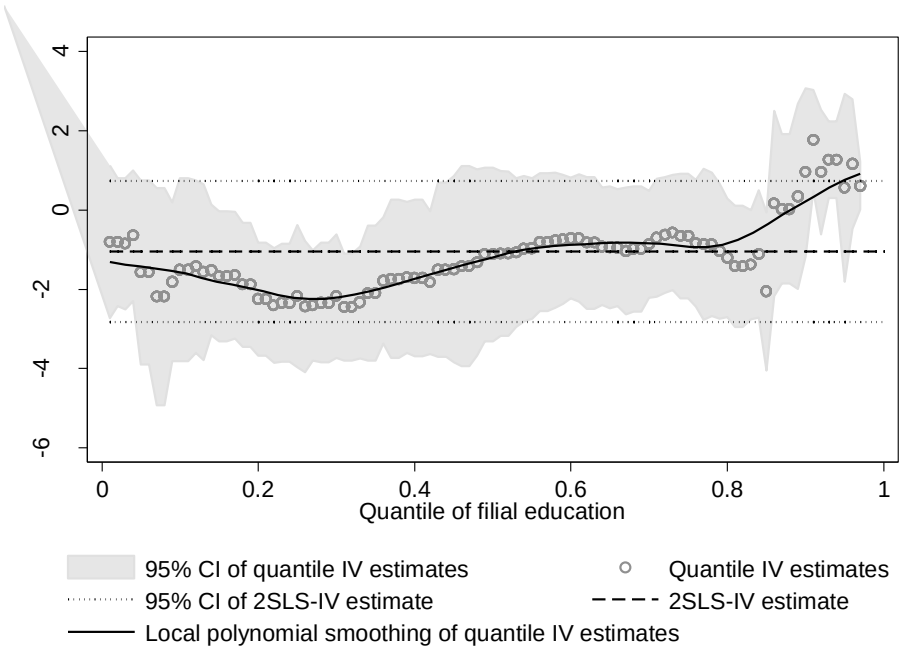
(c) Male



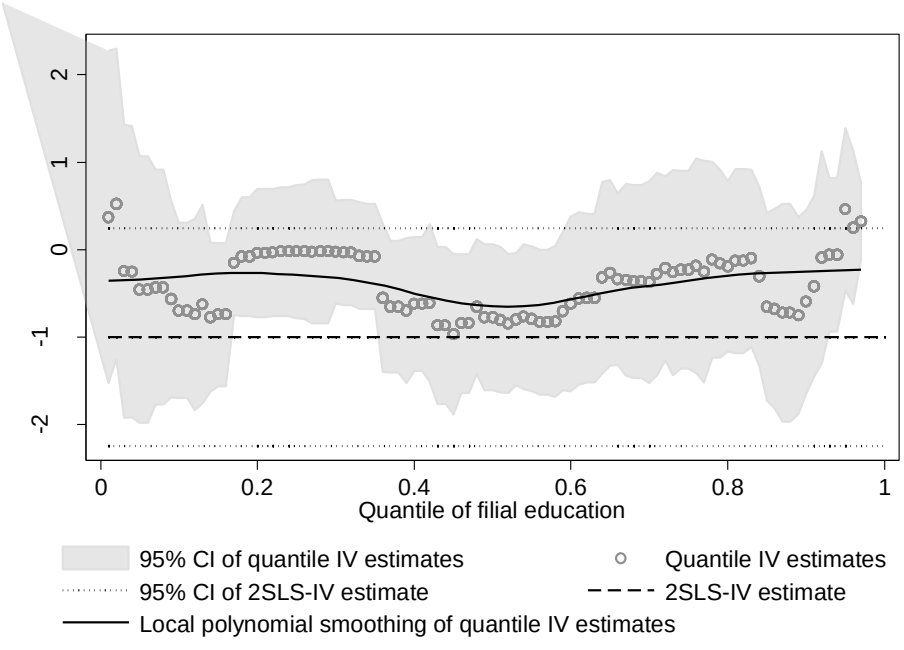
(d) Female



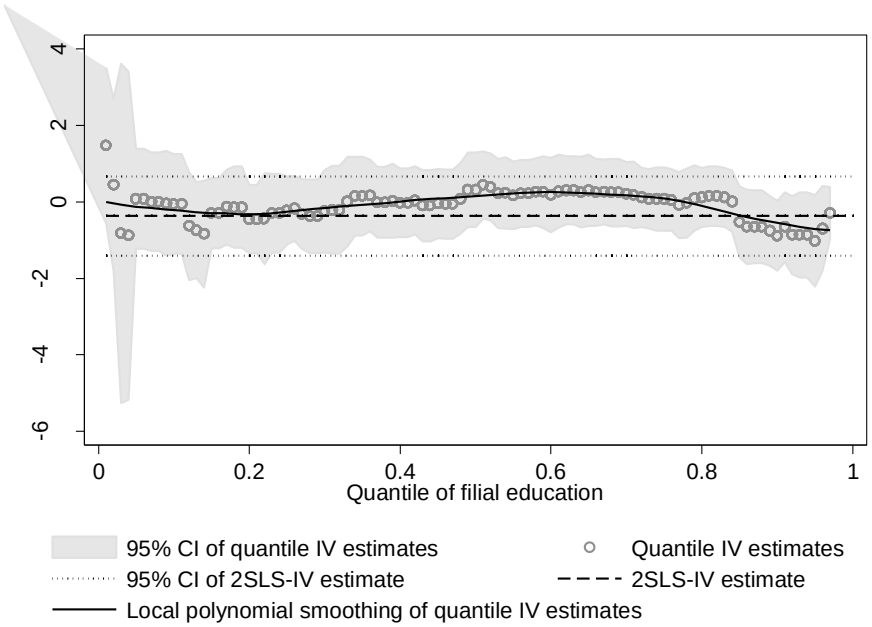
(e) Birth cohort: ’80



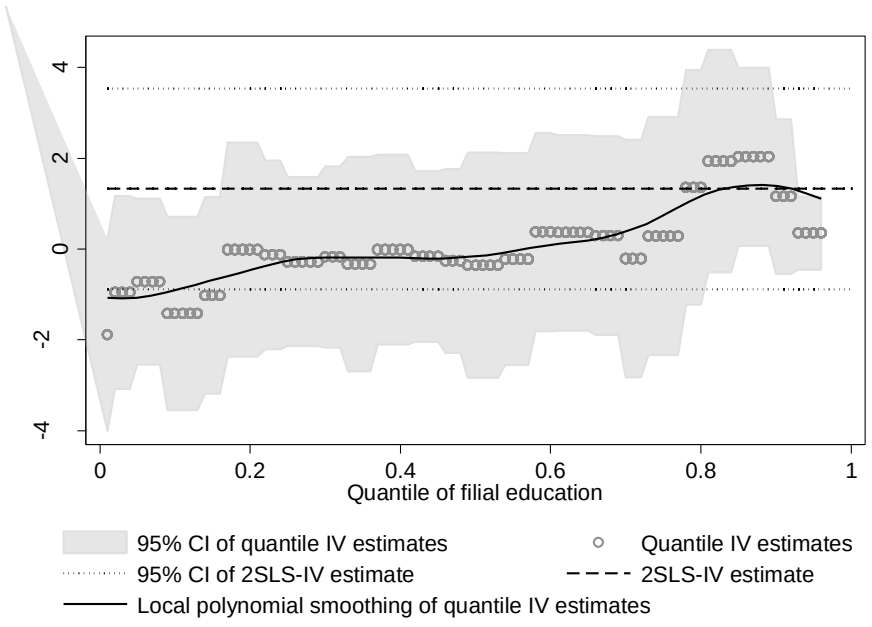
(f) Birth cohort: ’90



(g) Purchasing-time: Pre- or primary school

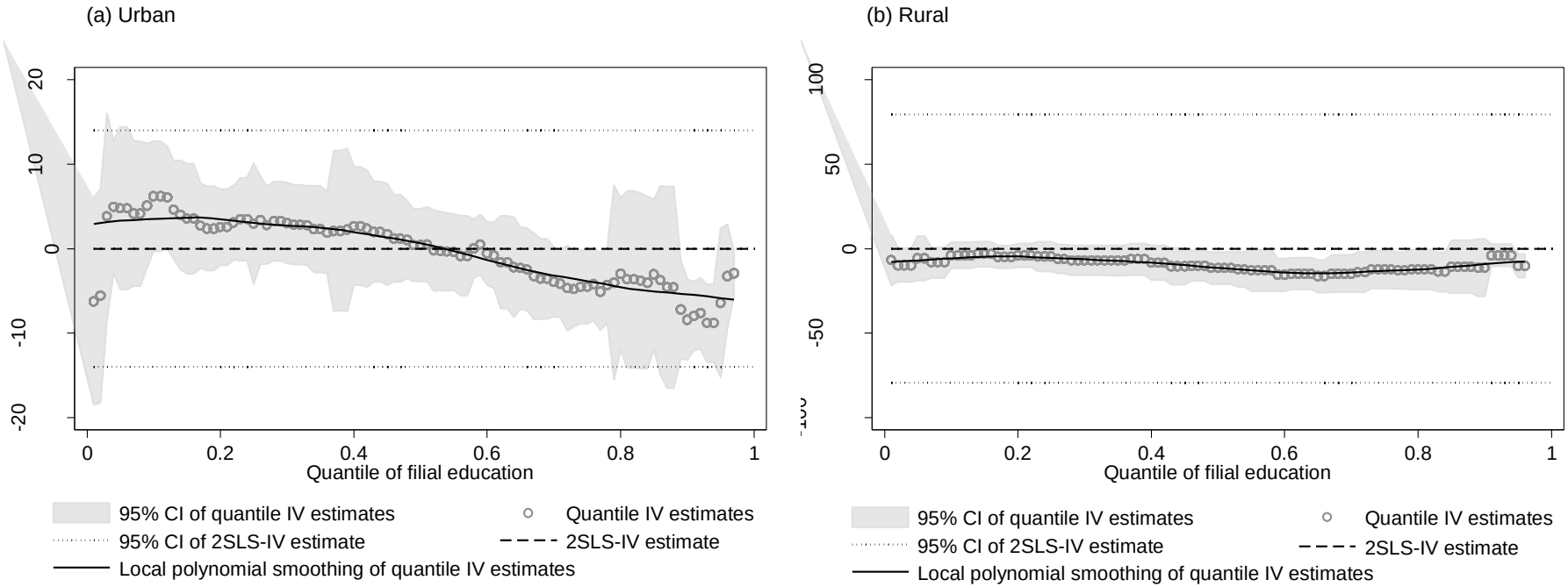


(h) Purchasing-time: Secondary school or above

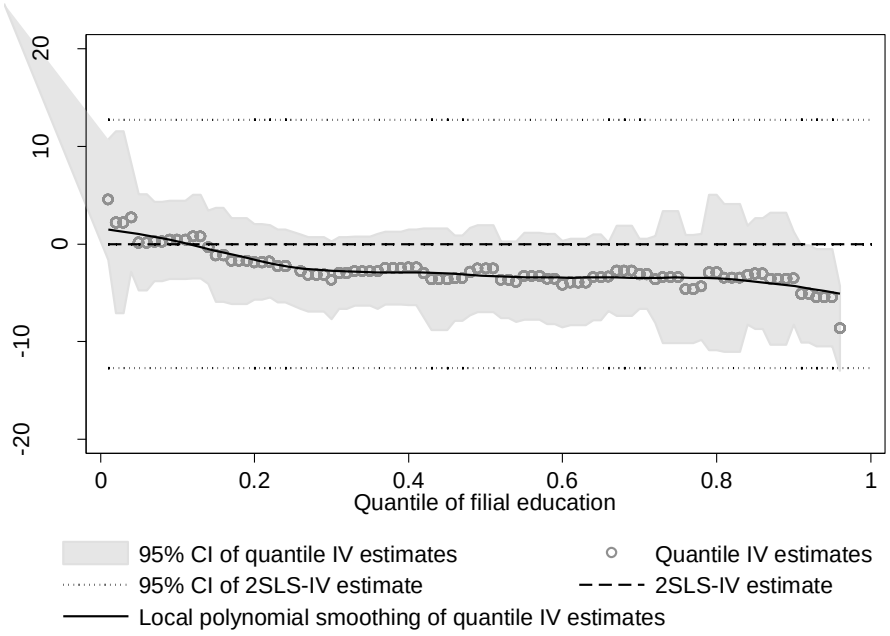


Source: Authors' calculation based on the CHFS.

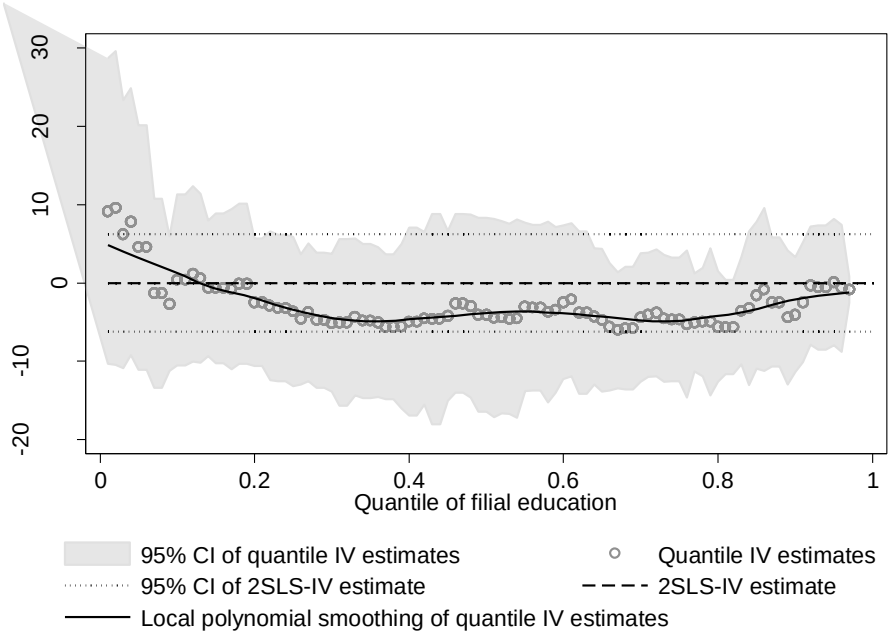
Figure A.2: Quantile estimates of house price appreciation



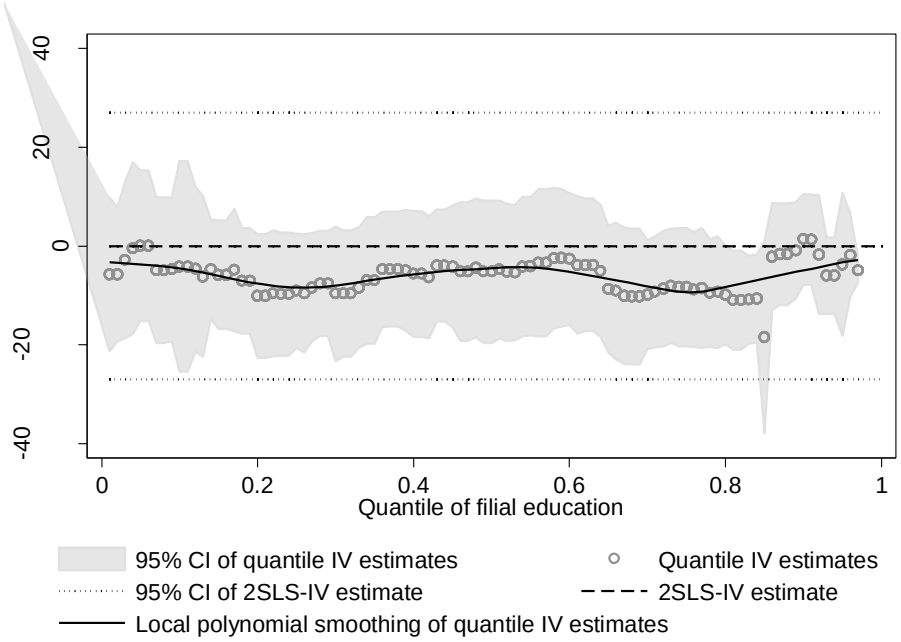
(c) Male



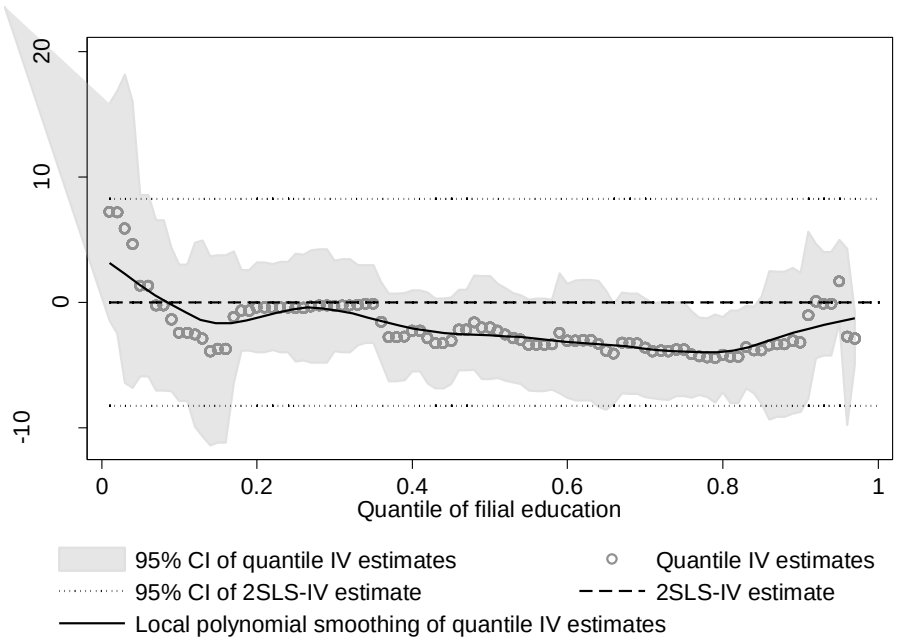
(d) Female



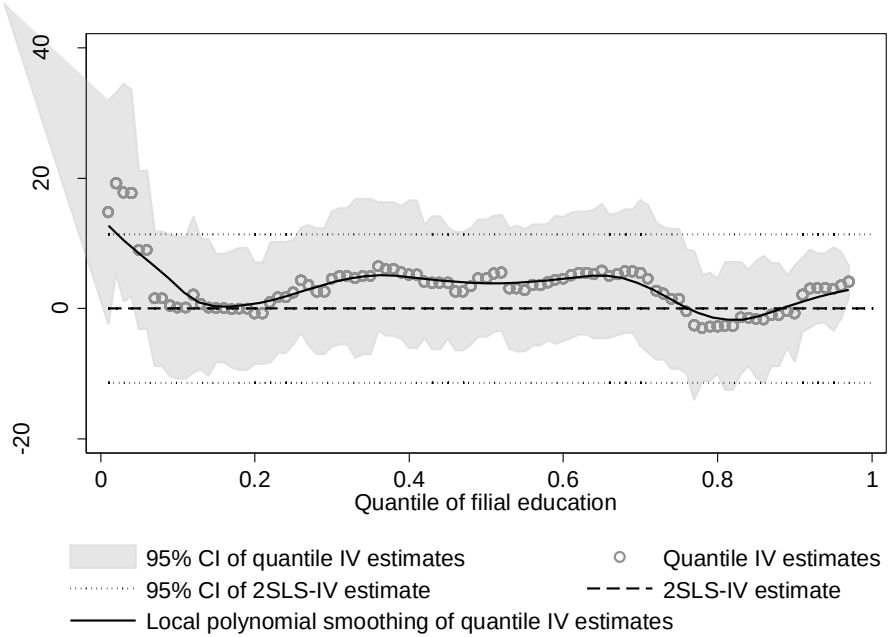
(e) Birth cohort: ’80



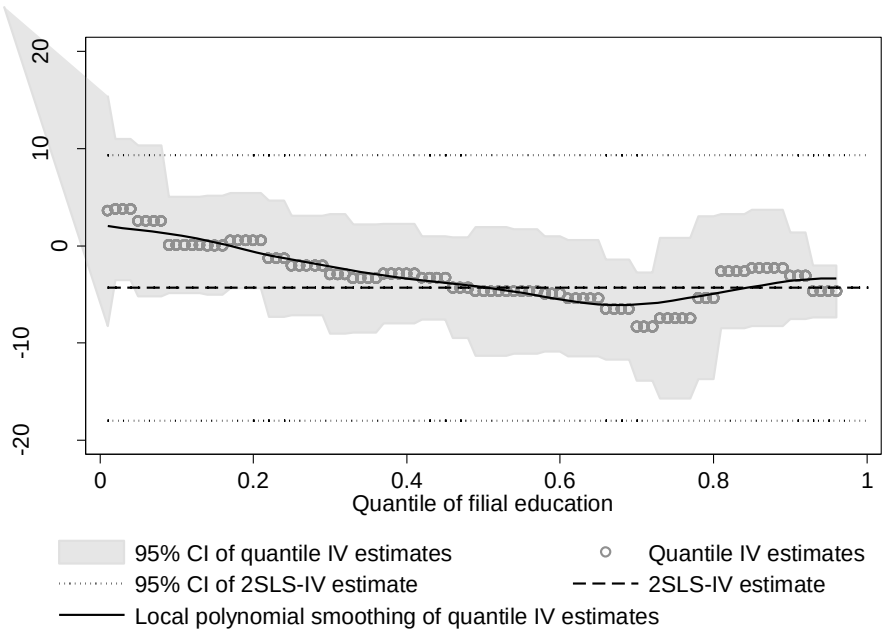
(f) Birth cohort: ’90



(g) Purchasing-time: Pre- or primary school



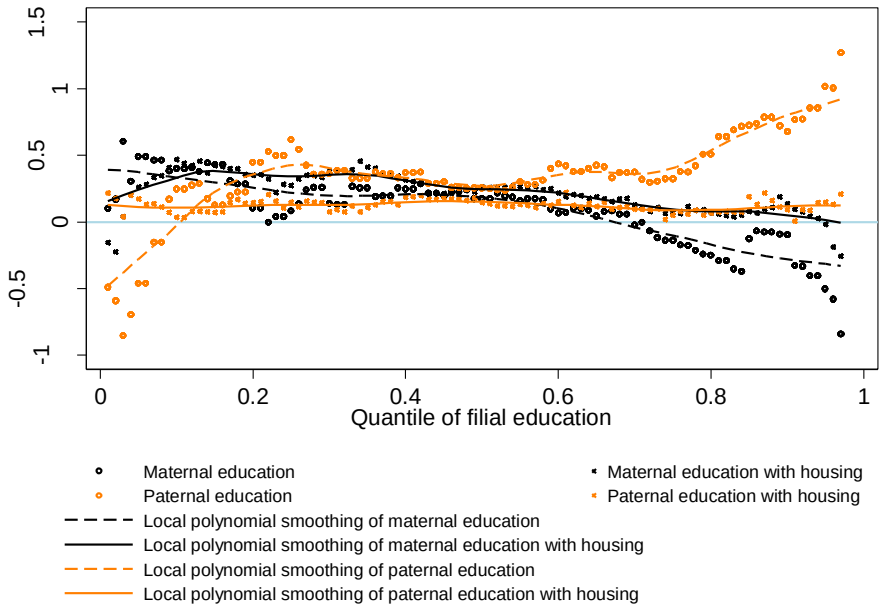
(h) Purchasing-time: Secondary school or above



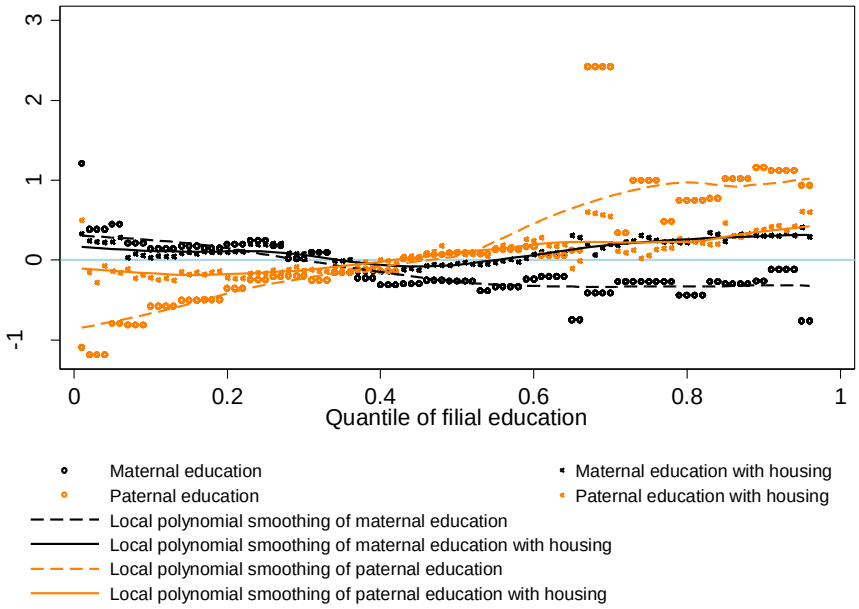
Source: Authors' calculation based on the CHFS.

Figure A.3: Quantile estimates of parents' education (by subgroup)

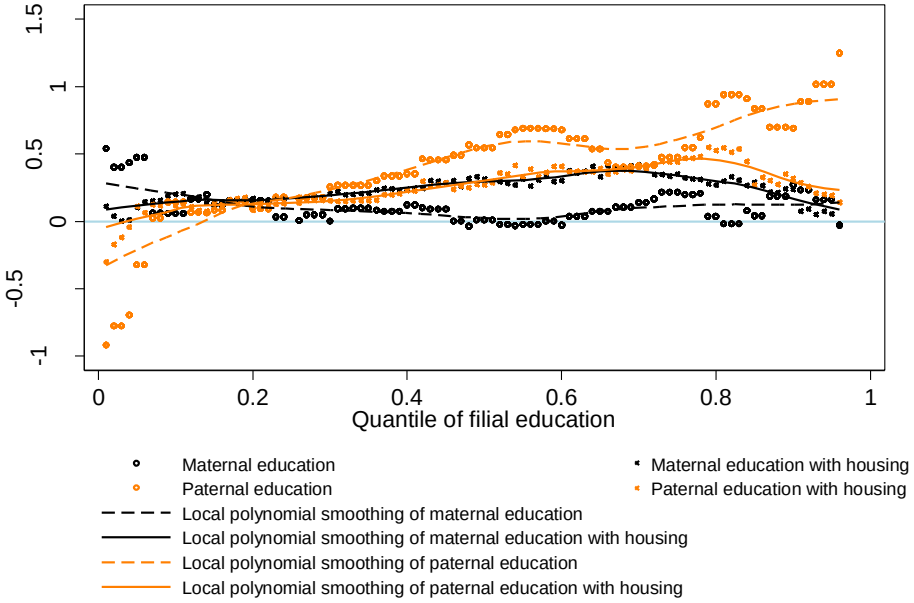
(a) Urban



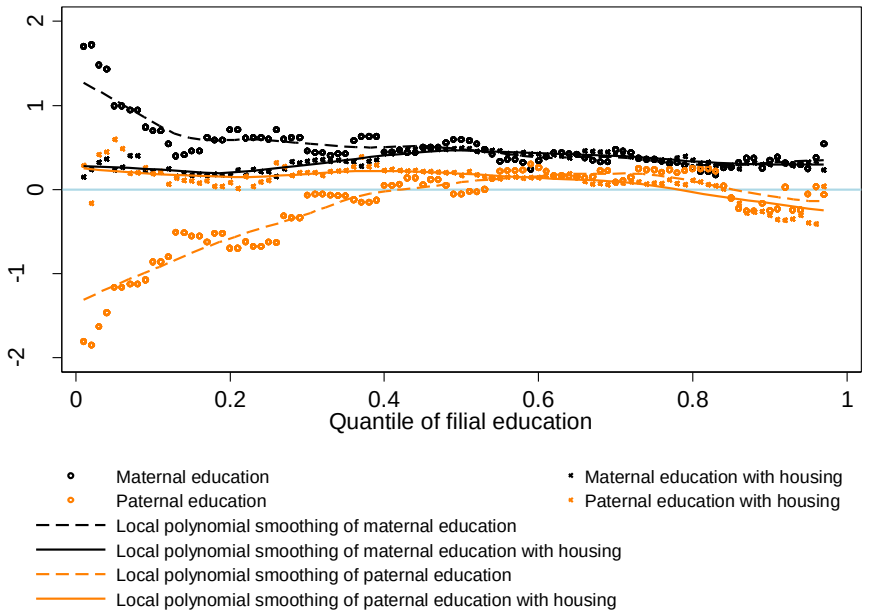
(b) Rural



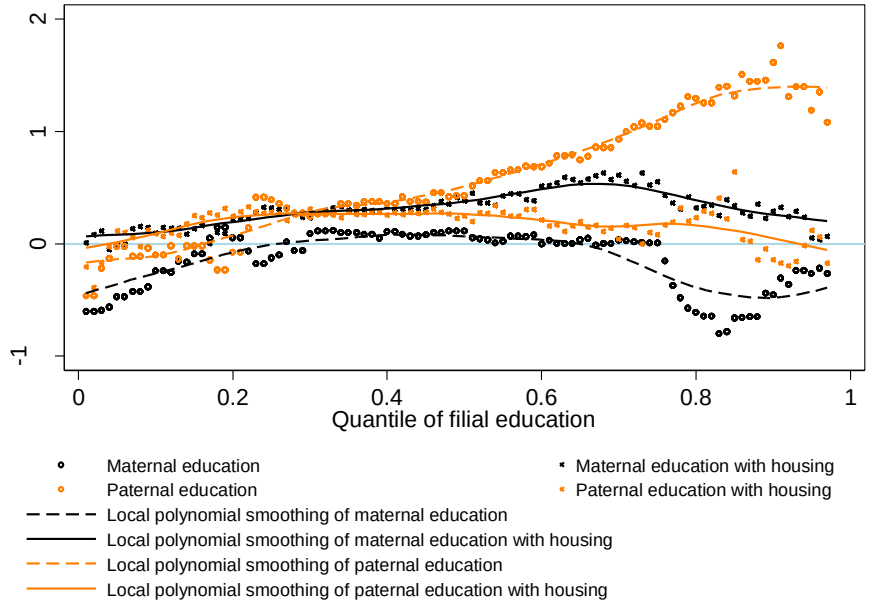
(c) Male



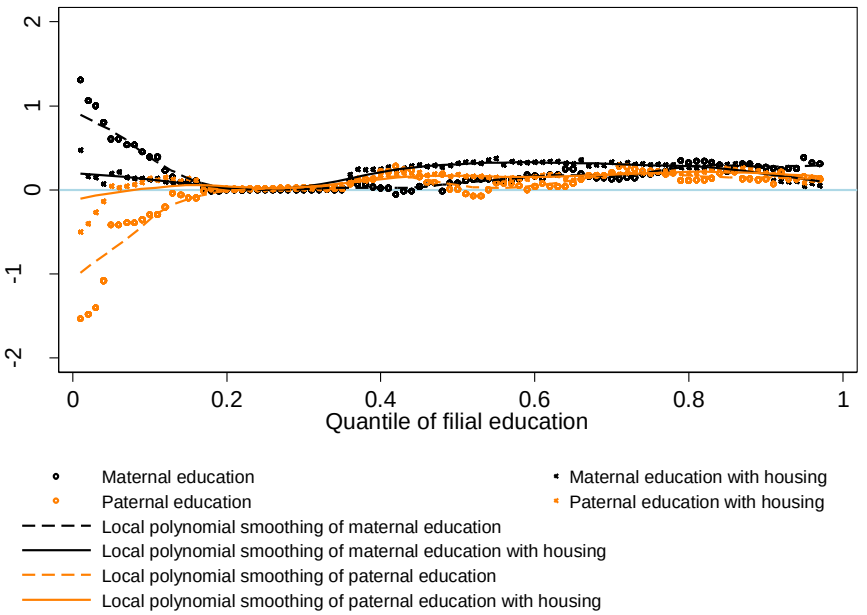
(d) Female



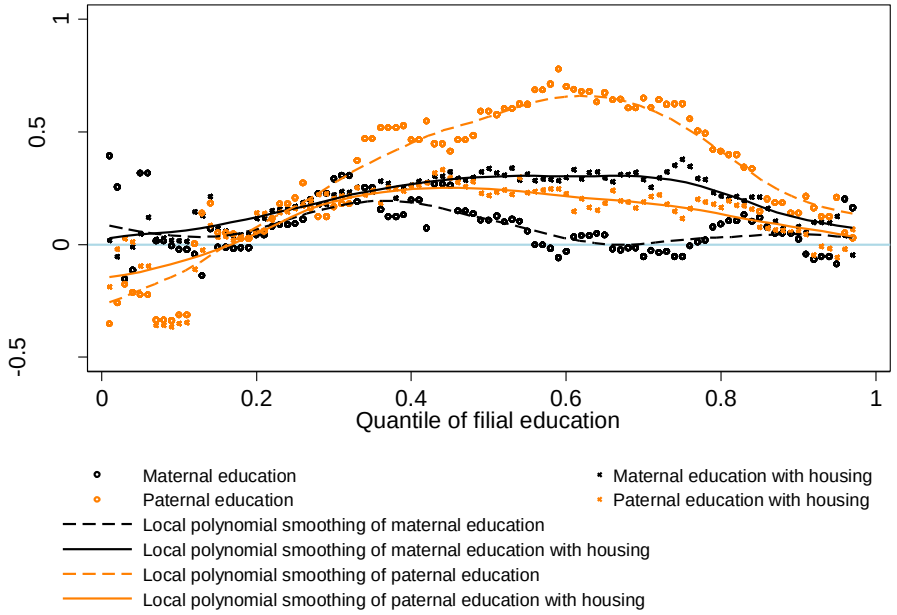
(e) Birth cohort: ’80



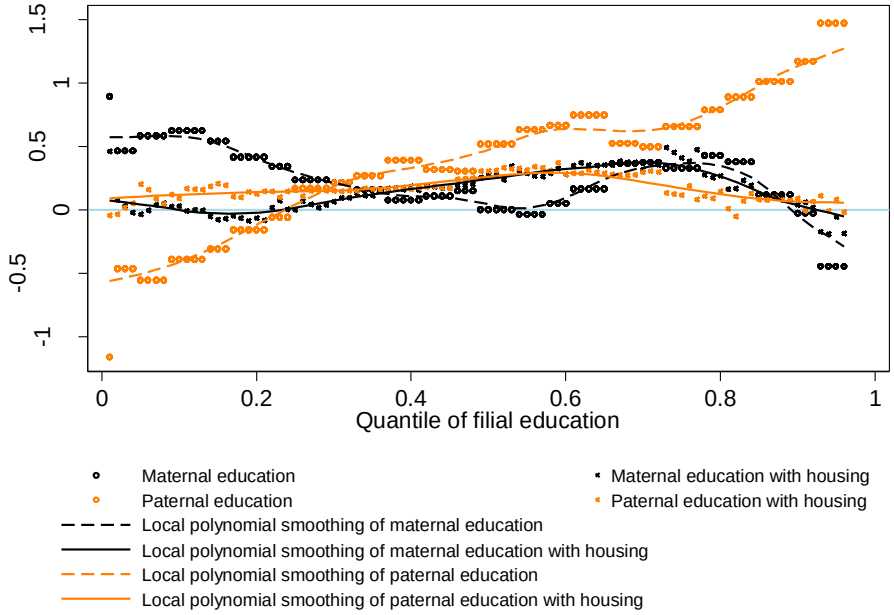
(f) Birth cohort: ’90



(g) Timing of purchasing properties (pre- or primary school)



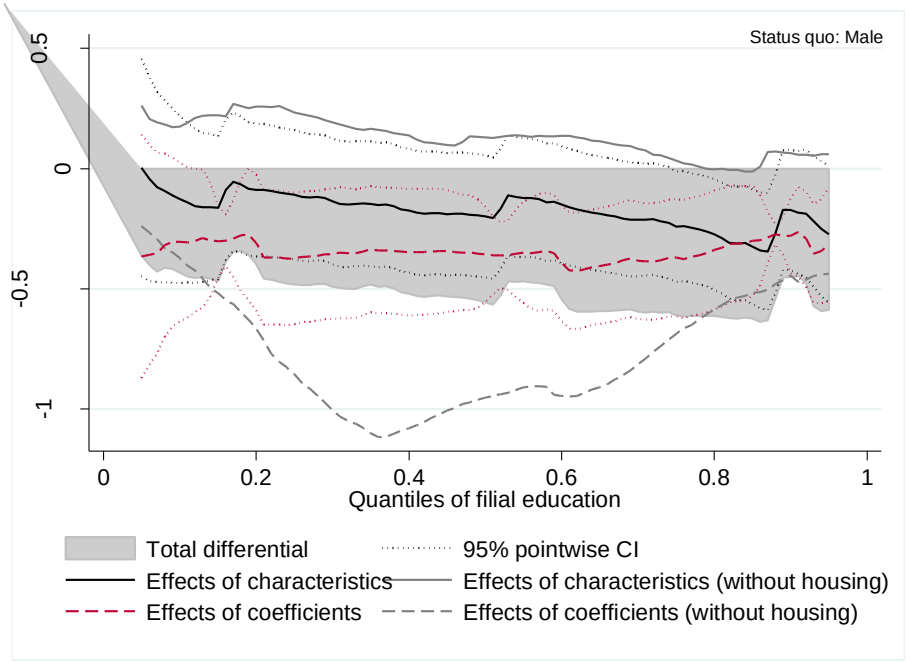
(h) Timing of purchasing properties (secondary school or above)



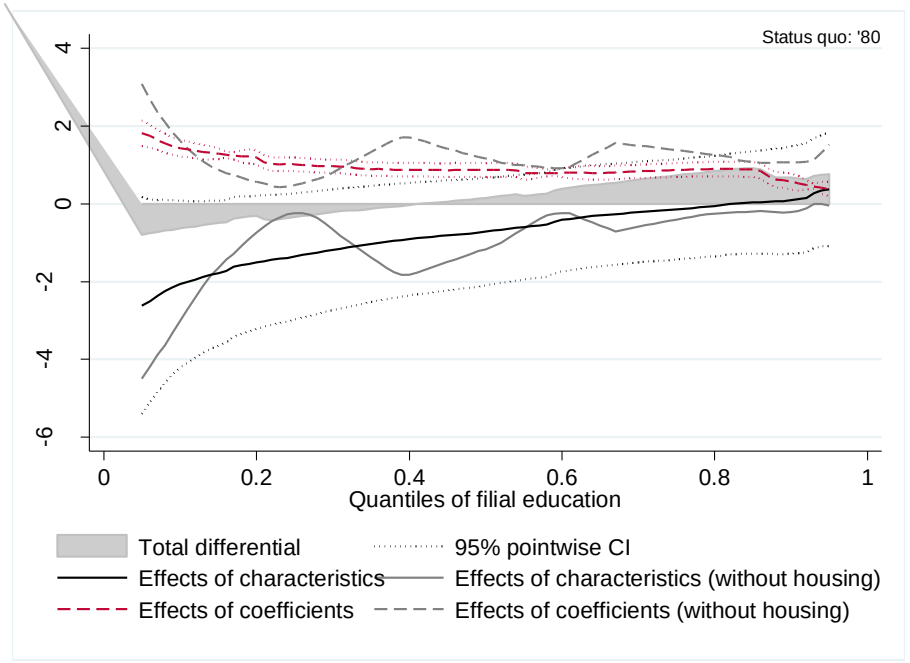
Source: Authors' calculation based on the CHFS.

Figure A.4: Quantile decomposition (by subgroup)

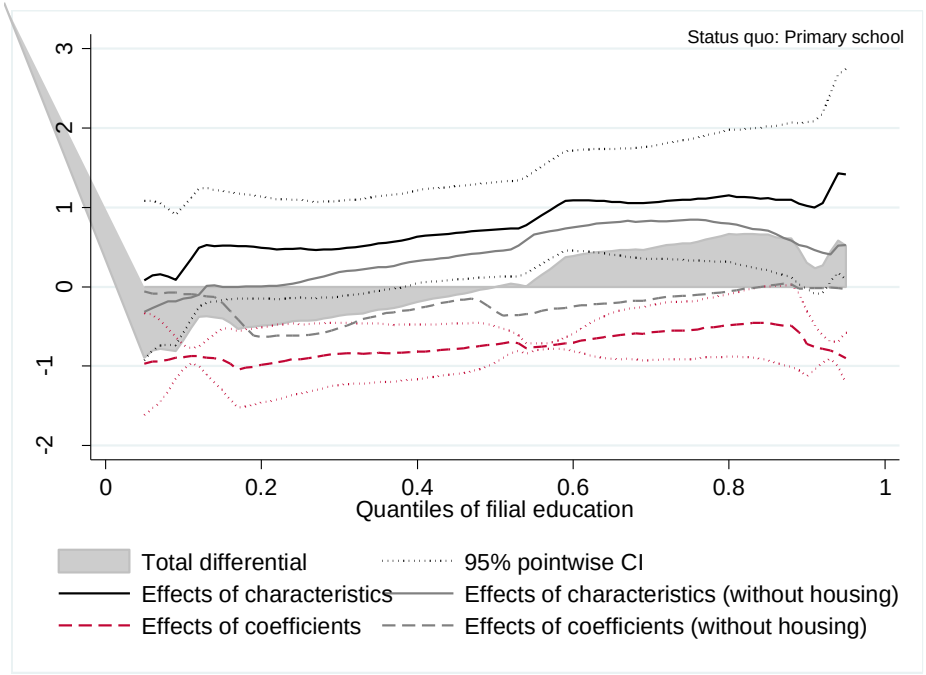
(a) Gender



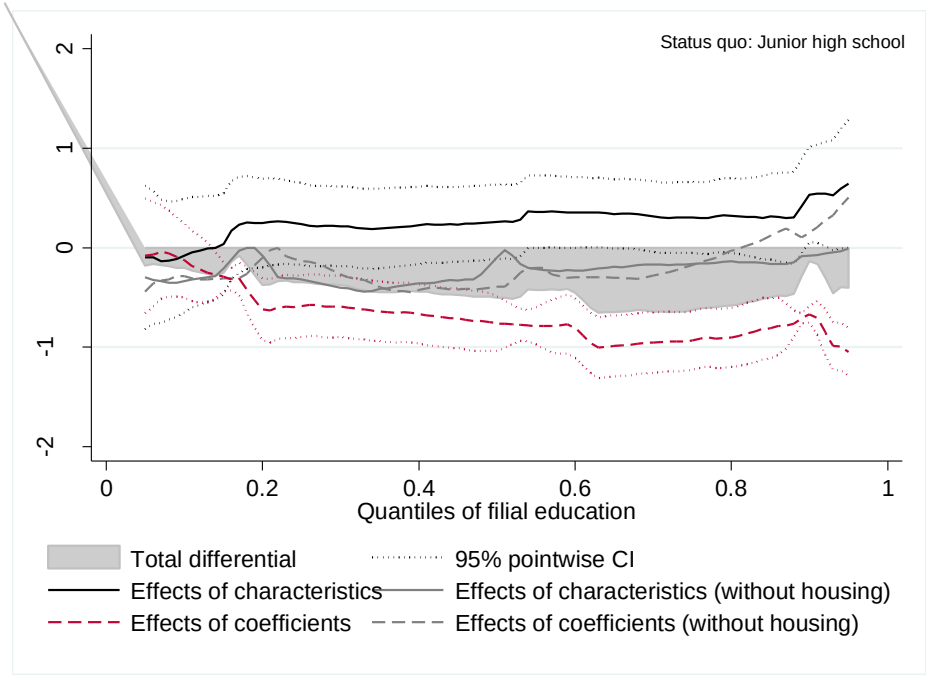
(b) Birth cohort



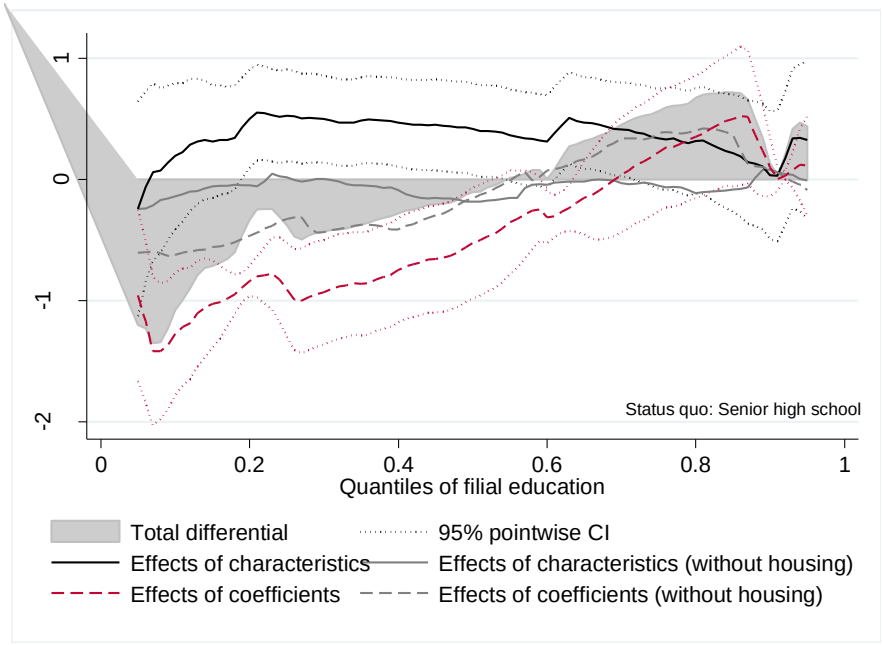
(c) Pre-school vs. primary school



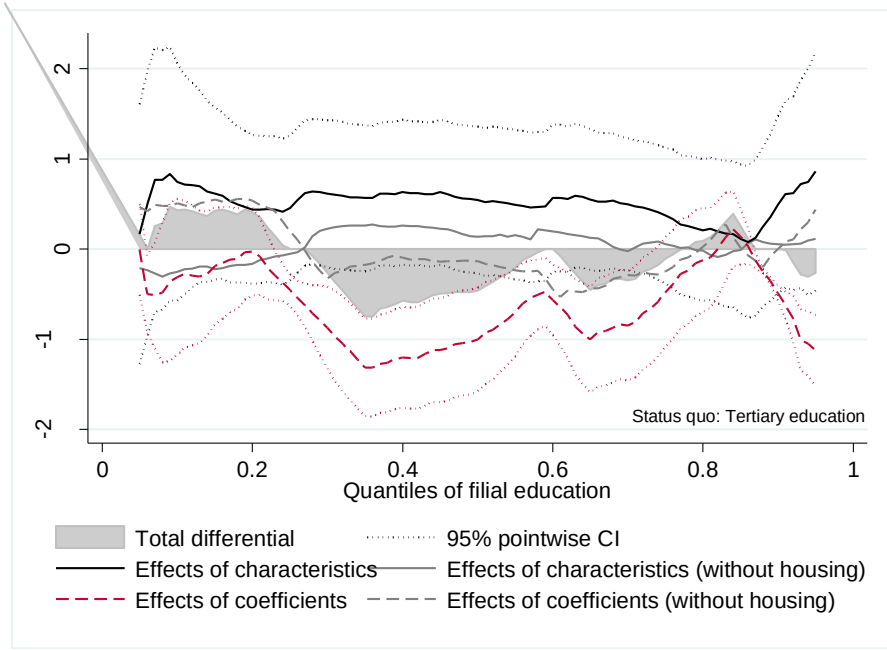
(d) Primary school vs. junior high school



(e) Junior high school vs. senior high school



(f) Senior high school vs. tertiary education



Source: Authors' calculation based on the CHFS.

Table A.1 Definition and descriptive statistics

Variable	Definition	Mean	S.D.
Education	The number of years of filial education. The survey recorded a categorical variable of individual educational level: never attended school=1, primary school=2, junior high=3, senior high school=4 or vocational school, university/college=5, master degrees=6, doctoral degrees=7. Based on this, we count the number of years of education completed by the offspring.	11.586	2.904
House size	Size of the family's first residential property, measured by square metres.	164.568	147.696
House price	The total expenditure (including loans for housing) of the family's first residential property divided by the house size.	493.700	1,346.621
Annual appreciation of house price	Difference between the current and initial natural logarithmic house prices divided by the number of years since purchase. The initial house price is calculated as above. The current house price is calculated as the value of the property in 2010 divided by the house size.	0.094	0.130
Father's education	The number of years of education completed by father. Calculated in the same way as the individual (offspring) education.	9.248	3.325
Mother's education	The number of years of education completed by mother. Calculated in the same way as the individual (offspring) education.	7.980	3.788
Gender	Dummy variable, male=1; female=0.	0.574	0.495
Age	Age in years.	20.802	4.039
Rural	Dummy variable indicating the individual's residential place, rural areas=1; urban areas=0. The urban–rural divide is according to the NBS.	0.467	0.499
Urban	Dummy variable indicating the individual's registration type (i.e., '*Hukou*'), urban household registration=1; rural household registration=0.	0.354	0.478
Household size	The number of adult-equivalent family members according to the OECD equivalence scale.	2.64	0.625
Number of children	The number of children of the family.	1.818	0.901
Number of houses	Total number of houses owned by the family.	1.193	0.466
Household income per adult-equivalence	Household annual disposable (net) income divided by the household adult-equivalent size. Household annual disposable income includes wages, income from family businesses, agricultural production and properties, and transferred income, net of taxes.	12,361.2	32,475.9
Financial assets	Monetary value of household financial assets including current or savings accounts, pensions and insurance, mutual funds, bonds, shares, money lent out, and other forms of financial assets.	44,514.9	136,849.5

Non-financial assets	Monetary value of the non-financial assets including the value of the household's main residential property, other housing properties, vehicles, non-financial assets of family businesses, and other forms of non-financial assets.	501,421.6	869,642.3
Debts	Monetary value of the household's total debts including mortgage (for housing and vehicles), educational loans, credit card debts, and other forms of debts.	8,409.4	36,074.95
Household wealth per adult-equivalence	The household's net worth divided by the household adult-equivalent size. The household's net worth is the sum of financial and non-financial assets minus debts.	210,628.4	390,815.1
Housing wealth per adult-equivalence	Monetary value of the household's first residential property divided by the household adult-equivalent size.	164,216.9	333,735.1
Non-housing wealth per adult-equivalence	Monetary value of the household's non-housing wealth divided by the household adult-equivalent size.	46,411.46	109,418
Ln(GDP per capita in 2010)	Natural logarithm of GDP per capita in 2010 when the CHFS was conducted.	10.360	0.416
Ln(GDP per capita before the house-purchasing year)	Natural logarithm of GDP per capita (inflated to 2010 prices) in the year before the household purchased their first residential property.	9.289	0.642
Annual growth rate of provincial house price before the house-purchasing year	The growth rate of provincial average house price in the year before the household purchased their first residential property.	0.053	0.108
Annual growth rate of provincial urbanization rate before the house-purchasing year	The growth rate of provincial urbanization rate in the year before the household purchased their first residential property. Urbanization rate is defined as the share of urban population in the province. Urban population is defined as those living in urban areas (regardless of their household registration type) according to the NBS.	0.023	0.117

Note: All monetary values are translated into real terms at the 2010 price level. The deflators are the annual provincial Consumer Price Indices in rural and areas (the 2010 price level=1), respectively.

Source: Authors' calculation and compilation based on data from the CHFS, China Statistical Yearbooks and China Compendium of Statistics 1949-2008 published by the NBS.