



The intergenerational impact of house prices on education: evidence from China

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ABSTRACT

We investigate heterogeneous and nonlinear intergenerational transmission of education and the impact on this of house prices. Using the China Household Finance Survey, we construct household history of property purchases and educational investment over the past 16 years with current filial educational achievement. High house prices tighten the household's credit constraints, resulting in the concave slopes of filial education as a function of father's education. On average one standard deviation in father's (mother's) education accounts for 0.375 (0.098) standard deviations of filial education. Decomposition reveals the "glass ceiling" and the "glass floor" in two tails of education distribution.

JEL classification

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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 (Clark and Cummins, 2015), occupation (Long and Ferrie, 2013), health (Halliday et al., 2021), education (Qin et al., 2016), and socioeconomic status (Clark, 2014). While the higher the levels of inequality, the more likely these inequalities are to be transmitted from one generation to the next (Corak, 2013), countries characterised by lower levels of relative income inequality than others such as the Nordic countries also experience persistent inequality – albeit to less extent – into children (Björklund et al., 2012; Bratsberg et al., 2007) and this intergenerational

association can last as long as three to four generations (Chan and Boliver, 2013 for the UK, Hällsten, 2014 for Sweden, and Hertel and Groh-Samberg, 2014 for the US and Germany).

In this paper, we investigate what has been hitherto a relatively neglected subject in the intergenerational mobility literature, particularly in the context of developing countries: the nonlinear intergenerational transmission of human capital in terms of years of schooling and the mechanisms via the wealth gradients when educational resources are unequal and children's learning ability highly depends on parental investment in human capital.

Literature in developing countries shows relatively high and persistent intergenerational persistence in education.¹ We further investigate heterogeneity and nonlinearity in intergenerational correlation of education and the mechanisms driving the nonlinear shape. These have been under-researched in both the developing and developed countries.

A few studies in developed countries reveal either flat (Bratsberg et al., 2007 for Denmark, Finland, and Norway), log-linear (Cardak et al., 2013

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¹ Lillard and Willis (1994), among the first, use Malaysian birth cohorts from 1910 to 1980 to document the parent-daughter and parent-son correlations of education – 0.5 and 0.3, respectively. In India, the intergenerational immobility in terms of the proportion of children staying in the same educational category of parents is 31% among women aged 15–24 in 1993 or 2004 (Choudhary and Sign, 2017), while for men it is 50% for the 1951–55 cohort and declines to 33% for the 1981–85 cohort (Azam and Bhatt, 2015). Emran and Shilpi (2015) reaffirm this pattern and trend by calculating the intergenerational correlation coefficients of 0.574 in 1992/93 and 0.54 in 2006. China suggests less educational persistence where the coefficient ranges from 0.429 to 0.481 between 1989 and 2009 (Qin et al., 2016).

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for the US), convex, and/or S-shape intergenerational transmission of income (Grawe, 2004 for Canada), while it remains unknown how different parts of the distribution of child education are formed. The existing literature informs three strands of channels transmitting education across generations. First, social transmission matters such as the school quality (Grawe, 2010 in the U.S.), educational policy (e.g., the tracked education systems in the EU (Burger, 2016), and the distribution of public-school spending (Kotera and Seshadri, 2017 in the U.S.). Second, children's unobserved and observed characteristics determine what they can develop or inherit from their parents, such as genes (Ayorech et al., 2017), demographics such as gender (Emran and Shilpi, 2015), age at enrolment (Bauer and Riphahn, 2013), infant or childhood health and nutrition (Currie and Moretti, 2003; Carvalho, 2012), children's cognitive and non-cognitive skills (Lundborg et al., 2018), innate ability and heritability (Dardanoni et al., 2008; Han and Mulligan, 2001). Third, the family's resources help shaping the intergenerational linkage such as household assets (Huang, 2016), credit constraints (Grawe, 2004), family structure (Martin, 2012), paternal and maternal presence (Kalil et al., 2016; Amin et al., 2015), social networks or capital (Heath et al., 2010), and neighbourhood (Patacchini and Zenou, 2011).

There have been few studies on mechanisms in transition economies and in which shape of intergenerational relationship they would result. Analysing these countries not only adds new and possibly different empirical evidence to the aforementioned channels due to different parental decision-making functions and socioeconomic conditions from those in developed countries, but also enriches our understanding how different markets, cultures, beliefs, preferences, tastes and social norms would work with (or change) the existing channels and lead to different patterns of educational mobility. China provides a good example of combining both economic and cultural/societal factors in shaping heterogeneous intergenerational mobility. We specifically focus on the third strand of channels – family wealth proxied by the value of housing – a major household asset (Cowell and Van Kerm, 2015; Xie and Jin, 2015).² Wealth could confound the intergenerational transmission of education by, for example, increasing children's educational attainments by direct support and/or indirectly increasing children's college expectations (Elliott et al., 2011). However, positive association between the family's assets and the child's educational attainment can vary greatly, reflecting heterogeneous constraints and opportunities faced by households at different points in the wealth distribution (Atkinson, 2015). In accordance with our aim of revealing heterogeneous transmission patterns, we go beyond the level of wealth, but consider the role of wealth distribution, which is caused by house price appreciation in our set-up, in reproducing parental educational achievements in a nonlinear way.

This paper contributes to the literature on educational mobility in three important ways. First, it adds to knowledge on the nonlinear and heterogeneous intergenerational transmissions of education in contexts of transition economies. We exploit a rich Chinese household dataset, which not only allows us to estimate nonlinearity in intergenerational transmission of education, but also could enrich our understanding in the following aspects. For one thing, different from the time trends in other developing countries, China seems to experience increasing educational immobility across generations while the government supports and expands public education. It is worth comparing the intergenerational association in such contexts with that of other countries. For another, the shape of educational mobility is accompanied by high and increasing wealth inequality in China, which could incur much heterogeneity within the overall pattern of transmission. Taking different extent to which children's education respond to their parents' education into account, we use quantile regressions 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 the Great Gatsby Curve between fathers' and mothers' transmission of education and between various demographic groups.

Second, this paper investigates the mechanisms underlying nonlinear intergenerational correlation of education. It particularly analyses the role of housing assets in shaping nonlinear education mobility by examining two kinds of credit-constraint effects.

For one thing, benefiting from mortgage market liberalization in developed countries such as the US, UK, Australia and Canada, house owners may have more collateral in terms of more housing wealth as a result of house price appreciation and easier liquidity and therefore, be more able to borrow against their housing equity (Incoviello, 2004; Cooper, 2013). Parents with relaxed credit constraints could borrow from their children's future income and invest optimally in children's human capital.

This “collateral role” of house price appreciation can also affect the value (including the perceived value) of housing wealth and thus, make households readjust their intertemporal consumption. In the UK, Campbell and Cocco (2007) find that house price appreciation stimulates consumption as a result of the effect of more perceived wealth and this is stronger for the elder house owners than for young renters. In the US context, a 10,000 USD increase in parental home prices raises children's college enrolment rate by 2% and the BA graduation rate by 1.6%, which is driven by poor households whose income falling below 75,000 USD a year (Lovenheim and Reynolds, 2013). Cooper and Luengo-Prado (2015) further differentiate between different house tenure and find that rising house prices prior to children's college enrolment provided house-owners (renters) with more housing wealth (costs) thus, house owners (renters) invested more (less) in their children's human capital.

For another, one has to note that both renters and home buyers confront incomplete refinancing markets in transitional economies regardless of their house tenure. Their borrowing ability may be weakened by higher purchasing prices of housing properties. As such, increasing house prices may tighten consumption credit constraints for potential home buyers as well as owners (who are still paying the mortgage). They would invest less in their children's education than the optimal,³ resulting in concave conditional expectation of children's socioeconomic outcomes given parents' (Grawe, 2004; Bratsberg et al., 2007). At the same time, however, the expected intergenerational relationship might also be convex if families are credit-constrained because the optimal investment in human capital increases with ability (which is often positively correlated with parental income/wealth), but lower-level education is meritocratically available (Bratsberg et al., 2007). While credit constraints may generate non-linearities, their shape is uncertain, depending on where in the distribution credit constraints occur and how parents deal with them (Björklund and Jäntti, 2008).

As Lovenheim (2011) points out, for effective policy interventions, it is important to understand whether the relationship between house-price changes and children's educational achievements stems from the changes of parental wealth or the different degrees of borrowing constraints. Further, there is much heterogeneity in wealth and credit constraint effects due to parents' house ownership status and/or the economic status. Using rich household data adds to the limited literature on mechanisms underlying heterogeneous and nonlinear educational mobility in both developed and developing countries.

Third, this paper reveals the sources of nonlinear and heterogeneous differences in house-price adjusted intergenerational correlation of education by decomposing conditional quantile functions. The underlying

² Liu et al. (2015) have pointed out that in the rise in aggregate wealth comes almost entirely from appreciation in housing capital.

³ Deidda's (2014) study in five European countries and Cooper and Luengo-Prado's (2015) study in the US suggest that increasing house prices incur economic hardship for renters, which in turn crowds out their consumption in other goods or investment. In the UK, this crowding-out effect is larger for younger and poorer investors who are likely to be credit constrained (Cocco, 2005).

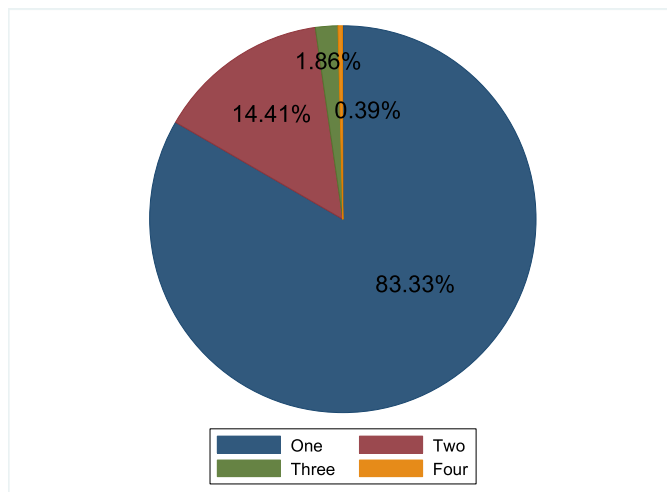


Fig. 1. Distribution of the number of properties owned by the household. Source: Authors' calculation based on the CHFS.

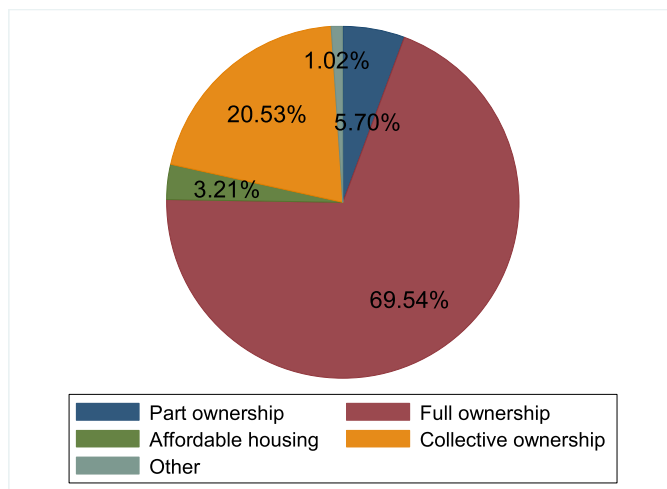


Fig. 2. Structure of property ownership. Source: Authors' calculation based on the CHFS.

assumption is that 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 results highlight the heterogeneous and nonlinear mobility of education between generations and the heterogeneous transmission mechanisms. We document a credit-constraint role of high house prices upon purchase, which is consistent with the existing findings in developed countries (typically the US), and a non-standard wealth effects of house price appreciation after purchase in terms of reducing some households' investment in child education. The latter appears to stem from the limited collateral function of housing wealth or microcredits due to incomplete and imperfect financial markets in transitional economies and conventional perception on housing. Taking house prices into account makes maternal educational association between generations more prominent than the paternal one. The magnitude of maternal association is larger for daughters than for sons. The endowment effects, which are enhanced by house prices, drive urban-rural differences in filial education, which exacerbates intergenerational inequality.

The remainder of this paper is organised as follows. Section 2 describes the data and presents some descriptive statistics. Section 3 presents the model and decomposition method. Section 4 discusses the results while Section 5 concludes with reflections on the policy

implications of our findings.

2. Data

2.1. Data source

The present study uses the China Household Finance Survey (CHFS) collected by the Survey and Research Center 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 a stratified sampling frame, selecting units with probability proportional to size (PPS). It includes 29,324 individuals in 8438 households spreading across 320 communities in 80 counties of 25 provinces.⁴ We selected the sample of offspring according to the following two criteria: (1) Individuals aged 20 or below when the household purchased its first residential property. These individuals were born after the Cultural Revolution (1966–1976), allowing us to exclude huge institutional shocks to their educational pathways. Considering often delayed school entry in China as well as other developing countries, setting the age cut-off at 20 allows us to include college decisions.⁵ (2) Households acquired the first residential property with non-zero expenditure after 1994, when China implemented major reforms to housing and property markets, whereby subsidised housing, in terms of allocation of free housing in the socialist egalitarian era, was abandoned and households had to purchase properties from property markets (Liu et al., 2015).

The above selection criteria were chosen with the objective of capturing parents who confronted educational and house ownership decisions simultaneously. House prices faced by households at the time of purchase could have played an important role in family's coordinated decisions, affecting their children's educational prospects in adolescence. However, one may be concerned with the endogeneity of these simultaneous decisions.

In our data, there is a trade-off between the full sample and our restricted sample. The former is less affected by the endogeneity from simultaneous decisions than the latter, but it suffers from potential confounding coming from radical institutional reforms in the housing and education sectors that could affect individual decision making.⁶ After considering these limitations and the possibility of using instrumental variables for house purchases and housing prices, we choose the restricted sample in the present study.

1776 individuals (aged between 15 and 32 in 2011) out of 1341 households in all 25 provinces remained in our sample after excluding missing values. Of these, 57% (43%) were male (female), while 53% (47%) lived in urban (rural) areas. We also checked the balance of key covariates between our sample and the full sample by running t-tests. We found 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 meter on the purchase of the family's first residential property.⁷

Our selection criteria assured that all sampled households have owned at least one property. 17% of sampled households owned more than one property (Fig. 1). Nearly 70% of households have full

⁴ See <http://www.chfsdata.org/> for detailed description of the CHFS [accessed 8 January 2021].

⁵ Using the cut-off at 18 or 22 does not change our findings qualitatively.

⁶ Education services, especially college/university education, were severely interrupted or even stopped during the Cultural Revolution.

⁷ Filial age and education were different at 1% 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.

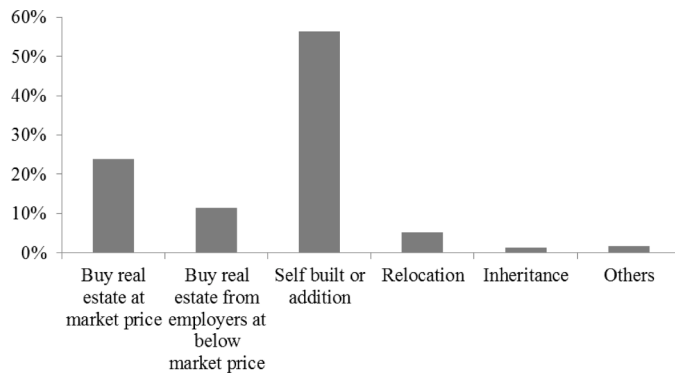


Fig. 3. Methods of acquiring the first property. Source: Authors' calculation based on the CHFS. Note: "Relocation" means households relocate due to the government planning. According to the official documents, they can obtain monetary subsidies from the government based on the size of their previous 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.

ownership of their properties (Fig. 2). At the individual level, 27% of the sampled population had siblings who were also part of selected sample, while 20% did not live with their parents at the time of survey.⁸

We define house price as the unit price (*yuan* per square meter) paid by the household for their first residential property.⁹ The housing market and social welfare reforms of 1994 generated dual markets with a range of prices. In fact, as shown in Fig. 3, only one fourth of households bought properties at market prices; 11.5% bought properties at subsidised prices while nearly 60%, especially among rural households, built their properties gradually, by paying market prices for labor and building material. Irrespective of how households acquired their first property, our sample is made of households that paid non-zero house prices at or below-market levels.¹⁰

2.2. Income, wealth, and educational portfolios

This sub-section provides a brief account of households' livelihood profiles, which are summarised in Table 1. The average rural household annual net income is about 57% of that of urban households. The wealth gap is more pronounced, with rural households holding assets that are equivalent to only 30% of those of urban households, which is largely

⁸ One may be concerned with endogeneity in living arrangement caused by high house prices. Given our sample selection, 77% (72%) 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.

⁹ The real average price of the first property was 1,327.4 *yuan* in 2010 for urban households, as opposed to 4,817.78 *yuan* for commercial residential properties in Monthly Macroeconomic Report and China Statistical Yearbooks published by the NBS. This is due to the fact that 35.77% of our urban samples purchased commercial housing, while the remaining majority have used other means such as purchasing properties from their work units, removal, etc. The real average price of constructing the first property was 588.48 *yuan* in 2010 for rural households, which is close to 673.4 *yuan* in the Rural Household Survey conducted by the NBS. 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.

¹⁰ Appendix A further discusses possible measurement errors in house prices. In Section 4, we provide an analysis of impact heterogeneity by population sub-groups to account for different types of housing prices and also restrict the analysis to the sample that contains only households that paid market prices or owned more than one property, as part of our robustness checks.

Table 1
Households' 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 property	1014.648	1327.397	588.477
Net annual income per adult equivalent	13,952	17,032	9694
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	8248
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 (amount, <i>yuan</i>)	11.46% (128,455)	14.12% (164,074)	8.33% (57,216)
Share of hhs borrowing from other sources, including relatives, friends, and other institutions (amount, <i>yuan</i>)	82.38% (50,832)	78.43% (65,933)	87.04% (34,767)
Share of hhs borrowing from both sources (amount, <i>yuan</i>)	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% (9821)	7.97% (13,196)	15.81% (7470)
(Total educational loans ^b)			
of which			
Share of hhs borrowing from bank (amount, <i>yuan</i>)	11.92% (11,123)	16.13% (12,424)	8.99% (9497)
Share of hhs borrowing from other sources, including relatives, friends, and other institutions (amount, <i>yuan</i>)	81.46% (8430)	79.03% (11,719)	83.14% (6253)
Share of hhs borrowing from both sources (amount, <i>yuan</i>)	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:

^aAll 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.

^b The shares are calculated based on the sample size of each column.

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

^d The shares are calculated in those who have borrowed.

^e The average ratio is calculated among those who borrowed loans.

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

the result of less housing (79%) and financial (73%) assets.

Since the legal reform of 1994, which privatised the housing market, individuals have been able to purchased housing properties in real-estate markets. As shown in Fig. 4, residential housing prices have more than doubled over the past 15 years, with an annual growth rate of 7.7%. Rural households, many of which built their residential properties gradually, suffered in particular from a high growth rate of costs (10.4%). The average appreciation rate of dwelling prices in our two samples is of similar order, about 9.4% per annum since the time of purchase.

Higher housing prices result in higher house price-income ratios for both urban and rural households (see Table 1), which is likely to impose credit constraints to households. More than one third of households borrowed from formal and/or informal sources to purchase their first property. Borrowing happens more frequently among rural (38%) than urban households (33%) even though the house price experienced by the former is only 44% that of the latter. Among borrowers, roughly 82% contracted informal loans and this proportion was higher for rural households, although formal loans were the main source of funding for

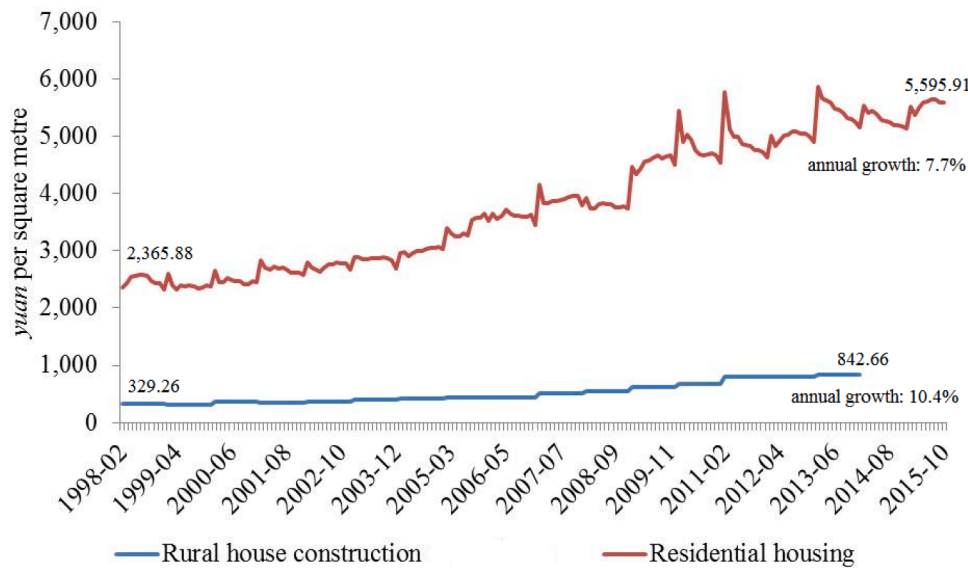


Fig. 4. Average selling/construction price of commercial residential properties (1998–2015). Source: Authors' calculation based on data from Monthly Macroeconomic Report and China Statistical Yearbooks published by the NBS and the Rural Household Survey conducted annually by the NBS. Note: Selling prices of commercial 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).

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	1341	778	563

Source: Authors' calculation based on the CHFS.

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% of households in the distribution of each indicator.

Source: Authors' calculation based on the CHFS.

Table 4
Distribution of educational levels.

Education	Offspring Male (%)	Offspring Female (%)	Parents Father (%)	Parents 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.

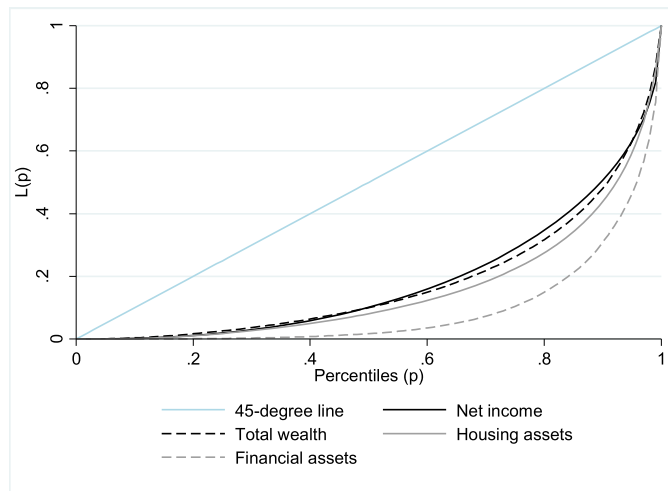


Fig. 5. Lorenz curves of household income and wealth per capita equivalent. Source: Authors' calculation based on the CHFS.

housing purchases.¹¹ The total loans were 30 (16) times as large as the urban (rural) household's annual net income (Table 1).

As shown by the household wealth portfolio in Table 2, housing assets have become the most important component of household wealth. Housing

assets constitutes 84% of the household's non-financial assets and about 77% of total assets. Urban households hold a higher proportion of housing assets than rural households. Urban households also own proportionally more financial assets (particularly bonds and equity securities), and have less debts than their rural counterparts. In fact, the debt-asset ratio of rural households is more than twice than the ratio of urban households.

Inequality emerges with rising income and wealth. The Lorenz curves in Fig. 5 and the Gini coefficients presented in Table 3 suggest that wealth inequality is driven by unequal distribution of financial and housing assets, which is higher than income inequality.

The distribution of offspring's education presented in Table 4 shows more females receiving undergraduate degrees than males.¹² On

¹¹ Among those who have housing loans, on average 45.7% (26.4%) of the total price of urban (rural) households' first property relies on formal loans.

¹² Appendix B provides more evidence on the Chinese education system and the importance of family wealth to children's educational achievements.

average, offspring individuals completed senior high school, while their fathers and mothers only completed junior high school and primary school, respectively. The intergenerational educational correlation coefficient for mothers was in the order of 0.49 while for fathers, around 0.44. This pattern holds in both urban and rural households. We also observe that the rural offspring were more likely to face educational disadvantages than the urban offspring.

Overall, it appears that the purchase of housing assets imposes a heavy financial burden on households, which is subject to substantial urban-rural differences given different real-estate markets. Educational borrowing, and investment in children's education, more generally, cannot be isolated from house ownership decisions.

3. Model

3.1. Distribution-dependent determinants of filial education

Motivated by the theoretical models,¹³ we estimate a benchmark education equation in which individual i 's educational attainment in adulthood (in 2011) e_i is determined by individual characteristics, family (including parental) background, and aggregated factors as follows:

$$e_i = \alpha + \beta_1 X_i + \theta_1 e_i^f + \theta_2 e_i^m + \theta_3 \ln H_h + \theta_4 e_i^f \ln H_h + \theta_5 e_i^m \ln H_h + \theta_6 A_h + \theta_7 e_i^f A_h + \theta_8 e_i^m A_h + \beta_2 X_h + \beta_3 X_p + \varepsilon_i \quad (1)$$

where X_i is a vector including i 's own demographic characteristics such as gender and age.¹⁴ e_i^f and e_i^m denote father's and mother's education, respectively, and reflect the parent-child educational association. X_h includes family characteristics such as the number of children in the family, to account for competition of limited resources within a household where there were more than 1 child, and the relative increased in investment in children's education because of lower childcare costs due to the one-child policy (Zhu et al., 2013);¹⁵ the natural logarithm of family wealth per adult equivalent, which captures the pure and long-term wealth effect of the intergenerational education transmission

¹³ 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 offspring. Solon (2004) adapted the Becker-Tomes model to account for intergenerational transmissions of education, whereby parents utility function is derived from their own consumption and that of their children. Thus, the steady-state intergenerational persistence hinges positively on parents' investment in their children's human capital and parents' endowments passed onto their children, which are determined by parents' income (and their borrowing constraints), altruism, expected returns to human capital investment and available public resources in the education sector. The model predicts that the higher the payoffs from investing in children's human capital, the more parents will be inclined to make that investment.

¹⁴ See Table A1 in Appendix for detailed definition and descriptive statistics of all variables.

¹⁵ It is worth noting bi-directional causality between one's educational attainments in adulthood and the number of siblings. It is not possible to plausibly instrument out endogeneity because the CHFS does not have households' information over the past (typically before the child's birth year or during the childhood). Indeed, the existing literature (e.g., Liu, 2014; Li and Zhang, 2017) finds much weaker quality-quantity trade-off in educational attainments than that in anthropometric outcomes (e.g., height and BMI) and ascribes this to the Chinese government's huge efforts in improving education throughout the past decades. Further, in order to fit the dependent variable into our analytical model for continuous changes, we measured education by computing the number of years of schooling based on the level of education in the raw data. This measure could accommodate moderate changes in years of schooling caused by the quality-quantity trade-off. Considering that this trade-off could be more pronounced in poor areas (Qin et al., 2017), we re-estimated subsamples lying in the upper half of the distribution of household per capital wealth (excluding the housing wealth). The results hold qualitatively same as Column 1 of Table 5.

(Björklund and Jäntti, 2009);¹⁶ the number of all residential properties owned by the household, which captures the wealth effect of a household and their decisions on livelihoods;¹⁷ the household's residential place (rural or urban areas),¹⁸ and registration type (rural or urban *Hukou*) which may affect the house price and educational services available to the household. $\ln H_h$ and A_h capture, respectively, two roles of housing assets in filial education – the level of house price paid by the household when their children were in schooling age (≤ 20 years old), and the annual appreciation rate of the property since the time of purchase. They reflect the two credit constraint effects introduced in Section 1: The former captures the possibly less borrowing ability (i.e., tightened consumption credit constraints) at higher house prices upon purchase; the latter reflects the possibly more borrowing ability (i.e., the collateral/wealth effect) under appreciation of house prices after purchase. Interaction terms between these two variables and parents' education and household wealth per adult equivalent are also included to investigate the channels by which housing prices play a role in household livelihoods.

Aggregated correlates at the province level are included in X_p , including public investment in education, the natural logarithmic of GDP per capita in 2010, and provincial dummies to control for unobservable heterogeneity at that level of aggregation. The disturbance ε_i follows the i.i.d. normal distribution.

We estimate Eq. (1) by the (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% of the sampled individuals had siblings who were also included in the full sample estimates. We use the growth rate of provincial average housing prices which is either rural or urban price appreciation depending on the household's location, the growth rate of provincial urbanization, and the natural logarithmic of provincial GDP per capita as excluded instruments in the first stage of 2SLS-IV, all of which were in the year immediately before the household purchased its first residential property. Identification lies in differences in provincial house price appreciation and over time within rural and urban areas, respectively. As shown in Fig. 4, urban and rural house prices increased by 139.7% and 104.5%, respectively, over the period 1995–2010. Within urban and rural areas, the ratio of highest provincial growth rate over the lowest one varied between 4.54 and 8.37 in different years.

¹⁶ The CHFS does not record the life-cycle income. Literature on intergenerational mobility often uses parental income in their 30 s to proxy for the long-term income. Given that the data limitations, this is not feasible in the present study. We use wealth (excluding housing assets) to proxy for the family's long-term economic resources. It contains less measurement error than income and can be inherited directly by children as their input to education (Adermon et al., 2018). People also save and transmit their wealth in very different ways whether they stand at the top or at the bottom of the wealth distribution (Pfeffer and Killewald, 2015), which would contribute to nonlinearity in intergenerational correlation. Column 9 of Table 5 could be deemed as a robustness check of controlling for long-term well-being as it essentially uses those whose fathers were at their 30 s or early 40 s at the survey year.

¹⁷ There might be substitution between investment in child education and in residential properties. Again due to data limitations on past history, it is not possible to address the endogenous number of residential properties owned by the household. We re-estimated wealthy subsamples, considering that they might be less credit constrained and thus, are less likely to experience substitution between different investments. Results hold qualitatively same as Column 1 of Table 5.

¹⁸ The residential place might also be an endogenous choice to education. However, given that the CHFS did not collect households' past history of movement, it is not possible to instrument out this endogeneity. That having been said, households' residential places are more of an institutional result in the Chinese context, because China has long adopted the household registration (i.e., *Hukou*) to control migration and provision of social services (including educational resources).

We further investigate the nonlinearity in the intergenerational relationship. To this end, we use quantile estimations expressing the τ^{th} percentile of filial education as a function of parental education. Considering endogenous house prices, we estimate Eq. (1) in a two-step conditional quantile IV specification following Lee (2007):

$$Q_{e|e^f, e^m, A, X}(u|e^f, e^m, A, X) = \alpha(\tau) + \beta_1(\tau)X_i + \theta_1(\tau)e_i^f + \theta_2(\tau)e_i^m + \theta_3(\tau)\ln H_h + \theta_4(\tau)e_i^f \ln H_h + \theta_5(\tau)e_i^m \ln H_h + \theta_6(\tau)A_h + \theta_7(\tau)e_i^f A_h + \theta_8(\tau)e_i^m A_h + \beta_2(\tau)X_h + \beta_3(\tau)X_p + \hat{v}_i(\tau) + u_i \quad (2)$$

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

$$(\hat{\alpha}, \hat{\beta}, \hat{\theta})(\tau) \equiv \underset{\alpha, \beta, \theta \in \Theta}{\operatorname{argmin}} E_n \left[\rho_{\tau} \begin{pmatrix} e_i - \hat{\alpha} - \hat{\beta}_1 X_i - \hat{\theta}_1(\tau)e_i^f - \hat{\theta}_2(\tau)e_i^m - \hat{\theta}_3(\tau)\ln H_h - \hat{\theta}_4(\tau)e_i^f \ln H_h - \hat{\theta}_5(\tau)e_i^m \ln H_h - \hat{\theta}_6(\tau)A_h - \hat{\theta}_7(\tau)e_i^f A_h - \hat{\theta}_8(\tau)e_i^m A_h - \hat{\beta}_2 X_h - \hat{\beta}_3 X_p - \hat{v}_i(\tau) \end{pmatrix} \right] \quad (3)$$

where $\hat{\theta}_1(\tau)$ and $\hat{\theta}_2(\tau)$ measure the elasticity of the τ^{th} children's education with respect to parental education, unconditional on house prices and other individual or family characteristics. Differences in those estimators across the quantiles tell us how sensitive different parts of the children's distribution attributed to parental education are to small changes in which parent's education. $\hat{\theta}_3(\tau)$ and $\hat{\theta}_6(\tau)$ measure role housing prices in the transmission of education across generations, while the interaction terms $(\hat{\theta}_4(\tau), \hat{\theta}_5(\tau), \hat{\theta}_7(\tau)$ and $\hat{\theta}_8(\tau))$ show through which channel this effect was realised. Note that the dependent variable is discrete in its nature. We follow Machado and Santos Silva (2005) and use jittered data for quantile estimation.

3.2. Counterfactual inferences and quantile decomposition of offspring education

We further decompose the differences in offspring education on entire distribution between demographic groups. A quantile specification better approximates the *actual* conditional quantile function of filial education, especially when it has smooth conditional density. Chernozhukov et al. (2013) develop a framework, in the spirit of Blinder-Oaxaca decomposition, based on counterfactual inferences to conditional quantile functions. The method allows covariates to change not only the location of filial education, but also the entire shape of the distribution. The difference between the quantile of filial education for group j and the same quantile for group k , given their own observed characteristics, is given by

$$F_{e_j|e_j^f, e_j^m, H_j, A_j, X_j}(e_j|e_j^f, e_j^m, H_j, A_j, X_j) - F_{e_k|e_k^f, e_k^m, H_k, A_k, X_k}(e_k|e_k^f, e_k^m, H_k, A_k, X_k) \quad (4)$$

where $F_{j|j}$ or $F_{k|k}$ denotes the actual conditional distribution function for each group given their own observed characteristics. The observed quantile-specific differences in filial education in Eq. (4) can be further broken down into two components:

$$\underbrace{\left[F_{e_j|e_j^f, e_j^m, H_j, A_j, X_j}(e_j|e_j^f, e_j^m, H_j, A_j, X_j) - F_{e_k|e_k^f, e_k^m, H_j, A_j, X_j}(e_k|e_k^f, e_k^m, H_j, A_j, X_j) \right]}_{\text{Coefficients (Opportunity or Discrimination) Effect}} + \underbrace{\left[F_{e_k|e_k^f, e_k^m, H_j, A_j, X_j}(e_k|e_k^f, e_k^m, H_j, A_j, X_j) - F_{e_k|e_k^f, e_k^m, H_k, A_k, X_k}(e_k|e_k^f, e_k^m, H_k, A_k, X_k) \right]}_{\text{Characteristics (Endowment) Effect}} \quad (5)$$

where $F_{e_k|e_j^f, e_j^m, H_j, A_j, X_j}(e_k|e_j^f, e_j^m, H_j, A_j, X_j)$ represents the *counterfactual* conditional distribution of education for k 's offspring, i.e., education that would have been achieved for k 's offspring had they been endowed with characteristics of j 's offspring who are at the same quantile of education as k 's. This counterfactual conditional distribution is calculated by integrating the conditional distribution of education for j 's offspring with respect to the distribution of observed characteristics for k 's offspring:

$$\hat{F}_{e_k|e_j^f, e_j^m, H_j, A_j, X_j}(e_k|e_j^f, e_j^m, H_j, A_j, X_j) = \int_{e_j^f, e_j^m, H_j, A_j, X_j} \hat{F}_{e_k|e_k^f, e_k^m, H_k, A_k, X_k}(e_k|e_k^f, e_k^m, H_k, A_k, X_k) d\hat{F}_{e_j^f, e_j^m, H_j, A_j, X_j}(e_j^f, e_j^m, H_j, A_j, X_j) \quad (6)$$

where the covariate distribution for j 's offspring is obtained by the empirical distribution function $\hat{F}_{e_j^f, e_j^m, H_j, A_j, X_j}(e_j^f, e_j^m, H_j, A_j, X_j) = \frac{1}{n_j} \sum_{i=1}^{n_j} 1\{(e_{ij}^f, e_{ij}^m, H_{ij}, A_{ij}, X_{ij})' \leq (e^f, e^m, H, A, X)'\}$, where n_j is the group size.

As such, the effect of *coefficients* in Eq. (5) is the change in filial education by holding observed characteristics of j 's offspring but sequentially changing the structure (distribution) of education of j 's offspring to that of the k 's offspring, i.e., changing the estimated coefficients in the quantile regression for group j at each quantile of j 's filial education to those of group k who are at the same quantile. This component tells us what education a child born in a family of the j group (and thus, with endowments of the j group) would achieve had s/he been only able to benefit from the returns to endowments of the k group. The effect of *characteristics* in Eq. (5) is the change in filial education by holding the structure (distribution) of k 's filial education but changing k 's observed characteristics to the j 's at each quantile. This component tells us what education a child facing k group's returns to endowments (educational opportunities) would achieve had s/he been born in a family of the j group. Empirically, we estimated and decomposed filial education with and without housing-relevant variables. Comparing these results will inform us about the importance of housing in the accumulation of human capital across generations.

4. Estimation results

4.1. The heterogeneous correlation of education between generations

We begin by gradually controlling for the housing-related covariates, while parental direct impact loses significance (Table A2 in Appendix). This raises the question on the important role of housing wealth in altering the parent-child educational association. With a full set of controls, the OLS, ordered probit, and the 2SLS-IV estimation yields largely consistent results except for paternal transmission (Columns 1–3, Table 5). The father-child association loses significance when moving from the continuous specification (OLS) to the one tailing for discrete years of schooling (ordered probit) and to correction of endogenous house prices (IV). This is alarming to the literature on intergenerational mobility of education as the nature of the variable of interests and the model specification given which family variables are included would possibly alter conclusion in a qualitative way. In the 2SLS-IV regressions, the fitness of first-stage regressions is satisfactory in Tables 5 and 6. F -test of the null hypothesis that all first-stage regressors equal zero is firmly rejected at the 1% significance level in all regressions. Tests of overidentification and weak instrumental variables are broadly passed (except for the female and college sub-samples), indicating the validity of our instruments.

There is a significant paternal and/or maternal intergenerational correlation of education when house prices are not considered or endogeneity in house prices is not address (Table A2, Columns 1 and 2 of

Table 5

Determinants of filial education (by estimation methods and sub-samples).

Independent variable	OLS	Ordered Probit	2SLS-IV	Urban-rural Divide		Gender		Birth cohort	
	(1)	(2)	(3)	Urban (4)	Rural (5)	Male (6)	Female (7)	'80 (8)	'90 (9)
<i>Housing</i>									
Ln(House price)	0.032 (0.041)	−0.102 (0.128)	−0.345 (0.539)	−1.304 (1.092)	−0.150 (0.162)	−0.525 (0.656)	−0.023 (0.174)	−0.376 (0.177)**	−0.935 (0.419)**
Annual appreciation of house price	−0.038 (0.486)	−1.913 (1.354)	0.0001 (1.208)	0.0001 (7.140)	0.0001 (1.198)	0.00002 (6.480)	0.000002 (9.555)	0.00003 (0.353)	−2.782 (1.153)**
<i>Parents' characteristics</i>									
Father's education	0.230 (0.083)**	−0.033 (0.108)	−0.121 (0.308)	−0.663 (0.425)	0.240 (0.148)*	−0.298 (0.392)	0.168 (0.233)	0.205 (0.171)	−0.489 (0.675)
Ln(House price) × father's education	0.012 (0.009)	0.023 (0.017)	0.046 (0.050)	0.112 (0.073)	−0.009 (0.021)	0.082 (0.070)	−0.032 (0.046)	−0.004 (0.025)	0.097 (0.052)*
Annual appreciation × father's Education	0.041 (0.098)	0.142 (0.147)	−0.005 (0.367)	0.159 (0.319)	0.416 (0.185)**	0.117 (0.513)	−0.062 (0.315)	−0.274 (0.289)	0.294 (0.148)**
Mother's education	0.144 (0.068)**	0.166 (0.092)*	0.298 (0.248)	0.237 (0.691)	0.083 (0.161)	0.390 (0.268)	0.200 (0.284)	−0.142 (0.188)	0.321 (0.108)**
Ln(House price) × mother's education	−0.014 (0.010)	−0.012 (0.015)	−0.018 (0.043)	0.003 (0.099)	0.013 (0.022)	−0.042 (0.046)	0.038 (0.023)*	0.047 (0.024)**	−0.009 (0.025)
Annual appreciation × mother's Education	−0.039 (0.088)	0.037 (0.070)	−0.086 (0.242)	−0.194 (0.622)	−0.658 (0.337)**	−0.128 (0.452)	0.046 (0.569)	0.254 (0.329)	−0.028 (0.096)
Individual demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial controls and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	1776	1776	1776	946	830	1020	756	697	1079
R ²	0.393	0.183	0.379	0.344	0.356	0.394	0.450	0.513	0.310
Weak instruments test: First-stage F-test of zero estimated coefficients of all excluded instruments (p-value)	−	−	4.406 (0.004)	7.932 (0.005)	4.450 (0.003)	4.469 (0.004)	2.258 (0.080)	5.642 (0.004)	5.919 (0.003)
Hansen's J statistic (overidentification test of instruments), χ^2 (p-value)	−	−	0.240 (0.887)	0.989 (0.610)	0.705 (0.703)	0.611 (0.737)	10.641 (0.005)	2.170 (0.141)	0.510 (0.476)

Note: ***,

** and * denote separately 1%, 5% and 10% significance levels. Columns (1)–(3) are based on full samples. 38 individuals who were born in the 1970s were included in the subsample of the '80 cohort in Column (8). Sampling weights are used throughout the estimation. Household-clustered standard errors are in parentheses. Source: Authors' calculation based on the CHFS.

Table 6

Determinants of filial education (by timing of purchasing the first property).

Independent variable	Preschool	Primary school	Junior high school	Senior high school	College
	(1)	(2)	(3)	(4)	(5)
<i>Housing</i>					
Ln(House price)	−0.063 (0.117)	0.175 (0.618)	1.754 (1.538)	1.483 (1.416)	−1.052 (0.531)**
Annual appreciation of house price	0.000001 (1.478)	0.00002 (5.842)	0.00002 (65.809)	−2.832 (2.878)	0.00003 (19.981)
<i>Parents' characteristics</i>					
Father's education	−0.128 (0.137)	0.369 (0.416)	0.681 (1.028)	0.531 (0.826)	0.029 (0.729)
Ln(House price) × father's education	0.019 (0.018)	−0.033 (0.082)	−0.073 (0.192)	−0.037 (0.132)	−0.049 (0.084)
Annual appreciation × father's education	−0.356 (0.356)	−0.087 (0.391)	−0.143 (7.311)	0.050 (0.292)	−1.056 (1.435)
Mother's education	0.406 (0.114)**	0.125 (0.249)	0.480 (0.397)	0.680 (0.429)	−0.758 (0.353)**
Ln(House price) × mother's education	−0.018 (0.013)	0.015 (0.053)	−0.069 (0.087)	−0.078 (0.080)	0.126 (0.058)**
Annual appreciation × mother's education	0.184 (0.414)	−0.062 (0.329)	0.164 (0.410)	−0.277 (0.276)	0.918 (1.058)
Individual demographics	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes
Provincial controls and dummies	Yes	Yes	Yes	Yes	Yes
No. of obs.	293	667	354	333	92
R ²	0.429	0.392	0.518	0.466	0.843
Weak instruments test: First-stage F-test of zero estimated coefficients of all excluded instruments (p-value)	3.667 (0.013)	3.039 (0.029)	9.227 (0.004)	4.663 (0.010)	1.489 (0.229)
Hansen's J statistic (overidentification test of instruments), χ^2 (p-value)	0.456 (0.796)	1.485 (0.476)	1.186 (0.553)	0.925 (0.336)	0.653 (0.419)

Note: See Table 5. The regressions are estimated by 2SLS-IV.

Table 5). The two-stage IV approach takes away statistical significance (Column 3 of Table 5), as it sacrifices variance of second-stage residuals and therefore statistical power. This sacrifice could be strong, as in our

case, when the variations of endogenous house prices that are explained by the excluded instrumental variables are not sufficiently large to maintain the second-stage variations of predicted house prices. Given

Table 7

Quantile IV estimation (full sample and by urban-rural divide).

Independent variable	Full sample			Urban			Rural		
	10th	50th	90th	10th	50th	90th	10th	50th	90th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>Housing</i>									
Ln(House price)	−1.039 (0.531)**	−0.329 (0.322)	0.011 (0.394)	−0.064 (0.838)	0.328 (0.345)	−0.161 (0.436)	−1.634 (0.874)*	−1.330 (0.523)***	−0.534 (1.255)
Annual appreciation of house price	−0.603 (2.633)	−2.295 (1.447)	−4.056 (1.769)**	2.414 (4.438)	0.432 (1.903)	−5.232 (2.208)**	−8.825 (6.198)	−12.326 (5.148)**	−11.417 (8.354)
<i>Parental characteristics</i>									
Paternal education	−0.015 (0.304)	0.442 (0.147)***	0.459 (0.210)**	0.015 (0.491)	0.306 (0.156)**	0.376 (0.297)	−0.730 (0.482)	−0.081 (0.276)	0.766 (0.580)
Ln(House price) × paternal education	0.046 (0.055)	−0.027 (0.021)	−0.050 (0.028)*	0.009 (0.086)	−0.028 (0.021)	−0.050 (0.043)	0.094 (0.071)	0.019 (0.035)	−0.073 (0.096)
Annual appreciation × paternal education	−0.299 (0.153)**	−0.108 (0.082)	0.083 (0.161)	0.218 (0.445)	0.062 (0.073)	0.094 (0.235)	0.453 (0.639)	1.043 (0.485)**	0.892 (1.033)
Maternal education	0.317 (0.270)	0.153 (0.144)	0.021 (0.144)	0.576 (0.396)	0.190 (0.173)	−0.285 (0.293)	0.408 (0.421)	−0.154 (0.257)	−0.296 (0.346)
Ln(House price) × maternal education	−0.015 (0.046)	0.021 (0.023)	0.008 (0.024)	−0.008 (0.005)	0.010 (0.025)	0.044 (0.045)	−0.033 (0.058)	0.027 (0.033)	0.091 (0.058)
Annual appreciation × maternal education	0.208 (0.236)	0.197 (0.121)*	0.181 (0.140)	−0.433 (0.379)	−0.048 (0.152)	0.376 (0.281)	0.078 (0.548)	0.006 (0.350)	−0.086 (0.572)
Individual demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial controls and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage residual	0.861 (0.354)**	0.476 (0.269)*	0.531 (0.279)*	0.092 (0.540)	−0.068 (0.199)	0.456 (0.344)	1.114 (0.746)	0.916 (0.480)*	0.522 (0.974)
No. of obs.	1776	1776	1776	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 correlation, <i>T</i> statistic (<i>p</i> -value)	3.369 (0.001)	4.916 (0.000)	0.884 (0.377)	0.623 (0.534)	2.443 (0.015)	1.622 (0.105)	2.170 (0.030)	2.467 (0.014)	0.344 (0.731)
Machado-Santos Silva test for heteroskedasticity, χ^2 (<i>p</i> -value)	76.057 (0.000)	114.373 (0.000)	77.069 (0.000)	89.704 (0.000)	89.646 (0.000)	89.438 (0.000)	60.601 (0.000)	62.889 (0.000)	117.083 (0.000)

Note: See Table 5. Quantile estimation is based on jittered data. Jittering is repeated for 1000 times. The pseudo R² and the tests are based on non-jittered data for the purpose of justifying the use of quantile regressions but not for interpreting results.

that Chinese real-estate markets have long not been well-regulated or functioned, there might remain many variations of house prices that are not captured by the spatial-temporal variations of house prices, urbanization, and the GDP per capita growth. The IV approach addresses endogeneity of house prices at the expense of precision of estimators.

Despite average insignificant impact of parental education in the IV estimation, there appears to be much heterogeneity in parental education. Fathers' education associates positively with filial education in rural areas (Column 5 of Table 5), while only at the marginal significance level of 10%. Mothers' education is crucial in improving the '90 cohort's schooling (Column 9 of Table 5), which comes mainly from families purchasing their residential property when children were in primary education (Column 1 of Table 6). It however appears to be negatively related with filial education if the family purchased the housing property during the child's tertiary education (Column 5 of Table 6). It should be noted that Column 5 of Table 6 is subject to weak instrumental variable problems given the very small sample size. Therefore, the results for these sub-samples are at most suggestive and our discussion shall not focus on it.

It seems that there is no average impact of the level of house prices *per se* on filial education. Nevertheless, splitting samples into birth cohorts yield significant negative impact, especially for the '80 cohort (Column 8 of Table 5) attending college when their family purchased the housing property (Column 5 of Table 6). A 10% increase in housing prices was found to be associated with 0.376–1.052 fewer years of filial schooling, which was equivalent to one school term or one academic year if the child was in college. The consumption credit constraint effect of high house price levels is consistent with the fact that larger costs of higher education (e.g., 5000–10,000 *yuan* or more for tuition fees per academic year) compared with secondary or primary education (e.g., roughly 1000–1500 *yuan* of tuition fees per academic year and rural students are waived from these during 9-year compulsory education). Furthermore, there are positive and statistically significant interactions

between the level of house prices and maternal (paternal) education for the '80 ('90) cohort (Columns 8–9 of Table 5).¹⁹ The positive maternal interaction term seems to stem from families purchasing their first housing property during children's higher education (Column 5 of Table 6), but again this result should be taken with caution given the weak instrumental variable problem. The positive interaction terms indicate that higher parental education helps mitigating the consumption credit constraint of a high level of house prices. Well-educated parents would still be able to transmit their education to children under high house prices, particularly during children's (costly) tertiary education.²⁰ As such, the distribution of parental education together with the consumption credit constraint role of house prices creates sources of heterogeneous intergenerational transmission of education.

House-price appreciation does not exhibit direct impact on filial education, neither. This is inconsistent with the prediction of a (non-standard) wealth effect (as a result of stronger borrowing ability coming from more collaterals) when house price rises, as discussed earlier in

¹⁹ There is also a positive maternal interaction term for female children (Column 6 of Table 5). Nevertheless, this column should be read with much caution given the overidentification problem of instrumental variables.

²⁰ This argument needs to be understood with caution. If considering the negative impact of maternal education and its positive interaction with the level of house prices together, one more year of mothers' schooling could yield negative maternal transmission of education at the lower level of house prices. Given the limited sample size of the tertiary education group, these findings are only suggestive but not convincing enough.

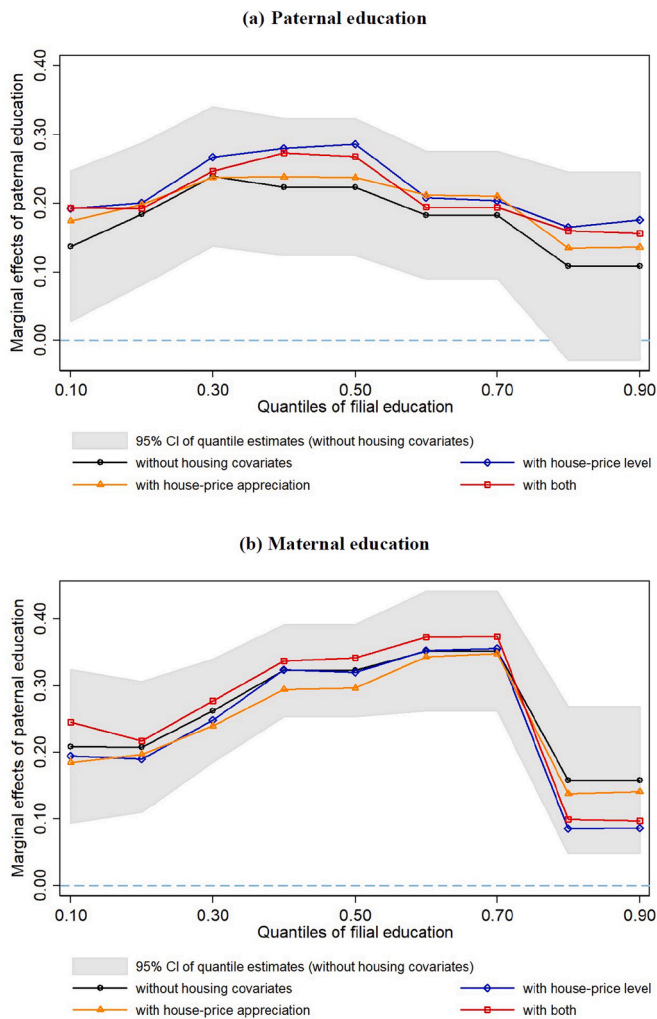


Fig. 6. Quantile estimation of the marginal impact of parental education. (a) Paternal education. (b) Maternal education. Note: The marginal effects are calculated based on Eqs. (7) and 8. Housing-relevant covariates are gradually added into regressions to compute different kinds of marginal effects of parental education. Source: Authors' calculation based on the CHFS.

Section 1.²¹ We shall delineate the reasons from perspectives of economic rationality and social norms in Section 4.3. The positive interaction between house price appreciation and paternal education for the '90 cohort (Column 9 of Table 5) means that conditional on (higher) paternal education, house price appreciation improves filial education, seeming to conform to the collateral-based wealth effect. As such, the distribution of parental education together with the collateral role (non-standard wealth effect) of house price appreciation also creates sources of heterogeneous intergenerational transmission of education.

²¹ One may be concerned about 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 housing prices and this did not alter the overall conclusion either. These provinces are those having high annual growth rate of real house prices ($\geq 10\%$) over the period 2004–2014 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 4.3.

It is susceptible that those owning more than one property are wealthier than those owning only one property and thus, would be more able to “liquidate” housing assets. This liquidity-ability based “wealth effect” would influence their investment in child education. Surprisingly, the estimator of the number of properties owned by the family in Tables 5–6 remains statistically insignificant. We also re-estimated the Eq. (1) with a restricted sample that included 296 households owning more than one residential property, and yet, the estimates of the level and appreciation of house prices remained consistently insignificant. The interaction terms show that conditional on the level of house prices, higher maternal education helps improving filial education (0.097 at the 5% significance level), but higher paternal education suppresses filial education (-0.112 at the 10% significance level). The interaction terms between house price appreciation and parental education remains insignificant. These imply that well-educated fathers owning more than one residential property would substitute investment in child education for other activities.

4.2. The nonlinear shape of intergenerational correlation of education

Given the heterogeneity in above findings, the intergenerational correlation of education is likely to be nonlinear as one moves along the distribution of education. Next, we estimate the quantile specification (Eq. (3)). Table 7 presents the quantile IV results for the full sample and the rural and urban subsamples which are of our main interest for between-group comparison. 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.²² Statistically significant residuals from the first-stage quantile regression of house prices indicate the existence of endogeneity, which is driven by urban samples, and thus justify our choice of adopting a quantile IV specification strategy.

Filial education appears to be responsive to paternal education only in the upper half of filial education distribution, from 0.442 to 0.459 in Columns 2 and 3 of Table 7, and in urban offspring with medium schooling (0.306 in Column 5).²³ Sub-sample estimations also reveal many nonlinearities.²⁴ Consequently, the shape of intergenerational correlation of education becomes nonlinear. To show this clearly, we use Eq. (3) to derive the marginal effects of parental education on filial

²² It is worth noting that it is a weak test as heteroskedasticity could lead to nonlinearities across conditional quantiles (Grawe, 2004).

²³ One may also suspect that rural children are likely 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% significance levels, but the grandfather-child correlation coefficient is 0.24 without statistical significance.

²⁴ Among quantile IV estimates not included in Table 7, paternal transmission is also prominent for sons at the upper half of the distribution of filial education. Mother-daughter association is significant at 5% to 10% levels, regardless of the daughter's position in their educational distribution, although the magnitude of the correlation goes down with 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 female filial education. Mothers' educational transmission is strong and significant at 10% level for the '90 cohort to achieve a high educational attainment at the 90th percentile, which underscores the critical role of mothers in nurturing children's future prospects in education. Fathers' educational transmission is also crucial and statistically significant at 1% level, especially for the '80 cohort to obtain at least the 90th percentile level of filial education. This supports our earlier finding from the benchmark regressions that highlights the role of fathers in sustaining filial tertiary education.

education at each quantile of the distribution of filial education, $\tau \in [0.1, 0.9]$ with a step of 0.1, as below:

$$\frac{\partial e_i}{\partial e_i^f} = \hat{\theta}_1(\tau) + \hat{\theta}_4(\tau) \ln \bar{H}_{hr} + \hat{\theta}_7(\tau) \bar{A}_{hr} \quad (7)$$

$$\frac{\partial e_i^m}{\partial e_i^m} = \hat{\theta}_2(\tau) + \hat{\theta}_5(\tau) \ln \bar{H}_{hr} + \hat{\theta}_8(\tau) \bar{A}_{hr} \quad (8)$$

where $\bar{H}_{hr}$ and $\bar{A}_{hr}$ are average levels and the appreciation of house prices within the τ^{th} quantile. We gradually added housing-related variables to Eq. (3) and calculated Eqs. (7) and (8). Fig. 6 draws the total marginal effects of parental education for each model specification.

There are first increasing and then decreasing slopes of children's education as a function of parental education everywhere in children's distribution. Despite to different extent, the concavity of intergenerational correlation holds steadily across different controls (without or without housing-related covariates). The shaded areas in Fig. 6 are above zero. This means that the concave shape is statistically significant at 5% level throughout the distribution of education when no housing-related covariates are considered. As reviewed in Section 1, the credit-constraint theory predicts different slopes of children's expected education as a function of parents' education. The next two sub-sections will delineate how this shape is affected by house prices.

4.3. The impact of house prices on filial education

Higher house prices reduce education for offspring at the bottom tail of education distribution (−1.039 in Column 1 of Table 7), which seems to be composed of rural population (−1.634 and −1.33 in Columns 7 and 8 of Table 7).²⁵ This finding remains robust – although with a smaller magnitude – when we re-estimated the equation with a restricted sample including only households that owned more than one property. The negative impact of house prices is also observed among male offspring, the '80 cohort, and those whose families purchased their first property during tertiary education.

The above results reflect the effect of high house prices on tightening credit constraints upon home purchase. Even though the average house price among those at the bottom half of child education distribution (786.5 yuan/m²) was nearly one-third lower than that of those at the upper half (1155.3 yuan/m²), 43.8% of the former borrowed housing loans (including either formal or informal ones) as opposed to 31.5% of the latter. This is because the former's average wealth (excluding housing wealth) per capita (36,673.29 yuan) was 34.7% lower than that of the latter (56,149.62 yuan). As such, only 5.3% of the former borrowed educational loans for their children (from either formal or informal sources) as opposed to 10.4% among the latter. All those differences between two groups are significant at the 1% level. Housing costs appear to crowd out consuming child human capital investment more among those at the bottom of educational distribution who are more likely to be credit constrained in terms of limited borrowing ability than among those at the top of educational distribution. As aforementioned in Section 1, this negative impact of house prices due to credit constraints has also been found developed countries like the US (e.g., Lovenheim, 2011), even among renters (Cooper and Luengo-Prado, 2015).

House-price appreciation inhibits school progression for the well-educated offspring (−4.056 in Column 3 of Table 7), seemingly

contradicting theoretical prediction of positive collateral effects. This is likely driven by the well-educated urban individuals (Column 6 of Table 7), and rural individuals of median schooling (Column 8 of Table 7). Households have shown a strong inclination to invest in housing or financial assets relative to other consumption.²⁶ In fact, we find a similar proportion of households who answered “being willing to spend more when the value of assets increases” between the upper (50%) and bottom (49%) half of the distribution of households' housing wealth.

This can be understood from the socioeconomic environment in transitional economies. First, in the absence of suitable financial products to insure risk, the life-cycle model predicts that individuals would invest in housing, typically early in the life cycle, as a way of insuring future price fluctuations (Banks et al., 2004). The “social insurance” role of housing wealth leads to higher owner-occupation rates, more housing wealth, and less propensity to realize capital gains on housing through refinancing to fund non-housing consumption. At the same time, high volatility of house prices (for example in China as documented by Wu et al., 2015) makes wealth components relying on house-price appreciation, which in turn serves as a hedging means of insuring against future uncertainties in livelihood, especially when parents are less able to borrow from their children's future income (i.e., having been more liquidity constrained) in transitional economies than in developed countries.²⁷ As such, the wealth effect as a result of house price appreciation after purchase may appear not to increase investment in child education, but rather again in more investment in housing or financial assets that are easier to be liquidated compared with children's human capital.²⁸

Second, social norms matter. Households tend to regard housing as a “status” good in addition to its market value (i.e., a dual function highlighted by Liu et al., 2015 and Li and Wu, 2017 in China).

²⁶ The correlation coefficient between household financial assets per adult equivalent and the annual appreciation rate of house prices is 0.22 at the 1% significance level. We also regressed respectively the former and the number of residential properties owned by the household on the latter, controlling simultaneously for individual demographics (gender, age, and age square) and provincial dummies. Standard OLS estimation with household-clustered standard errors suggests that an additional 1% of appreciation rate is associated with more financial assets per adult equivalent of 60.5 thousand yuan at 5% significance level and 0.31 more residential properties at 1% significance level.

²⁷ We checked robustness by restricting samples to market-based purchases and re-estimating 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% significance level), diluting the positive paternal transmission (0.99 at 1% 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 Beijing, Shanghai, Anhui, Zhejiang, and Guangdong provinces where there were high annual growth rate of real house prices ($\geq 10\%$) over the period 2004–2014 in Wu et al.'s (2015) calculations and re-estimated Columns 1–3 of Table 7. Paternal transmission in the specification of Column 1 becomes marginally significant (−0.433) at the 10% level, while negative impact of the level of house prices still holds (−1.09 at the 5% significance level). Maternal transmission becomes 0.525 at 1% significance level in Column 3. Other findings hold qualitatively. These imply even stronger negative wealth effects under (lower) appreciation of market house prices.

²⁸ We also examined other subgroups. 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 of statistical insignificance at some quantiles.

²⁵ In the literature of intergenerational inequality, it has been found that the two extremes of the distribution account largely for the intergenerational inequality (e.g., the top 1% in the US in Chetty et al., 2014b and both the bottom and the top 5% in France in Bourdieu et al., 2019). Here

Table 8

Coefficients of intergenerational transmission of education (by sub-samples and model specifications).

Sample	Parent	Without housing effects (1)	With house price (2)	With house-price appreciation (3)	Both house price & its appreciation (4)
Full	Father	0.201	0.475	0.289	-0.203
	Mother	0.281	0.355	0.259	0.332
Urban	Father	0.106	0.354	0.188	-0.418
	Mother	0.199	0.316	0.252	0.269
Rural	Father	0.150	-0.279	0.065	0.293
	Mother	0.058	-0.191	-0.194	0.060
Male	Father	0.243	0.606	0.378	0.799
	Mother	0.164	0.312	0.189	0.380
Female	Father	0.087	0.300	0.101	0.097
	Mother	0.521	0.402	0.456	0.363
'80	Father	0.169	0.541	0.161	0.183
	Mother	0.135	0.171	0.149	-0.025
'90	Father	0.173	0.328	0.293	-0.273
	Mother	0.299	0.418	0.282	0.411
Pre- or primary school	Father	0.127	0.608	0.150	0.460
	Mother	0.386	0.439	0.335	0.353
Secondary school or above	Father	0.234	-0.241	0.390	0.045
	Mother	0.110	0.032	0.167	0.382

Note: Column 1 is calculated based on the OLS estimators of Eq. (1) without endogenous housing-related covariates. Columns (2)-(4) are calculated based on the 2SLS-IV estimators of Eq. (1) by gradually including housing-relevant covariates.

Source: Authors' calculation based on the CHFS.

Particularly in marriage markets of patrilineal societies, the groom or his family is responsible of providing residential properties. This is not only found in China (Wei and Zhang, 2011), but also in Vietnam (Teerawichitchainan and Knodel, 2012) and Ghana (Deere et al., 2013).

4.4. The impact of house prices on the nonlinear shape of intergenerational correlation of education

We continue to investigate how families' responses to house prices would link their children's education nonlinearly to parental education. First, including housing-related covariates do not alter the overall concave shape of intergenerational association. The extent of intergenerational correlation of education is changed given the credit-constraint effects of house prices and the unusual wealth effect of house-price appreciation in the Chinese socioeconomic contexts.

Specifically, compared with the intergenerational correlation without housing-related covariates (black lines in Fig. 6), controlling for the consumption credit-constraint effect of the level of house prices (blue lines) or for the wealth effect of the house-price appreciation (orange lines) strengthens paternal transmission along the distribution of filial education (Fig. 6(a)), while pulls the maternal transmission downwardly at the moderately high filial education (largely for those lying above the 70th percentiles in Fig. 6(b)).

The different shifts in the marginal effects of parental education can be attributed to the different roles parents play and the response to house prices they make along the distribution of filial education. Fathers may not get involved in nurturing their children as much as mothers typically do, but as Solon (2004) modes, they can contribute to children's educational attainments by increasing human capital investment

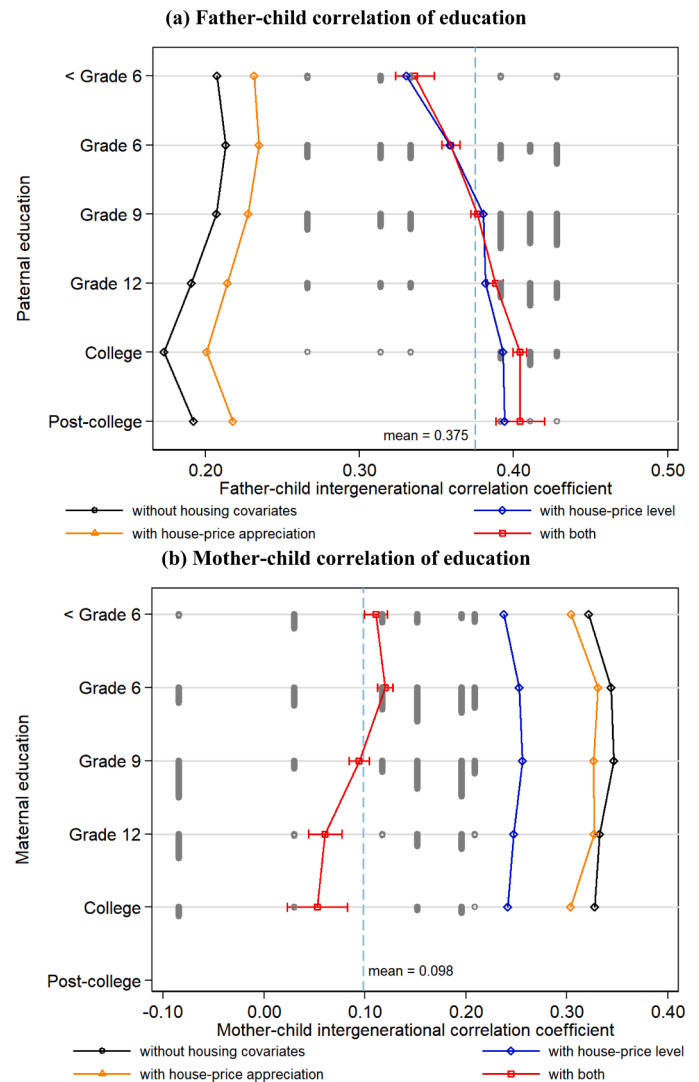


Fig. 7. Intergenerational correlation coefficient (by parental education). (a) Father-child correlation of education. (b) Mother-child correlation of education. Note: Hollow circles represent pointwise and quantile-dependent intergenerational correlation coefficients when controlling both housing-related covariates. The vertical dash line denotes the sample average of those intergenerational correlation coefficients. The pointwise and quantile-dependent intergenerational correlation coefficient is calculated as $\hat{\theta}_1(\tau) \frac{d}{d\sigma}$ for the quantile specification without controlling for the two housing effects where σ^f and σ^m represent standard deviations of parental and filial education. It is calculated as $\hat{\theta}_1(\tau) \frac{d}{d\sigma} + \hat{\theta}_4(\tau) \frac{d}{d\sigma} \frac{d^{HHI}}{d\sigma}$ when controlling for the level of house prices, $\hat{\theta}_1(\tau) \frac{d}{d\sigma} + \hat{\theta}_7(\tau) \frac{d}{d\sigma} \frac{d^A}{d\sigma}$ when controlling for the house-price appreciation, and $\hat{\theta}_1(\tau) \frac{d}{d\sigma} + \hat{\theta}_4(\tau) \frac{d}{d\sigma} \frac{d^{HHI}}{d\sigma} + \hat{\theta}_7(\tau) \frac{d}{d\sigma} \frac{d^A}{d\sigma}$ when controlling for both covariates. The estimators $\hat{\theta}_1(\tau)$, $\hat{\theta}_4(\tau)$ and $\hat{\theta}_7(\tau)$ are obtained by the quantile IV estimation of Eq. (3). Source: Authors' calculation based on the CHFS.

if their expectations of educational returns are high.²⁹ Therefore, when faced with the same consumption credit constraint as a result of high level of house prices, fathers' economic support to child education becomes more prominent in forming child educational attainments and increases as their expected educational returns rises along the filial

²⁹ In our quantile regressions, the average (wage) return to fathers' education is 6% (26.6%) less for offspring at the lowest quartile of filial education than for their better educated counterparts in the second lowest (highest) quartile at 1% significance level.

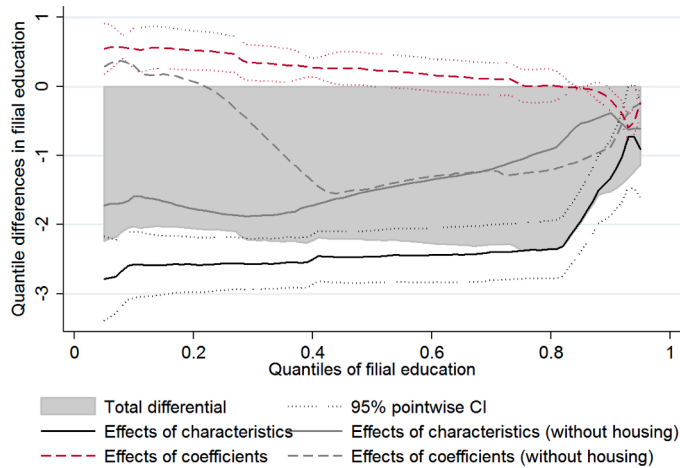


Fig. 8. Quantile decomposition of rural-urban differences in distribution. Note: The label, “without housing”, indicates estimation and decomposition results of our model without controlling for housing-relevant variables in quantile regressions (i.e., the level and appreciation of house prices and their interactions with parents’ education and household wealth). The standard errors are obtained by bootstrapping the results 1000 times. Source: Authors’ calculation based on the CHFS.

distribution. It is therefore not surprising to see the largest upward shift of paternal association when controlling for the level of house prices are in the bottom (the 10th percentile), the median- (between the 40th and the 50th percentiles) and the top educated children (towards the 90th percentile).³⁰ Consistent with this argument, the mother-child association of education becomes weak if the main channel carrying parental education to their children is through their economic support (especially at the top of distribution of filial education) rather than nurturing measured by time with children.³¹

Second, the unusual wealth effect of house-price appreciation (orange lines) acts as if the credit-constraint effect in changing the intergenerational relationship. It also strengthens paternal transmission along the distribution of filial education (Fig. 6(a)) and pulls the maternal transmission downwardly at the moderately high filial education (largely for those lying between the 40th and the 50th percentiles in Fig. 6(b)), while to less extent than that of the credit-constraint effect of house prices.

4.5. Intergenerational correlation coefficients of education in the presence of nonlinear transmission patterns and rising house prices

Given the effect of house prices and the observed heterogeneity and nonlinearities in the intergenerational association of education, we follow Björklund and Jäntti (2009) and standardised the marginal rates of parental transmissions in the intergenerational correlation

coefficient, to remove the effects of marginal distributions in the two generations, and to facilitate cross-generations comparisons.³² Take the paternal transmission as illustration. We use the standard deviations of fathers (σ^f) and filial education (σ^c) to calculate average coefficient of the paternal transmission, $\hat{\theta}_1^{\frac{d^f}{\sigma^f}}$ in the 2SLS-IV without controls of housing-relevant covariates. When gradually adding the house price and its annual appreciation rate, the intergenerational correlation coefficient becomes $\hat{\theta}_1^{\frac{d^f}{\sigma^f}} + \hat{\theta}_4^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^{pH}}{\sigma^c}}$ for the case of including the level of house prices, $\hat{\theta}_1^{\frac{d^f}{\sigma^f}} + \hat{\theta}_7^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^A}{\sigma^c}}$ for the case of including house-price appreciation, and $\hat{\theta}_1^{\frac{d^f}{\sigma^f}} + \hat{\theta}_4^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^{pH}}{\sigma^c}} + \hat{\theta}_7^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^A}{\sigma^c}}$ for the case of including both kinds of covariates. Columns (1)–(5) of Table 8 report the results.

In a “standard” intergenerational correlation model without controlling two kinds of housing covariates, one standard deviation of father’s (mother’s) education can explain 0.2 (0.28) standard deviations of filial education (Column 1 of Table 8). Comparing rows of Table 8, the relative importance of mothers and fathers in determining filial education switches across demographic groups. Comparing columns, we can see that inclusion of the credit-constraint effect of the level of house prices doubles the paternal correlation and increases the maternal correlation by 26.3% (from 0.281 to 0.355). Inclusion of the house-price appreciation also raises the intergenerational coefficients, but to less extent. Across subgroups, the highest overall intergenerational correlation coefficient appears in the father-son association (0.799 in Column 4 of Table 8) after taking housing effects into account. The maternal correlation is stronger than the paternal one in the full sample as well as in subgroups except rural, male children, the ’80 cohort, and among families that purchased their first property after their children’s secondary education, as these groups may rely more on family’s (father’s) economic support for educational progression.

It is worth noting that including two housing effects even reverses the sign of the paternal transmission for the full and a few subsamples. This highlights the importance of taking the nonlinear pattern of intergenerational association (as revealed in Sections 4.3 and 4.4) into account. We calculated the pointwise quantile-specific intergenerational correlation coefficients. For instance, for the individual in the τ^{th} quantile, his/her paternal intergenerational coefficient takes the form of $\hat{\theta}_1(\tau)^{\frac{d^f}{\sigma^f}}$ for the quantile specification without controlling for the two housing effects. Then, we gradually added housing-relevant covariates and calculated $\hat{\theta}_1(\tau)^{\frac{d^f}{\sigma^f}} + \hat{\theta}_4(\tau)^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^{pH}}{\sigma^c}}$ in the case of controlling for the level of house prices, $\hat{\theta}_1(\tau)^{\frac{d^f}{\sigma^f}} + \hat{\theta}_7(\tau)^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^A}{\sigma^c}}$ in the case of controlling for the house-price appreciation, and $\hat{\theta}_1(\tau)^{\frac{d^f}{\sigma^f}} + \hat{\theta}_4(\tau)^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^{pH}}{\sigma^c}} + \hat{\theta}_7(\tau)^{\frac{d^f}{\sigma^f} \cdot \frac{\sigma^A}{\sigma^c}}$ in the case of both covariates. The estimators $\hat{\theta}_1(\tau)$, $\hat{\theta}_4(\tau)$ and $\hat{\theta}_7(\tau)$ are obtained by the quantile IV estimation of Eq. 3.

Finally, Fig. 7 draws the distribution of individual paternal (maternal) coefficient against his/her father’s (mother’s) education level, and calculates the mean coefficient within each level of parental education.

Taking nonlinear intergenerational transmission along the child distribution yields qualitatively different coefficients compared with that of the 2SLS-IV, even though the housing effects are always controlled. Taking the average across all pointwise and quantile-specific coefficients, we find that one standard deviation in father’s (mother’s) education accounts for 0.375 (0.098) standard deviations of filial education. There is again a clear concave trend of intergenerational correlation coefficients between fathers and children (the red line in Fig. 7a) when parental education rises (i.e., an educational “Great Gatsby Curve”). This testifies to the predictions of the credit-constraint theory

³⁰ Note that the bottom quantile also sees more paternal transmission when controlling for the level of house prices. We suspect the nurturing effect may account for it. Fathers of rural individuals at the bottom 10th percentile of filial education work, on average one day less per week than fathers of those at the 20th percentile and thus, may have more time with their children. However, as the dataset is not for the life cycle records, we lack hard evidence on parental interactions with their children during schooling.

³¹ In fact, for those at the upper half of the filial education distribution, their mothers work on average 0.6 fewer hours per day and one fewer month per year than mothers of those at the lower half of the filial education distribution. This is predictable as the former has on average 2.86 more years of education than the latter does at the 1% significance level. Thus, the former enjoys 30% higher educational return without working intensively as the latter. Thus, despite of 60% of higher house prices, the former still have more time for child care than the latter.

³² Note that it would be better read it as correlation rather than causality. Despite of a number of controls in our regressions, the data limitations do not allow us to disentangle completely the genuine transmission from the genetic (Currie and Moretti, 2007) or “foetal” origins in terms of mothers’ health (Currie and Almond, 2011).

on intergenerational transmission of socioeconomic outcomes. There is an overall S-shape for the mother-child relationship, with a concave part for mothers completing Grade 9 or below. This suggests that the credit-constraint effects of house prices drive the nonlinear correlation for less educated mothers, while for those having completed at least high schools, their transmission of education to children is mainly driven by other factors. Moreover, we repeated calculations of pointwise and quantile-specific correlations in other model specifications without controlling for housing effects generally. Comparing those lines in Fig. 7 shows that excluding the possible impact of housing in transmitting education to the next generation not only under-(over)-estimates the magnitude of paternal (maternal) linkage (up to 3 times as in the maternal coefficient), but also yields different shape of intergenerational correlation. This latter would mislead the interpretation of theories.

4.6. Sources of different intergenerational transmissions of education in the presence of rising house prices

We close discussion by exploring the sources driving differences in the distribution of filial education between demographic groups and how house prices would affect these sources. We are particularly interested in the urban-rural differences given the persistent educational gap.

Using the quantile decomposition method discussed in Section 3.2, Fig. 8 plots the total difference (the shaded areas) in filial education between rural (j in Eq. (4)) and urban (k in Eq. (4)) households and its two components by decomposition at different quantiles (Eq. (5)). The rural-urban educational gap is always negative – roughly 2 years – when we move upwards along the distribution of filial education till the 8th decile and then, decreases to a one-year gap thereafter. This negative gap indicates lower educational attainments among the rural filial throughout the entire distribution of filial education.

We proceed decomposing the rural-urban educational gap according to Eq. (5). First, there is a large and persistent “effect of characteristics” – the black solid curve in Fig. 8. It means that urban children would have completed 2.4–2.8 fewer years of schooling than the actual level if they had been born with rural endowments.³³ Among children below the 8th decile, the lower the educational level, the stronger the negative rural endowment effect.

Second, there are positive although decreasing quantile differences in “effects of coefficients” below the 8th decile (the red dash curve in Fig. 8), indicating that the least and moderately educated rural children are “positively discriminated” compared with their urban counterparts. This means that urban children need to complete about 0.5 more years of schooling in order to obtain similar returns to rural children’s endowments. In other words, returns to endowments are higher for rural than for urban children, albeit the magnitude of returns decreases as rural children’s education is improved. Housing policies in rural China (e.g., free ownership of the land for own housing and curtilage) did not seem to explain rural-urban educational gap. If anything, positive returns to endowments (e.g., housing properties at low costs) insulated rural households from distortions coming from urban housing markets and thus, maintaining positive returns to rural children’s education.

Comparing the effects of characteristics and coefficients together, it is clear that the rural-urban educational gap is explained by rural households’ limited endowments restricting their children from

achieving basic and moderate education (till the 8th decile). If we alternatively interpret the two effects from urban children’s perspectives, they appear to enjoy a “glass floor” – indicated by always-negative and huge effects of characteristics – as their families’ characteristics would ensure their educational attainment by direct endowment effects, regardless of the lower returns to urban children’s endowments than those to rural children’s – indicated by positive effects of coefficients.

In the highest two deciles of filial education, the effects of coefficients become negative, indicating the appearance of a “glass ceiling” for rural offspring that obtain high educational achievements. The negative rural-urban educational gap is jointly explained by effects of characteristics and coefficients. It is also worth noting that, in the upper two deciles, the magnitude of the effects of endowments is larger than the effects of coefficients in absolute terms. One can infer that the urban offspring are more likely to inherit their parents’ high endowments, with the returns to wealth being higher than the returns to education.

Indeed, our data show that, in the highest decile, the urban offspring has an annual wealth income that is 1.6 times higher than their labor income.³⁴ Thus, urban parents do not necessarily invest significantly in their child education and their offspring rely simply on the wealth effects to inherit their parents’ socioeconomic status. Piketty et al. (2014) define the offspring whose capital income is higher than their labor income as “rentiers”. They found that Paris was a “rentier society” over the period 1872–1927–10% of Parisians was rentiers, owning about 70% of aggregate wealth. We find in China a similar proportion in 2011.

It is worth noting that results could be misleading, both quantitatively and qualitatively, if the above quantile decomposition is conducted *without* the level and appreciation of house prices or their interactions with other variables in the quantile regressions. Results are shown by the gray solid and dash curves in Fig. 8. First, the endowment effects without house price-related variables remain negative, but the magnitude of this effect is underestimated by one-third to half compared with that of the endowment effect *with* house-price variables.³⁵ Second, without house price-related variables in quantile regressions, the effects of coefficients (i.e., the returns to rural children’s endowments) become negative from the 2nd decile (the gray dash line in Fig. 8). In other words, for those at the low tail to median of the educational distribution, the previously positive returns to rural endowments stem mainly from rural housing properties that are at low costs and appreciation.

5. Conclusion

In this paper, we have provided an analysis of the extent of the intergenerational transmission of education in China, looking at the effect of house prices in that process. We used a nationally representative survey, the China Household Finance Survey 2011, to construct a household history of property purchases and educational investment decisions over the past 16 years.

We find that rising house prices intensified consumption credit constraints, which affected households’ investment on child education, relative to wealth effects as a result of more collaterals and higher borrowing ability that one would have expected from house price appreciation. We observe considerable heterogeneity between demographic groups in terms of the intergenerational transmissions of education, and nonlinearities within each group, depending on the distribution of parental and filial education. Inferences on the intergenerational correlation of education can be misled substantially

³³ The dominating “endowment effect” has also been reported in other countries. In India, 70% 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% in Sweden (Lefgren et al., 2012) where inequality is less marked. Both effects account for gender differences.

³⁴ Note that the investigation of the highest decile is subject to wider confidence intervals as revealed in Figures 6–7. One should be careful in generalising observations relating to this decile.

³⁵ We also decomposed filial educational gaps between subgroups divided by gender, birth cohorts and timing of purchasing residential properties. There are also endowment effects driving the filial educational gap. Excluding house price related variables underestimates the magnitude of this effect.

without considering house prices and group heterogeneity.

Including house prices when calculating the intergenerational correlation coefficients weaken the average maternal coefficient by 71.2%, from 0.34 to 0.098, but strengthen the paternal association by 85.6%, from 0.202 to 0.375. The concave slopes of filial education as a function of father's education testifies to the credit-constraint theory in parental investment in child education. The unusual wealth effect of house-price appreciation in the Chinese contexts further aggravates the negative impact of credit constraints on family's inputs in child education. To sum up, high house prices highlight the father's economic role via tightening the family's credit constraints and intensify the intergenerational immobility between fathers and children, while minimize the maternal role in transmitting education.

Rural offspring has on average 2 years less schooling than their urban counterparts. This cross-sectional rural-urban educational gap tends to persist into the next generation. At the low tail of the distribution of filial education, there appears to be a "glass floor" effect for urban offspring, via their better endowments, to achieve on average 2.4–2.8 more years of schooling compared with their rural counterparts. Nevertheless, the returns to endowments are higher for rural offspring than for urban offspring till the median-high level of education (the 8th decile). At the high tail of the distribution of filial education, there appears to be a "glass ceiling" effect for rural offspring, due to both worse endowments and lower returns to their endowments, to catch up their urban counterparts. Ignoring house prices would underestimate the endowment effect throughout the entire distribution of filial education and bias the returns to endowments to be higher for urban than for rural households at the median to median-high levels of education.

Policies aiming to address (cross-sectional) inequalities in parental endowments could also reduce the intergenerational persistence in the educational gap. Beyond this widely suggested social policy, given the consumption credit constraint role of house prices in households' educational investment, policies could also focus on addressing the skyrocketing house prices in China during its rapid and massive urbanization. Lower levels of purchasing prices of residential properties hold potentials in narrowing the intergenerational gap in education by reducing the endowment effects suffered by the disadvantaged group (e.g., rural households in our decomposition) and increasing returns to their endowments.

It is worth noting that the present study focuses only on homeowners. As found in the developed countries (EU in [Deidda, 2014](#) and the US in [Cooper and Luengo-Prado, 2015](#)), renters suffer from less borrowing ability as house prices rise and therefore reduce investment in child education. It would be valuable to investigate renters' cases in transition economies where the rental markets could be fragmented and highly heterogeneous.

Declaration of Competing Interest

The authors have declared that there is no conflict of interest. Jing You, Xinxin Ding, Miguel Niño-Zarazúa, Sangui Wang

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Appendix

A. Measurement errors in house prices

As the survey is retrospect, one may be concerned about the measurement errors in house prices. Along the year of purchase/construction, we compare the natural logarithmic house prices in the CHFS, another nationally representative survey – the China Family Panel

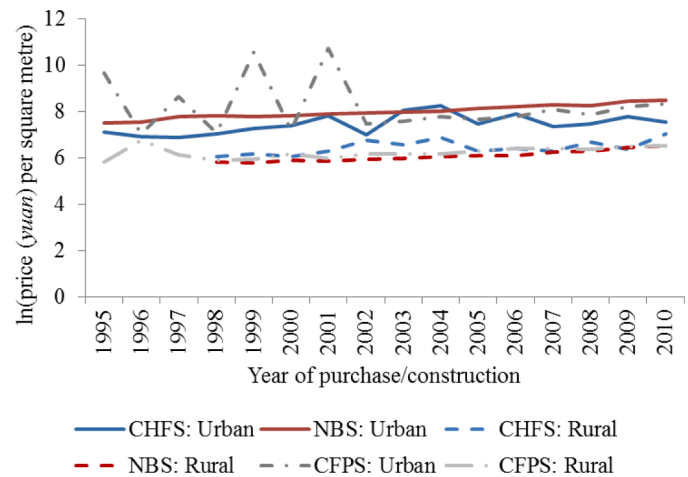


Fig. A.1. The average house prices in the CHFS, the CFPS, and the NBS. Source: Authors' calculation based on the CHFS 2011 wave and the CFPS 2014 wave. The NBS data are the same as those in [Fig. 4](#).

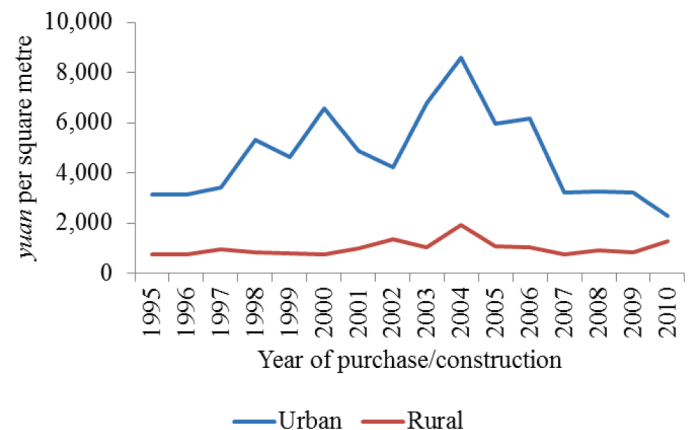


Fig. A.2. Perceived current value of the first residential property (yuan/m²). Source: Authors' calculation based on the CHFS 2011 wave.

Studies 2014 wave, and the data collected by the National Bureau of Statistics of China ([Fig. A.1](#)). For both urban and rural areas, the CHFS suggests the same increasing trends as the NBS data do. While the growth in the CHFS was more volatile than in the NBS data over the period 2002–2006, the CHFS overall better track the NBS trends than the CFPS, especially among urban households. The growth of urban house prices in the CFPS was more volatile than that of the CHFS over the entire period 1995–2010. We also check households' perceived current value of their first residential property. These values do not show a clear pattern together with the year of purchase/construction ([Fig. A.2](#)), indicating irrelevance between how many years ago the costs of housing took place and the household's estimation of its current value. The average value was 4881.56 yuan/m² among urban households and 955.59 yuan/m² among rural households, which are close to the official selling/construction prices in the NBS in 2010 – 4817.78 and 673.4 yuan/m² for urban and rural areas, respectively. This implies relatively precise estimates about property-related prices/costs. Overall the CHFS seems to be a satisfying dataset to accomplish the present study.

B. Educational system in China

Chinese students have to go through selective exams to progress to a higher level of education. While in 1995 the Ministry of Education stated for the first time that students had to be enrolled to the nearest school from their residential place during the compulsory education (i.e.,

Table A.1

Variable construction and descriptive statistics.

Variable	Definition	Mean	S.D.
Education	The number of years of education completed by children. 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 meters.	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	1346.621
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 by 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 by 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.	8409.4	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.

Grades 1–9),³⁶ the nation-wide abolishment of selective exams during the compulsory education began in 2014 when the Ministry of Education implemented the residency rule for school enrolment.³⁷ Given the time period of our data, there were limited home purchases surrounding top schools or sky-high house prices of those “school-district homes”. Over the sample period, admission depended on exam results and the household registration (“Hukou”) in the city/county of residence. While purchasing a home was correlated to but did not entitle a local household registration given strict control of population flow. If parents did

not own a residential property, their children could still attend school as easily as those of parents without a residential property, as long as one of the parents had a local household registration. This set-up allows us better purge the wealth and credit constraint effects of house prices on education from a direct entitlement of school access due to the house ownership or the purchasing behavior.

Education is categorised into 7 levels – preschool, primary school, junior high school, senior high or professional school, undergraduate or college, master's degree, and doctoral degree (Table A1).³⁸ 15.8% (8%) of rural (urban) households have taken educational loans mainly from informal sources. Despite more rural borrowers, the size of educational loans is much larger for urban households (see Table 1). This is consistent with higher (and more costly) educational achievements observed

³⁶ In 1995, the Ministry of Education released the *Notice on Regulating Arbitrary Charges in Primary and Middle Schools*.

³⁷ The official documents can be found at the Ministry of Education: http://www.moe.gov.cn/srcsite/A06/s3321/201401/t20140129_164088.html [in Chinese, accessed 8 January 2021] and the State Council at: <http://old.moe.gov.cn//publicfiles/business/htmlfiles/moe/s7503/200710/27695.html> [in Chinese, accessed 8 January 2021].

³⁸ We use years of education in the empirical analysis as the model specification is for continuous variables. See Table A1 in Appendix for a complete list of variable definition and descriptive statistics.

Table A.2
Determinants of filial education.

Independent variable	OLS	Ordered Probit	OLS	Ordered Probit	2SLS-IV	OLS	Ordered Probit	2SLS-IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Parents' characteristics</i>								
Father's education	0.176 (0.075)**	0.080 (0.037)**	0.098 (0.102)	0.045 (0.053)	−0.623 (0.568)	−0.049 (0.225)	−0.033 (0.108)	−1.333 (0.777)*
Mother's education	0.215 (0.049)***	0.097 (0.025)***	0.225 (0.075)***	0.102 (0.039)***	0.059 (0.183)	0.343 (0.191)*	0.166 (0.092)*	−0.655 (0.684)
<i>Housing</i>								
Ln(House price)			−0.107 (0.106)	−0.047 (0.053)	−1.855 (1.340)	−0.226 (0.274)	−0.102 (0.128)	−4.757 (2.618)*
Ln(House price) × father's education			0.016 (0.016)	0.007 (0.008)	0.135 (0.092)	0.045 (0.037)	0.023 (0.017)	0.260 (0.128)**
Ln(House price) × mother's education			−0.003 (0.011)	−0.002 (0.005)	0.034 (0.035)	−0.023 (0.032)	−0.012 (0.015)	0.190 (0.138)
Annual appreciation of house price						−3.654 (2.776)	−1.913 (1.354)	−5.468 (3.420)
Annual appreciation × father's Education						0.264 (0.300)	0.142 (0.147)	0.385 (0.307)
Annual appreciation × mother's Education						0.073 (0.142)	0.037 (0.070)	−0.022 (0.207)
Individual demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial controls and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	1776	1776	1776	1776	1776	1776	1776	1776
R ² (or Pseudo R ²)	0.379	0.180	0.386	0.183	0.226	0.386	0.184	0.111
Weak instruments test: First-stage F-test of zero estimated coefficients of all excluded instruments (p-value)	—	—	—	—	3.670 (0.012)	—	—	4.525
Hansen's J statistic (overidentification test of instruments), χ^2 (p-value)	—	—	—	—	1.854 (0.396)	—	—	0.173 (0.917)

Source: Authors' calculation and compilation based on data from the CHFS.

among urban households (for both parents and offspring) than among rural households.

China launched the government-subsidised student loans in 8 cities in 1999, and has expanded the student assistance system to the whole country since 2007 by introducing national scholarships.³⁹ The tuition fees of higher education have also increased from free higher education before 1999 to about 5000–12,000 *yuan* (about 770–1850 USD) per student per year thereafter, depending on the subjects and provincial regulations. This accounted for roughly 20%–43% for a couple having one child (=5000 or 12,000/(13,952 × 2) as in Table 1). Of various kinds of government assistance, the student loan is up to 6000 *yuan* (about 923 USD) per student per year and the need-based grant is up to 3000 *yuan* (about 460 USD) per student per year. Both are for poor families and require various assessments and approvals from different government sectors. According to the Ministry of Education, in 2011 (i.e., the sample year of our data), there were 1.18 million student borrowers making loans of 13.28 billion *yuan*; over 2011–2013, only 13.2% (about 20%) of college students obtained loans (need-based grants).⁴⁰ Students can also apply for financial assistance, especially for those who are not qualified for the need-based loans targeting at the listed poor families. Nevertheless, the amount of financial assistance is very small. According to the Report of National Student Loans published annually by the Ministry of Education, there were 77.3 million students in 2011 receiving various financial assistances amounting to 8.5 billion *yuan*. Of which, 4.4 billion (51.8%) were for higher education. This is equivalent to on average 110 *yuan* per student, constituting at most 2.2% (=110/

5000) of one-year tuitions fees for a college student.

Different from many public supports to education in developed countries, the student loans or assistance in China are not accessible for most families or insufficient to cover the educational costs. Over the sample period in our analysis, family wealth was the primary source to support child education, especially for higher education

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³⁹ According to the No. 58 Notice at the State Council released on 17 June 1999, the pilot cities were Beijing, Shanghai, Tianjin, Chongqing, Wuhan, Shenyang, Xian and Nanjing.

⁴⁰ The data on student loans are from the Report of National Student Loans (1999–2013) published by the Ministry of Education. It is available at: <http://old.moe.gov.cn/publicfiles/business/htmlfiles/moe/s8280/201408/174176.html> [in Chinese, accessed 8 January 2021]

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