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House price, fertility rates and reproductive intentions

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ABSTRACT

This paper uses national representative data collected through population census and household surveys to estimate the effect of house price on women's childbearing behaviors and intentions. It shows that higher house price significantly lowers women's reproductive probability and that women aged 30 and under, who have been married for 3–5 years, and those with no children are more sensitive to such effect. A significantly negative fertility response to house price is observed among renter families and those with self-built houses, but the response is insignificant for home-owning families. Subsample analysis by child gender reveals that house price mainly affects the probability of male births. Furthermore, women in regions with higher house prices are more willing to have daughters whereas those owning more houses tend to have sons.

1. Introduction

China's fertility rate has been on the decline since the adoption of the one-child policy in the late 1970s. Between 1980 and 2010, the country's total fertility rate (TFR) dropped from 2.24 to 1.18, a level far below the global average and the replacement rate required to sustain the current population. Low fertility rate is now considered a major contributor to the shrinking of working-age population and population aging, and one of the thorniest socioeconomic issues. Despite the gradual relaxation of the birth control policy in recent years,[1] the expected increase in the fertility rate was not yet observed (Chen, 2016; Mu, 2017; Song, 2016; Zhong, 2016). Obviously, factors such as housing and job opportunities for women also play an essential role in shaping fertility intentions and behaviors. Because house provides necessary space for childrearing and is the major component of the asset for most families,[2] its prices might have a substantial effect on families' fertility decisions.

To identify such impact and discuss the underlying mechanism is the main task of this paper. This not only has important policy implications, but also fills the gap in the literature that studies fertility behaviors. The opposing movement of house price and fertility rate in some developed countries has catalyzed a series of theoretical and empirical studies on the relationship between them (Adsera & Ferrer, 2018). Theoretical models (Becker, 1960, 1965; Liu & Clark, 2016) note that the increase in house prices may affect family fertility decision through price (substitution) effect and wealth (income) effect. The composite effect of house prices on fertility also depends on factors such as whether a family owns the house(s), the condition of the house(s) (number and floor area), income elasticity of childrearing, and the substitution elasticity of children, leisure and other consumption goods. The lack of a clear

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[1] The Chinese government allowed couples to have a second child if either parent is an only child since 2013. The restriction on childbirth was further relaxed as China moved to a universal two-child policy in 2016, allowing all couples to have a second child.

[2] According to *the 2019 Survey Report of Household Financial Position of Chinese Unban Residents* (published on China Finance on April 24, 2020), 96% of the surveyed residents own at least one house, and house accounts for 59.1% of total family assets.

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theoretical hypothesis is echoed by the empirical disagreement over whether, how, and how much house price affects fertility decisions. The existing studies on China either use macro-data or lack complete information, which hinders them to fully explore the heterogeneous effects of house prices and the underlying mechanisms (see more detailed discussions in the next section).

China provides a unique context for the study of the topic. With accelerated urbanization and the commercialization of houses,[3] the house price in China has been on a sustained rise. The prices of commodity houses climbed from 2714 yuan per square meter in 2004 to 5617 yuan per square meter in 2016.[4] The increase is more notable in medium and large cities. Beijing, for example, has seen an increase in the price of local commodity houses from 6033 to 19,553 yuan per square meter between 2004 and 2016.[5] The volume of house transactions has risen sharply as well. Housing reform and the establishment of the real estate market have been influencing every aspect of the socioeconomic behaviors of families and individuals. Particularly, China's deep-rooted cultural tradition to “build a nest to woo the phoenix” has created a high homeownership rate. In addition, the temporal pattern and scale of change in house price vary in different regions in China, primarily because of the housing system reforms were implemented in batches and stages across the country. As such, this paper examines the impact of house price on fertility rate and seeks to identify the causality between the former and the latter by exploiting the regional and temporal differences in house price and fertility rate trends.

Specifically, this paper first uses individual data from the 2010 national population census and finds that the house price's effect on the likelihood of childbearing remains statistically significant and negative when accounting for many other factors. On average, a 1% increase in house price leads to a decrease of 6.4‰ in the likelihood of women delivering births within 12 months prior to the census. Such a negative effect remains when alternative measures of house price is used, as well as when possible bias stemming from endogeneity and poor control group choice are considered. The heterogeneity analysis shows that the inhibitive effect of house price on fertility is more prominent among women aged 30 and under, the group married for 3–5 years, women who have no child, and those from downtown areas. To reveal possible mechanisms, it finds that house price has a stronger effect on non-migrants (especially for those currently living in downtown areas). Higher house price lowers women's reproductive probability for non-homeowners and owners of self-built homes, whereas that for owners of purchased homes are almost unaffected. The effect of house price increase on reproductive probability is mainly manifested on the births of boys. Moreover, an increase in house price causes women and men to put off marriage and also delay the reproductive age of married women.

It then constructs a panel for fertility rate at the city level with data from the 2005 nationwide 1% population sampling survey and the 2010 national population census. The aggregated analysis shows that a hike in house price of 1% leads to a decrease of 0.15–0.25 percentage points in TFR. Since TFR reflects the total number of children a woman may have throughout her life, the negative effect of house price suggests that women may react to higher house price by reducing fertility other than adjusting the age schedule of reproduction. Moreover, the plummet in fertility rate in China is accompanied by a prominently skewed sex ratio at birth (Wang & Guo, 2014). Many scholars contribute this phenomenon to the strong son preference and gender-biased sex selection in China (Liu, 2005). It is unclear whether and how an increase in house prices affects a family's gender preference for children. On the one hand, parents may lean toward fewer children when the cost of childrearing increases with house price, and thereby heighten existing son preference. On the other hand, son preference may be weakened by house price hikes for the following reason—the Chinese tradition positions houses as a must-have for males on the marital market. Therefore, higher house price means higher cost for raising sons and thereby higher competitive pressure for families of male children, which would lead to diminished son preference.[6] As some literature (e.g., Qian, 2008) notes, income elasticity for sons and daughters may not be entirely the same, if families consider sons as normal goods and daughters luxury goods. The wealth (income) effect of house price hikes plays a more dominant role than its price (substitution) effect, higher house price may be associated with higher family demand for daughters. Our gender-based analysis finds that house price increase has a significant and negative effect on male births, but its effect on female births is insignificant.

Later, the paper investigates the impact of house price on reproductive intentions, its underlying mechanism, and the heterogeneity of the effect based on microdata collected through the 2011 Chinese Social Survey (CSS). To date, of studies looking at the relationship between house price and fertility, few touches upon the effect of change in house price on women's reproductive intentions. Individuals' intentions for childbearing reflects their attitudes and views on reproductive behaviors and has been considered for a very long time as a meaningful prediction of the birth of a child (Ajzen, 1991; Zhong, 2016). However, quite a few studies find that the intention to have child is not precisely predictive of the outcomes, in many cases, using reproductive intention as the predictor may overestimate or underestimate the actual action. So far, researches involving housing market and fertility focus on the impact of house price on fertility behaviors. This paper's analysis of fertility intentions will enrich the relevant literature. Our results show that families in regions with higher house price are more willing to have daughters, whereas those owning more houses tend to have sons.

The remainder of the paper is laid out as follows. Section 2 proceeds with literature review. A description of the data, variables of interest and their summary statistics are presented in Section 3. Section 4 explores impact of regional house price on fertility from

[3] Reform of the housing system was a key component of China's urban economic transformation since the late 1980s. In the process of adjusting ownership structure, housing provision in urban China has gradually shifted from a public allocation system in which houses were provided by work units as a part of employees' welfare to one in which private ownership is allowed and the purchase of commodity housing is increasingly encouraged.

[4] We calculated the house prices for 2016 at 2004 constant prices using fixed-base urban consumer price index. Data for house prices and price index are sourced from the 2017 China Statistical Yearbook.

[5] We calculated the house price for 2016 at 2004 constant prices using fixed-base Beijing's consumer price index. Data for house prices and price index are sourced from China's Statistical Bureau and China Statistical Yearbook series.

[6] As the Chinese saying so aptly puts, “sons will *cost* you a fortune, daughters will *make* you a fortune.”

multiple dimensions, of which micro-level (with individual data) as well as aggregated analysis (at city level) are both considered. Section 5 then uses CSS data to conduct a micro-level analysis on how house price affects the childbearing behavior and intention of families with different types of house ownership. Section 6 concludes.

2. Literature review

China's house prices increased dramatically in the past two decades, which sparked tremendous research interest in its possible socioeconomic impacts. For example. Fu, Liao, and Zhang (2016) and Li, Li, Lu, and Xie (2020) note that an increase in house prices significantly reduced the labor force participation of female homeowners, mainly through the wealth effect of the capital gains of houses. Li and Wu (2014) argue that houses are more like investment goods when house prices keep rising, therefore might encourage households to invest more on houses and crowd out entrepreneurship. Researchers also examined the impact of house prices on a variety of other aspects including consumption/saving, human capital investment, marriage, and subjective wellbeing (Chen & Qiu, 2011; Cheng, King, Smyth, & Wang, 2016; He & Yang, 2019; Wrenn, Yi, & Zhang, 2019; Zhao, Liang, & Li, 2013). However, study on the impact of house prices on fertility is relatively scarce.

Since Becker's (1960) seminal work, which groundbreakingly considered children as normal goods (meaning that the demand for children increases with family income or wealth), many studies have examined how economic conditions such as parents' income, external wealth shocks and the opportunity costs of childrearing influence household fertility decisions (Amialchuk, 2006; Black, Kolesnikova, Sanders, & Taylor, 2013; Cohen, Dehejia, & Romanov, 2013; Coronado & Perozek, 2003; Lindo, 2010; Lovenheim & Mumford, 2013; Milligan, 2005).[7] As housing is a major component of a household's asset portfolio, the fertility impact of changes in house value has naturally become a subject of study in the fertility literature.

House prices may influence family fertility decisions through different channels. The first is the substitution effect induced by the price change. As raising children needs space, houses and children are strongly complementary. Therefore, the rise in house prices increases the cost of childrearing, and thus, the substitution effect would reduce families' demand for children (Dettling & Kearney, 2014; Lindo, 2010). An increase in house prices can also reduce a household's willingness to give birth if the parents need to buy homes for their children when they reach adulthood, a common phenomenon in the Chinese society. The pressure is especially intense for parents of male children, as the ability to buy a house is vital for their sons' competitiveness in the marital market (Li & Wu, 2014; Wei & Zhang, 2011; Wrenn et al., 2019).

Second, an increase in house prices could reduce families' purchasing power. Under the assumption that child quantity is a normal good, this income effect would weaken families' demand for children (Yi & Yi, 2008). Therefore, rising house prices not only force households to substitute other consumption for children, but also crowd out demand for children by reducing their purchasing power.

Nevertheless, for home-owning families, the increase in house prices also boosts family wealth. As mentioned earlier, house ownership represents an important form of family assets, and an increase in house prices could have a positive wealth effect on fertility if a household “cashes out” the wealth gain by selling the house or moving to a lower value house. Even if the increased wealth is not realized, the rise in house prices could help ease credit constraints when the house became collateral of higher value in an incomplete capital market. Consequently, the households are more likely to consume out of the home equity and increase their demand for children (Dettling & Kearney, 2014; Li & Wu, 2014). But again, considering the need to buy houses for children when they enter adulthood, the increased value of the house might be unable to offset the negative effect it has on fertility (Li, Li, & Gao, 2012; Yi & Yi, 2008).

Given all these possibilities as discussed above, the overall impact of house prices on fertility should be subject to careful empirical examination. Aggregate empirical analyses (such as, Borsch-Supan (1986), Haurin, Hendershott, and Kim (1993), Yi and Yi (2008), Li et al. (2012), Pan and Xu (2012)), often find that fertility rate goes down as house price increases. Due to the limitation of aggregate data, these studies usually cannot distinguish between homeowners and non-homeowners, neither can they examine the heterogeneous effects among different groups. Analyses based on microdata of different population groups have yielded more fruitful results. Based on US data, Lovenheim and Mumford (2013) showed that a $100,000 increase in housing wealth among homeowners would cause a 16–18% increase in the probability of childbirth. Dettling and Kearney (2014) also found that in the Metropolitan Statistical Area, a $10,000 increase in house price could lead to a 5% increase in fertility rates among homeowners and a 2.4% decrease among non-owners. Both studies indicate that for homeowners, the housing endowment effect far surpasses the negative substitution effect and the reduction in purchasing power. Other studies find that homeownership influences the timing of fertility decisions: home owning couples have earlier first births than non-owning couples (Mulder & Billari, 2010; Mulder & Wagner, 2001; Yi & Zhang, 2010).

Empirical evidence on how house prices in China affect reproductive decisions is still limited, and even fewer studies have explored the heterogeneous effects among different groups. Closely related to our study, Ge and Zhang (2019) merge the provincial

[7] For example, Black et al. (2013) investigate the impact of the husband's income on the number of children born to their wives. To control the cost of children, they chose women of the same education level from regions with similar house price levels. They found that women give birth to more children when their husbands have higher income, thereby empirically confirming that the quantity of children is normal goods. Many other studies attempt to identify the effect of external income or wealth shocks on the number of children families have. Such shocks include government subsidies or other forms of financial incentives (Cohen et al., 2013; Milligan, 2005), fluctuations in the stock market (Coronado & Perozek, 2003), husbands' job-related income shocks (Amialchuk, 2006; Lindo, 2010), fluctuation of resource (e.g., coal) prices (Black et al., 2013), and the fluctuation of house prices (Lovenheim & Mumford, 2013).

level house prices with China Family Panel Studies (CFPS) data and find that house prices are significantly associated with fertility. Differing from our study, they do not consider the heterogeneous effect for women's age, marriage duration, migration status, and region. Neither do they consider the differential impact of house prices on the birth of children of different gender. In another related study, Liu, Gao, Tisdell, and Wang (2020) find that having housing property rights has a significantly positive influence on fertility in China. However, they do not examine the fertility effect of house prices.

While data constraints present a principle obstacle, the possible endogeneity between house prices and fertility rate is another challenge for identifying the causal impact of house prices on childbearing decisions. Based on individual-level data from the 1% sampling survey in the 2005 and 2010 population census, we estimate the effect of house prices on fertility rates, controlling for historical fertility rates and regional fixed effects. Microdata also allows us to investigate the heterogeneous impact of house prices so that we can better understand the underlying mechanism. Therefore, we contribute to the literature in the following aspects. First, our study enriches the literature that examines the consequences of the rapidly rising house prices, emphasizing its detrimental impact on China's declining fertility rate. Second, by employing the wealth change induced by house prices and relates it to individual-level data, we can evaluate how fertility behavior responds to wealth change more accurately and in more detail. We not only examine differential impacts of house prices on homeowners vs. non-homeowners, migrants vs. non-migrants, and rural vs. urban residents, but also explore heterogeneous effects of women of different ages, marriage duration, and birth history.

3. Data and summary statistics

By matching individual fertility information and other personal attributes (age, gender, migration status, education level, etc.) from the 2010 national population census to macro or aggregate variables such as house price and GDP per capita at city level, this paper first investigates the effect of house price on women's childbearing probability from a micro perspective. It then estimates fertility rate at city level using data collected from the 2005 nationwide population sampling survey and the 2010 national population census. A panel is then constructed for testing at aggregate level. Last, it analyzes how the price of houses influence individual's reproductive intentions based on CSS data.

In the micro analysis based on data from the 2010 national population census, we use a random sample which consists of 1,267,381 individuals from 31 provinces.[8] Information on these individuals' age, education level (zero education or primary school, junior high school, high school, college, undergraduate and graduate), ethnicity, place of residence, place of hukou registration, type of hukou are also included in the data. For women aged 15–64 who have ever married, the data contain the total number of live births by gender given by them and of which the number who survived. For married women aged 15–50, the data contain their reproductive status within the year prior to the time of census (namely, from 2009.11.1 to 2010.10.31) and the gender of their children. We use these data to generate our dependent variable (*newbirth*) which is defined as whether gave birth(s) within the past 12 months (1 for yes, 0 for no, and missing for no records of such information). Individuals with collective hukou are then deleted, leaving us with a sample of ever married women aged 18–45 with family hukou status (271,531 individuals).

Furthermore, according to China's family planning policies, not every woman is eligible for reproduction in 2009 and 2010. We therefore estimate the maximum number of children allowed by law for each woman in our retained sample. As stated by the birth control rules, the maximum number of children women in urban areas with non-agricultural hukou can have is 1, and 0 if they already have a child. For women who hold agricultural hukou, the maximum number of children they can have is 1 for those who already have a daughter and 0 for those who already have a son; therefore about 1.5 for those without any live births. Women of minority ethnicity in Yunnan can have up to 3 children, and those who belong to ethnic minority groups in other provinces are allowed to have at most 2 children. The maximum number of children they can have will reduce accordingly, if they already have one, two or even three alive children. We retain individuals who are eligible to have at least one child, leaving 145,518 individuals in the sample after removing those who have some data missing when matched to macro indicators at city level.

Our key independent variable is average house price at city level.[9] As the dependent variable (*newbirth*) for the micro analysis is assigned values according to the reproductive status of females eligible for childbearing between November 1st in 2009 to October 31st in 2010, we use the natural logarithm of city house price lagged two years (namely, in 2008) to be the key independent variable (*lnhp_2*) for regression analysis. This is because, for those who delivered (or did not deliver any) children during this period, they would have made such decisions in 2009 or early 2010. City house price in 2008 can better balance exogenous requirements and proximity to fertility decisions. Moreover, as city house price may be a manifestation of regional long-term demographic trends that influence reproductive behaviors, we construct an alternative indicator (*lnhp_res_2*, also lagged two years) by calculating deviations for each year from linear trajectory between 2000 and 2015 for the natural logarithm of house price in each city. Such deviations may better reflex unpredictable changes in house prices to reveal causal effect of house price on fertility. Besides, as city house prices may

[8] Data are from the Microdata Database of the Sixth Census of 2010 at Tsinghua China Data Center (CDC). This database is obtained through a systematic sampling of the long table data from the census. The sampling ratio is 0.995%. It includes 405,660 households and 1,267,381 individuals. The main indicators show the sample is well representative for the whole population. The database covers 59 indicators related to housing, gender, age, ethnicity, household registration, migration status, education (for those aged 6 and above), marital status (for those aged 15 and above), and childbearing status (fertility history for ever married females aged 15–64, and childbearing status within the past 12 months for married females aged 15–50).

[9] House prices (or house values) were not collected for households in the Microdata Database of the Sixth Census of 2010, and house price at household level may suffer endogeneity problem since households simultaneously make their optimal choices on housing and childbearing based on their preferences and budget constraints.

induce possible problem of sorting bias,[10] we also consider another two alternatives (namely, *hpgr*_2_3 and *hpgr*_2_5) which are annual growth rates of city house price from 2007 to 2008 and from 2005 to 2008, respectively.

Original data for calculating city house price (per unit area) is sourced from China Premium Database of CEIC,[11] which is obtained by dividing sales of commodity houses by areas sold at city level. As for other independent variables (controls), GDP per capita (denoted by *lngdp_p_city*, partially helping to control for possible simultaneous effect of economic development) are also gathered from China Premium Database of CEIC; share of migrant population (%, *migrant_avg_city*), share of ethnic minority population (%, denoted by *minority_avg_city*) and share of marriageable population (aged 20–34, %, denoted by *popmarriratio_avg*) are computed with the sample data from the 2010 national population census, respectively. Table 1 tabulates the descriptive statistics for the main indicators.

Our analysis with micro data takes average house price at city level (which is the same for all individuals from the same city) as the key independent variable. We then consider another analysis to investigate the (aggregate) effect of house price on fertility at city level. To do this, we first calculate the TFR for each city, which is the sum of the average fertility rate for women aged 18–45. That is: $TFR_t = \sum_{a=18}^{45}\left(\frac{1}{N_a^t}\sum_{i\in a} f_i^t\right)$, where a indexes age, ${N_a}^t$ and $\sum_{i\in a} f_i^t$ represent the total number of women in a given age group and total live births they have. As such, $\frac{1}{N_a^t}\sum_{i\in a} f_i^t$ gives the average age-specific fertility rate (ASFR) for women in this city. We also calculate the TFRs for different types of women based on the gender of children, migration status and house ownership status, in order to explore possible mechanisms through heterogenous regressions. It is worth mentioning that these TFRs are more of a period rather than cohort metric that reflects the number of children women may have over their lifetime. They can only serve as a proxy to cohort TFRs under a strong assumption that fertility probability for any given age group does not change noticeably over time. We can get a city level panel for later analysis since such (period) TFRs in years 2005 and 2010 for all women eligible for childbearing and for women of different types can both be computed with data of the 2005 nationwide population sampling survey and the 2010 national population census, respectively.

We also introduce GDP per capita, share of migrant population, share of ethnic minority population and share of marriageable population as controls for the aggregate analysis. Of these variables, data for the first is also sourced from China Premium Database of CEIC, and those for the others are calculated with data of the 2005 nationwide population sampling survey and the 2010 national population census, respectively. Table 2 summarizes the descriptive statistics for the main indicators aggregated at city level.

Table 2 shows that the average TFR of the 295 cities declined from 1.476 in 2005 to 1.279 in 2010. The average number of sons per women is found to be larger than that of daughters (0.806 vs 0.663 in 2005, 0.706 vs 0.584 in 2010), which is largely the result of son preference rather than the mere result of natural fertility trends. The table also shows that the TFR for women aged 30 and below decreased from 1.243 in 2005 to 0.458 in 2010, whereas that for women aged over 30 increased from 0.234 in 2005 to 0.672 in 2010. This may be due to childbearing delay. Moreover, it shows that the TFR for non-migrant women is on average higher than that for migrant women. The former dropped from 1.409 in 2005 to 1.28 in 2010 and the latter from 1.215 to 1.071. The relatively lower TFR of the migrant population and its sustained downward trend may have something to do with the group's fertility intentions, it could also be a result of the high childrearing cost in the destination cities.

Moreover, we attempt to identify the impact of house price on reproduction intentions based on data assembled through the Chinese Social Survey (CSS), which is a nationwide large-scale continuous sample survey project initiated by the Institute of Sociology of the Chinese Academy of Social Sciences in 2005. Designing the sampling frame based on the 2000 and the 2010 population census which count population at district, country and city levels, the project collects information on individuals' employment status, family and social life, and social attitudes. Through random sampling and door-to-door interviews, it covers 31 provinces/autonomous districts/directly controlled municipalities across China, canvassing over 7000–10,000 households in 604 villages/neighborhood committees from 151 districts/counties. Since information on reproductive intentions was only collected in 2011, we use the data for 2011 for analysis. We restrict the sample to married female interviewees or male interviewees whose spouses were aged 15–49 at the time of interview in urban areas. After removing subjects with missing data, we are left with a sample of 1329 households.

Table 3 uses CSS data to describe the reproduction situation and intentions of families with different housing conditions. As it suggests, more girls are born to non-home owning families and more boys are born to home-owning families. In addition, in the case of the latter, the number of boys born increases with the number of houses owned. This could be explained by the effect of housing on reproduction. It may also because families with boys have a stronger tendency of purchasing house. Furthermore, the ideal number of children also increases with the number of houses owned.[12]

[10] We are grateful to the anonymous referee for pointing this issue out. Sorting bias may be induced as higher-income or more career-focused females are more likely to move to more developed cities, who tend to have less children and experience higher house prices.

[11] Data are drawn from various issues of the China Statistical Yearbook for Regional Economy, provincial and city statistical yearbooks.

[12] The sum of the ideal number of sons and daughters does not equate the ideal number of children because when asked about the ideal number of children, an alternative answer is that the gender of the child does not matter (this case is not included in our analysis).

Table 1
Descriptive analysis of micro data from the 2010 national population census.

Variable	Definition	Mean	S.D.	Min	Max
		(1)	(2)	(3)	(4)
newbirth	Whether gave birth(s) within the past 12 months (yes = 1)	0.056	0.230	0	1
lnhp_2	City house price in 2008 (log.)	7.869	0.491	5.734	10.044
lnhp_res_2	Deviation of city house price (log.) in 2008	0.096	0.244	−1.398	2.367
hpgr_2_3	Annual growth rate of city house price from 2007 to 2008	0.102	0.211	−1.828	1.522
hpgr_2_5	Annual growth rate of city house price from 2005 to 2008	0.124	0.097	−0.381	0.965
age	Age	31.755	8.403	18	45
educ	No more than primary education	0.216	0.482	0	1
	Junior high school	0.594	0.491	0	1
	High school	0.122	0.328	0	1
	College	0.046	0.209	0	1
	Undergraduate	0.020	0.139	0	1
	Graduate	0.002	0.041	0	1
migrant	Whether a migrant (yes = 1)	0.136	0.343	0	1
urban	Whether a non-agricultural hukou holder (yes = 1)	0.055	0.227	0	1
birth_yes	Whether gave birth(s) previously (yes = 1)	0.864	0.342	0	1
lngdp_p_city	City GDP per capital (log.)	2.383	0.632	−0.066	3.821
migrant_avg_city	Share of migrant population (%)	10.069	12.730	1.029	79.019
minority_avg_city	Share of ethnic minority population (%)	4.681	11.849	0	98.390
popmarriratio_avg	Share of marriageable population (aged 20–34, %)	22.185	4.229	13.569	42.859

Data source: the 2010 national population census, China Premium Database of CEIC.

Table 2
Descriptive summary of data aggregated at city level.

Variable	Definition	2005 (N = 295)	2010 (N = 295)	Total (N = 590)
tfr	Total fertility rate (TFR)	1.476	1.279	1.378
tfr_boy	Sons per woman	0.800	0.706	0.753
tfr_girl	Daughters per woman	0.663	0.584	0.623
tfr_age1	TFR for women aged 30 and below	1.243	0.458	0.850
tfr_age2	TFR for women aged over 30	0.234	0.672	0.453
tfr_mig	TFR for migrants	1.215	1.071	1.142
tfr_boy_mig	Sons per migrant woman	0.617	0.610	0.613
tfr_girl_mig	Daughters per migrant woman	0.598	0.472	0.535
tfr_nonmig	TFR for non-migrants	1.409	1.280	1.345
tfr_boy_nonmig	Sons per non-migrant woman	0.765	0.709	0.737
tfr_girl_nonmig	Daughters per non-migrant woman	0.633	0.583	0.608
lnhp_2	City house price (2-year lag, log.)	7.162	7.800	7.481
lngdp_p_2	City GDP per capita (2-year lag, log.)	1.578	1.977	1.778
migrant_avg_city	Share of migrants (%)	11.040	16.976	14.008
minority_avg_city	Share of minority nationalities (%)	0.076	0.074	0.075
edu_avg_city	Average education level	3.165	3.399	3.282

Data source: the 2005 nationwide population sampling survey, the 2010 national population census, China Premium Database of CEIC.

Table 3
Number of houses owned and reproduction intentions.

	No house	One house	More than one house	Average
	(1)	(2)	(3)	(4)
Ideal number of children	1.841	1.875	1.996	1.892
Ideal number of sons	0.988	0.984	1.060	0.998
Ideal number of daughters	1.012	0.966	1.033	0.982

Source of Data: CSS, 2011.

4. Empirical results and possible mechanisms

4.1. House price and reproductive probability: micro data results

In this section, we investigate how house price affects the likelihood of women's childbearing with individual data from the 2010 national population census. Probit model is adopted since many explained variables in the regressions are dummies. We include

Table 4
Whether gave birth in the previous year and house price (Probit).

	All				Never left	Left within 3 years	Left 3+ years ago
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lnhp_2	−0.0064***				−0.0046**	−0.0110***	−0.0066*
	(0.0013)				(0.0018)	(0.0026)	(0.0035)
lnhp_res_2		−0.0078***					
		(0.0018)					
hpgr_2_3			−0.0069***				
			(0.0016)				
hpgr_2_5				−0.0179***			
				(0.0047)			
town (yes = 1)	0.0028**	0.0031**	0.0036***	0.0037***	0.0025	0.0034	−0.0006
	(0.0013)	(0.0013)	(0.0012)	(0.0012)	(0.0017)	(0.0021)	(0.0030)
rural (yes = 1)	0.0061***	0.0063***	0.0046***	0.0047***	0.0006	0.0095***	0.0044
	(0.0011)	(0.0011)	(0.0014)	(0.0014)	(0.0019)	(0.0025)	(0.0036)
tfr_05	0.0035***	0.0041***	0.0030	0.0037**	0.0037	−0.0011	0.0161***
	(0.0013)	(0.0014)	(0.0018)	(0.0018)	(0.0025)	(0.0025)	(0.0043)
Ind. controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	145,518	145,518	145,405	144,308	27,987	26,615	90,877

Notes: 1) Here we report the partial effects.
2) Individual-specific attributes include age, education level, hukou status, migration status, and reproductive experience.
3) City-specific attributes include GDP per capita average education level, share of migrants, share of minority nationalities, share of population of marriageable age and regional dummies.
4) The standard errors are presented in the brackets.
5) * significant at 10%; ** significant at 5%; *** significant at 1%.

individual-specific indicators such as age, education level (a set of dummy variables representing discrete categories of educational attainment are used rather than converting them into a continuous variable of "years of education" or an ordinal variable, as educational attainment may not have a linear and monotonic effect on a woman's childbearing probability), hukou status (*urban*), migration status (*migrant*) and reproductive experience (*birth_yes*, whether gave birth(s) previously). We also introduce city-specific variables such GDP per capita (*lngdp_p_city*), average education level, share of migrants (*migrant_avg_city*), share of minorities (*minority_avg_city*), share of marriageable population (*popmarriratio_avg*) and the TFR at city level in 2005 (*tfr*_05). As different areas within the same city may differ considerably in house prices and other living cost, and individuals of similar tastes and budget constraints are likely to concentrate in the same area, we add another two dummies (*town* and *rural*) to indicate whether or not the residence place for the women in question is located in central downtown (including urban fringe), township (including township fringe) or the rural areas of the city. Province dummies are also considered for all specifications to control for province fixed effects. As the difference of house price occurs at city level, we also cluster the standard errors at city level, which applies to all following analyses if not otherwise specified.

1) Basic results

Table 4 first shows the results for when "whether gave birth(s) during the past 12 months" (*newbirth*) is the explained variable based on the whole sample consisting of all ever married women aged 18–45 without data missing for the key independent variable (*lnhp*_2) and other controls.

In the first column, we adopt city house price lagged 2 years (namely, city house price in 2008) as the key independent variable. The results show that house price's effect on the likelihood of childbearing remains statistically significant and negative when accounting for many other factors. On average, 1% increase in house price leads to a decrease by 6.4‰ in the likelihood of women delivering births within 12 months prior to the census.

In addition, regression coefficients of the two dummies (*town* and *rural*) and TFR at city level in 2005 (*tfr*_05) are all statistically significant and positive. Specifically, compared to women living in central downtown areas, those living in town and rural areas have relatively higher probabilities (on average by 2.8‰ and 6.1‰, respectively) to deliver births. This is comprehensible as those living in rural and town areas are more likely to hold agricultural hukou which on average allows them to have more children as per family planning policies. Besides, women living in these areas generally have less desire for career development, therefore are more likely to have more kids. For the indicator *tfr*_05, its estimated positive coefficient indicates that the reproductive probability of women is higher in cities with higher TFRs in 2005. This is also expected: since cities with higher TFRs in 2005 are likely to be those with relatively more minorities, more agricultural women, or stronger fertility culture, women in these cities will deliver relatively more births in 2010.

2) Robustness checks

We next test the robustness of the above results. To do this, we construct another three indicators—*lnhp_res*_2 (defined as deviation of city house price away from its linear trajectory between 2000 and 2015), *hpgr*_2_3 (defined as annual growth rate of city house price from 2007 to 2008) and *hpgr*_2_5 (defined as annual growth rate of city house price from 2005 to 2008)—and apply Probit estimation to reassess the impact of house price. The corresponding results are presented in the following three columns in Table 4.

Column 2 presents the results when *lnhp_res*_2 is alternatively used. As aforementioned, this indicator captures unpredictable changes in house prices and may better meet exogeneous requirements. We find that house price still has a statistically significant and negative impact on women's reproductive probability. We also find that such effect is slightly larger in Column 2 than that in Column 1: on average, a 1% unexpected increase in house price is associated with a decrease of 7.8‰ in the likelihood of child delivery for women of childbearing age. Results when using the other two alternatives (*hpgr*_2_3 and *hpgr*_2_5) are presented in Column 3 and Column 4, respectively. These two columns also suggest that after controlling other factors, house price has a significantly negative effect on the likelihood of women giving births. On average, annual house price rising by 1% leads to a 6.9‰-17.9‰ decrease in the likelihood of childbearing. The estimated effects are also slightly larger than that implied in Column 1. As the application of alternative measures of house price does not lead to considerable difference in the results, we refer to *lnhp*_2 as the key independent variable in the following analysis.

In the above analysis, we have controlled for regional socio-economic effects as well as the effect of observable personal attributes, to account for regional characteristics and individual factors that influence behaviors of women of reproductive age. This way, we can capture the marginal effect of house price on women's childbearing likelihood. We may, however, be exposed to problems of omitted variables or selection bias as discussed before. Given this, we divide the complete sample into three subsamples based on residence and hukou registration places. The first group ("never left" subsample) includes all individuals that report they have never left their hukou registration places, the second ("left within 3 years" subsample) and the third ("left over 3 years ago" subsample) includes those who report they left within three years and more than three years prior to the census, respectively. Problems of selection bias might be the least serious for the first group and the most for the second, since women are most likely to move just before deciding to have a child if their childbearing behaviors are indeed influenced by house price. We apply subsample regressions to these three groups to reassess the effect of house price on fertility. Meanwhile, subsample regressions may partly help to avoid the possibility of biased results due to poor choice of control group as the three groups may differ obviously in some other personnel attributes related to childbearing behavior.

Columns 5–7 present the corresponding results. We find that all three columns have significantly negative coefficients for *lnhp*_2, and that in Column 6 is the largest and that in Column 5 are the smallest: on average, a 1% increase in house price leads to a 11.0‰, 6.6‰ and 4.6‰ decrease in childbearing likelihood for women leaving their place of hukou registration, respectively. This shows that after controlling other factors, as well as possible bias stemming from endogeneity and poor control group choice, house price still has a significantly negative effect on the likelihood of delivering births.

Moreover, regression coefficients for variables reflecting types of residence place and earlier reproductive behaviors in Columns 2–7 are consistent with those in Column 1. Women living in rural areas are more likely to give births compared to their counterparts living in central downtown areas. Meanwhile, cities with higher fertility rates in earlier years tend to continue this trend.

3) Heterogenous analysis

This part looks at whether the impact of house price on fertility vary among different types of women. To account for the heterogeneity of house price's effect, we sort the sample into subsamples based on the types of residence place, age, length of marriage and reproductive experience of the women. Results are displayed in Table 5.

Eligible women are first grouped into those 30 years old or below and those above. Columns 1–2 show the corresponding regression results from these two subsamples. We find that the inhibitive effect of house price on fertility is more prominent among

Table 5
House price and reproductive probability of women of different groups (Probit).

	Age		Married for			Whether have child before		Currently living in		
	≤30	> 30	< 3 years	3–5 years	> 5 years	Yes	No	Downtown	Town	Rural
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
lnhp_2	−0.0113***	−0.0038***	−0.0047***	−0.0351***	−0.0100*	−0.0039***	−0.0377***	−0.0107***	−0.0065***	−0.0064***
	(0.0026)	(0.0012)	(0.0016)	(0.0106)	(0.0057)	(0.0008)	(0.0120)	(0.0031)	(0.0025)	(0.0013)
Obs.	66,977	78,493	48,932	7668	17,583	125,737	19,724	27,981	26,609	90,897

Notes: 1) Here we report the partial effects.
2) Individual-specific attributes include age, education level, hukou status, migration status, and reproductive experience.
3) City-specific attributes include GDP per capita average education level, share of migrants, share of minority nationalities, share of population of marriageable age and regional dummy.
4) The standard errors are presented in the brackets.
5) * significant at 10%; ** significant at 5%; *** significant at 1%.

women aged 30 and under (Column 1): a 1% increase in house price brings down the reproductive probability by 11.3‰, which accounts for 0.7% of the average reproductive probability (140‰) for women of this age group. In other words, if house price doubles, reproductive probability will drop by around 7%. House price has a much smaller effect on women aged above 30, as the absolute value of the coefficient is around one third of that of the group aged 30 and under. This is mainly because the fertility probability for women aged above 30 is already low.

In Columns 3 and 5, we split the sample into three subsamples according to the length of marriage: under 3 years, 3–5 years, and over 5 years. As the results show, the effect of house price is concentrated on the group married for 3–5 years. On average, a 1% increase in house price corresponds to 35.1‰ decrease in childbearing likelihood for women married for 3 to 5 years; and 10.0‰ and 4.7‰ decrease in probabilities of giving births for those married for more than 5 years and for less than 3 years, respectively. This particular group of women have relatively high reproductive probability. Meanwhile, women who have not given birth within the first one to two years of marriage are likely to be more sensitive to internal and external economic conditions so that the increase in house price may drive them to give up having children or adjust the timing of birth. Comparatively, women who have married for longer may already have had children and therefore are insensitive to the change in house price.

Columns 6 and 7 report results for when women are put into two subsamples based on whether they already have children. As we can see, for those who have, although the effect of house price on their reproductive probability is still significantly negative, it is relatively small. On average, house price increased by 1% would lead to 3.9‰ reduce in childbearing probability. We believe this can be largely attributed to the restriction of family planning policy in urban areas: most families only have one child and once the target has been fulfilled, house price has little effect on women's fertility decisions. However, since strict enforcement is not ensured in every region and there certainly are families willing to brave the possible fines for more children, house price still has some extent of effect on women's reproductive probability. Comparatively speaking, women who have no child during the period of investigation (within the year prior to the time of survey) are more influenced by the change in house price. The results in Column 7 show that a 1% increase in house price leads to 37.7‰ decrease in their reproductive probability. Because these women face the decision of whether and when to have child, change in house price is more likely to have a large impact on their reproductive behaviors.

Because we use the average price of commodity housing which concentrates primarily in urban areas, whereas rural residents mostly live in private houses built on homestead land, the effect of urban house price differs for the reproductive behaviors of different resident groups. For urban residents, the effect is direct. For rural residents, the effect is exerted somewhat indirectly through the expectation for moving to the cities in the future. In correspondence, we perform regression for the three subsamples of downtown, town and rural areas. Corresponding results are presented in the last three columns of Table 5. The estimations of *lnhp_2* in these three columns are all statistically significant and negative. Specifically, a 1% increase in house price corresponds to a 10.7‰, 6.5‰ and 6.4‰ decrease in childbearing probabilities of women living in downtown, town and rural areas, respectively. House price influences fertility rate of downtown areas the most, followed by towns and rural areas. These results fit our expectation that the direct effect is larger than the indirect effect. They also point to a spillover of the effect of urban house price on reproductive behaviors into the rural regions.

4) Possible mechanisms

In the analysis of how house price affects reproductive behaviors, population migration adds to the challenge of identifying this relationship. For example, residents with strong reproductive intentions may choose areas with lower house prices. Regional difference in house price drives the distribution of population across different regions, but has no effect on the TFR. Is it possible that the effect of house price we previously observed is the result of the flow of population? China's hukou system and registration data offer potential to address this consideration. In China, as the likelihood for urban residents to migrate is relatively low, holders of rural hukou make up the majority of working-age floating population in urban areas. This pattern allows us to focus on the effect of house price on local residents. We divide the sample into migrant population and non-migrant population based on whether the subject is

Table 6
House price and reproductive probabilities for migrant and non-migrant women (Probit).

	All		Downtown		Town		Rural	
	Non-mig	Migrant	Non-mig	Migrant	Non-mig	Migrant	Non-mig	Migrant
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnhp_2	−0.0065***	−0.0078**	−0.0117***	−0.0090**	−0.0080***	−0.0118	−0.0053***	0.0081
	(0.0012)	(0.0037)	(0.0039)	(0.0044)	(0.0029)	(0.0118)	(0.0013)	(0.0102)
Obs.	125,733	19,785	14,327	13,646	24,001	2121	87,361	3362

Notes: 1) Here we report the partial effects.
2) Individual-specific attributes include age, education level, hukou status, migration status, and reproductive experience.
3) City-specific attributes include GDP per capita average education level, share of migrants, share of minority nationalities, share of population of marriageable age and regional dummy.
4) The standard errors are presented in the brackets.
5) * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7
House price and fertility behaviors for women with or without own houses (Probit).

	Non-home owner	Owners of self-built home	Owners of purchased home	All	Downtown	Town	Rural
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lnhp_2	−0.0063*	−0.0063***	−0.0025	−0.0072***	−0.0095***	−0.0074***	−0.0057***
	(0.0038)	(0.0013)	(0.0071)	(0.0012)	(0.0032)	(0.0026)	(0.0014)
House price*self-built home				0.0012***	0.0014***	0.0006*	0.0011***
				(0.0002)	(0.0004)	(0.0003)	(0.0004)
House price*purchased home				0.0011***	0.0014***	0.0003	0.0011**
				(0.0002)	(0.0004)	(0.0004)	(0.0005)
Obs.	17,169	113,521	9369	140,291	24,794	25,455	90,012

Notes: 1) Here we report the partial effects.
2) Individual-specific attributes include age, education level, hukou status, migration status, and reproductive experience.
3) City-specific attributes include GDP per capita average education level, share of migrants, share of minority nationalities, share of population of marriageable age and regional dummy.
4) The standard errors are presented in the brackets.
5) * significant at 10%; ** significant at 5%; *** significant at 1%.

currently living outside their place of household registration and examine how house price affects each subsample. Table 6 gives the regression results for migrant population and non-migrant population.

When we do not distinguish between urban and rural residents, house price still has a significantly negative effect on non-migrant population, which is similar to previous results. Moreover, the effect of house price on migrant population is also similar (the coefficient is slightly larger). However, when we take into consideration the types of region, the coefficients for non-migrants in downtown, town or rural regions shift to −0.0117, −0.0080 and − 0.0053 and are all statistically significant in the three specifications; whereas only that for migrants in downtown areas remains statistically significant (−0.0090), the other two estimated coefficients for migrant population are not significant (probably because migrant population is small in towns and rural regions). It seems that house price has a somewhat stronger effect on non-migrants, especially for them in downtown areas.

What are the respective sizes of the endowment effect and price effect of house price on reproductive probability? To answer this question, we divide the sample by house ownership type. In Table 7, we first break the sample down to three subsamples of non-homeowners, owners of self-built homes, and owners of purchased homes, and analyze the effect of house price on each subsample. Columns 1–3 show that for non-homeowners and owners of self-built homes, increase in house price significantly reduce women's reproductive probability. However, the effect is much smaller and statistically insignificant for owners of purchased homes. This implies that on average, the endowment effect of house price increase should be smaller than the price effect, but not by much.

By introducing the interaction between house price and the type of house owned (i.e., self-built or purchased), we can conveniently compare the effect of house price on individuals with different types of house ownership. The coefficient for house price now indicates the effect on non-homeowners (see Columns 4–7 in Table 7). We can see that house price still has a significant and negative effect on non-homeowners for the full sample and the subsamples for downtown, town and rural areas. The coefficients for the interaction terms between house price and two types of ownership are significant and positive in most cases (except for the interaction term between house price and the dummy for owners of purchased homes with subsample of individuals from town areas, which is positive while statistically insignificant). In addition, price effect is the largest in downtown areas, followed by towns and rural regions. Considering the average level of house price, ownership of self-built or purchased houses more or less offsets the price effect.

Our results obviously deviate from those as aforementioned with data from other countries (many of which are developed ones), which find that fertility responds positively to the increase in home value. One possible explanation is that, Chinese families have to take into consideration the housing for their children in addition to the price effect of housing on themselves. In other words, high house price adds to the burden of parents who not only have to improve their own housing condition, but also provide housing for their children, especially sons so that they may gain more competitiveness in the marital market (Wei & Zhang, 2011).

Moreover, the plummet in fertility rate in China is accompanied by prominently skewed sex ratio at birth (Wang & Guo, 2014). Many scholars contribute this phenomenon to the strong son preference and gender-biased sex selection in China (Liu, 2005). This phenomenon is also argued to intensify the competition among males and cause families with sons to raise savings (Wei & Zhang, 2011), mainly for purchasing house in cities. The possible existence of gender-based selection also means that house price may have different effect on the probability of births of different sex, though the extent and the direction is unclear. On the one hand, parents may lean toward fewer children when the cost of childrearing increases with house price, and thereby heighten existing son preference. On the other hand, son preference may be weakened by house price hikes for the following reason: as the Chinese saying so aptly puts, “sons will *cost* you a fortune, daughters will *make* you a fortune”, Chinese tradition positions houses as a must-have for males on the marital market; higher house price means higher additional cost for raising sons and thereby higher competitive pressure for families of male children, which would lead to diminished son preference. As some literature (e.g., Qian, 2008) notes, income elasticity for sons and daughters may not be entirely the same, if families consider sons as normal goods and daughters luxury goods, and the wealth (income) effect of house price hikes plays a more dominant role than its price (substitution) effect, higher

Table 8
House price and probabilities to have boys and girls (Probit).

	All		Downtown		Town		Rural	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnhp_2	−0.0049***	−0.0005**	−0.0076***	−0.0008	−0.0047**	−0.0006	−0.0033***	−0.0003
	(0.0011)	(0.0002)	(0.0027)	(0.0005)	(0.0023)	(0.0006)	(0.0012)	(0.0002)
Obs.	145,518	145,518	27,945	27,981	26,609	25,486	90,897	90,853

Notes: 1) Here we report the partial effects.
2) Individual-specific attributes include age, education level, hukou status, migration status, and reproductive experience.
3) City-specific attributes include GDP per capita average education level, share of migrants, share of minority nationalities, share of population of marriageable age and regional dummy.
4) The standard errors are presented in the brackets.
5) * significant at 10%; ** significant at 5%; *** significant at 1%.

house price may be associated with higher family demand for daughters. Therefore, we seek to capture this difference by dividing the sample into subsamples based on the gender of children.

As the results in Table 8 show, for the full sample and the subsamples of downtown, town and rural areas, the effect of house price increase on the reproductive probability is mainly manifested on the births of boys. Increase in house price does not have significant impact of the births of girls. These results show that the demand for sons decreases as house price increases, which is consistent with the theoretical prediction of Edlund (1999). Edlund noted that despite son preferences in some developing countries, marital stress as a result of skewed sex ratio would tilt the preference of impoverished families toward raising daughters. In China, owning a house is usually a precondition for marriage and the burden of house purchasing is more often than not shouldered by the parents of the sons; as the estimated coefficients for effects of house price on probabilities to have sons are negative and statistically significant in all specifications, whereas those for having daughters are only statistically significant in the full sample and the absolute value of the estimation is much smaller. Therefore, increase in house price put more burden of future house purchasing on boys' parents and consequently reduce the willingness for families to have boys.

Change in house price not only affects the reproductive probability of married women, but also the age of marriage. Existing research shows that delayed marriage could lead to low fertility rate, so marriage postponement could be a main factor through which house price influence women's fertility. As such, we include both unmarried individuals and male individuals in the sample to investigate the effect of house price on the age of marriage. Results reported in Table 9 suggest that a 1% increase in house price causes men and women to delay marriage by 0.26 and 0.16 years, respectively. In other words, if house price doubles, men and women would each postpone marriage by 2.6 and 1.6 years. Apparently, women are less influenced than men by house price increase in terms of the average age at which they marry, and the finding is consistent with Wei and Zhang (2011)'s conclusion that increase in house price affects families with sons more than families with daughters in a population with distorted sex ratios. Analysis only with downtown subsample also confirms the above findings, and the estimated effects (as shown in Columns 4 and 5) of house price on marriage age for men and women are even larger.

Furthermore, increase in house price may also delay the reproductive age of married women. We estimate such effect on married women with children for the full sample and the subsample of women in downtown areas. Results are shown in Column 3 and 6, respectively. We find that house price increase significantly delays women's reproductive age, especially for those from downtown regions. On average, a 1% increase in house price would make married women to postpone their reproductive age by 0.35 and

Table 9
House price, age of marriage, and age of reproduction (OLS).

	Full sample			Downtown sample		
	Age of marriage-male	Age of marriage-female	Age of reproduction	Age of marriage-male	Age of marriage-female	Age of reproduction
	(1)	(2)	(3)	(4)	(5)	(6)
lnhp_2	0.2573***	0.1563***	0.3513*	0.3749***	0.2602***	0.7227*
	(0.0715)	(0.0572)	(0.1950)	(0.0958)	(0.0988)	(0.4011)
Obs.	112,304	112,732	7754	20,064	22,803	2180
R-squared	0.0592	0.1307	0.2386	0.0527	0.1856	0.1443

Notes: 1) Of the controlled variables, individual-specific attributes include age, education level, hukou status, migration status, and reproductive experience.
2) City-specific attributes include GDP per capita average education level, share of migrants, share of minority nationalities, share of population of marriageable age and regional dummy.
3) The standard errors are given in the brackets.
4) * significant at 10%; ** significant at 5%; *** significant at 1%.

0.72 years, respectively. As many studies find that postponing childbirth reduces the total number of births, increase in house price influence the total number of children women have through its impact on their age of marriage.

In sum, this section finds that the effect of house price decrease on reproductive probability can be both attributed to the delay in the age of marriage and the practice of sex-bases selective abortions. The latter is confirmed by the finding that house price affects the probability of male births more. It also suggests that house price factors into Chinese families' current housing needs and the needs of buying houses for their children in the future.

4.2. House price and TFR: aggregated data results

In the above analysis, we used micro data to estimate the effect of house price on the reproductive probability of women of different age groups at a certain point of time. How does the increase in house price affect the total number of children born to a woman throughout her lifetime? Without long-term panel data, we have to rely on strong assumptions in order to answer this question. In this section, we use a common method to calculate the TFR and examine the effect of house price on the TFR. It should be noted that this method builds on a strong assumption that the fertility rates of women of different age groups derived from cross-sectional data can represent the fertility rates of a woman throughout her life. Yet the reproductive behaviors of women of the same age at different points of time vary following the change in economic environment. Adjusting reproductive behaviors under the influence of house price change is exactly a case in point. For example, increase in house price could drive down the fertility rate of women within a certain age range and push up their fertility rate in later life. Therefore, the TFR obtained based on cross-sectional data is merely a rough proxy for the total number of children women have over their lifetime. This is something that should be kept in mind when interpreting the empirical findings presented in this section.

Specifically, our regression model is as follows:

$$TFR_{st} = \beta_0 + \beta_1 lnHP_{st} + \gamma X_{st} + \theta_s + \varphi_t + \epsilon_{st} \quad (1)$$

where s indexes region and t year. The TFR for region s in year t is denoted by TFR_{st} and the natural logarithm of the average house price is denoted by $lnHP$. The set of city-specific controlled variables, including the logarithm of GDP per capita the share of non-migrant (migrant) population, the share of ethnic minority population, and the share of population of marriageable age is represented by X. The θ_s are regional fixed effects, φ_t are year fixed effects, and ε_{ist} are residuals. Model (1) therefore is a fixed-effect model with variables that control for city-specific characteristics.

First, we estimate the TFRs for each city based on the full sample of women of reproductive age in urban areas and use them as the dependent variable. For the purpose of comparison, we first apply the OLS regression while controlling for provincial and year dummies. The results are listed in the first three columns of Table 10.

In the first column, we only control for provincial fixed effects and year fixed effects. As the results show, one unit increase in the natural logarithm of house price corresponds to 0.24, or 16% reduction in women's TFR. In the second column, we control for GDP per capita, the share of migrant population, the share of minorities and the average education level. The coefficient for house price in the natural logarithm is still statistically significant, though the magnitude changes from −0.24 to −0.16. Meanwhile, the coefficients for the share of minorities and the average education level are significant and have signs as expected, coefficients for the other two variables are insignificant. In Column 3, we control for the TFR of 2000, of which the estimated coefficient is statistically

Table 10
House price and fertility rate at city level.

	OLS			FE	
	(1)	(2)	(3)	(4)	(5)
lnhp_2	−0.2402***	−0.1609***	−0.1477***	−0.2336***	−0.2510**
	(0.0408)	(0.0462)	(0.0484)	(0.0744)	(0.1060)
tfr_00			0.2012***		
			(0.0460)		
lngdp_p_city_2		−0.0214	−0.0196		−0.0824*
		(0.0236)	(0.0249)		(0.0493)
migrant_avg_city		−0.0011	0.0000		0.0028
		(0.0017)	(0.0017)		(0.0035)
minority_avg_city		0.3333***	0.3075***		0.1576
		(0.0895)	(0.1131)		(0.2829)
edu_avg_city		−0.2471***	−0.2516***		−0.1412
		(0.0721)	(0.0835)		(0.1288)
2010.year	−0.0440	−0.0209	−0.0378	−0.1283	−0.0690
	(0.0378)	(0.0404)	(0.0432)	(0.0789)	(0.0911)
Province FE	Yes	Yes	Yes	–	–
Obs.	590	590	546	590	590
R-squared	0.4190	0.4403	0.4589	0.3781	0.3992

Notes: 1) The standard errors are given in the brackets.
2) * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 11
Effect of house price on the TFR of different population groups (FE).

	TFR-boys	TFR-girls	Non-migrant population	Migrant population
	(1)	(2)	(3)	(4)
lnhp_2	−0.1697**	−0.0744	−0.2470**	0.0692
	(0.0753)	(0.0676)	(0.1038)	(0.4393)
lngdp_p_city_2	−0.0674*	−0.0172	−0.1173**	0.2339
	(0.0353)	(0.0321)	(0.0467)	(0.2195)
migrant_avg_city	0.0024	0.0003	0.0016	−0.0055
	(0.0023)	(0.0024)	(0.0036)	(0.0155)
minority_avg_city	0.2827	−0.1249	0.0496	−1.4772
	(0.2500)	(0.1979)	(0.2822)	(1.1291)
edu_avg_city	0.0138	−0.1470*	−0.1240	0.1732
	(0.0946)	(0.0848)	(0.1255)	(0.4588)
2010.year	−0.0238	−0.0245	0.0208	−0.2104
	(0.0670)	(0.0552)	(0.0859)	(0.3753)
Obs.	590	590	590	589
R-squared	0.2433	0.2280	0.3298	0.0258

Notes: 1) The standard errors are given in the brackets.
2) * significant at 10%; ** significant at 5%; *** significant at 1%.

significant and positive; besides, the estimations for house price and other controls are quite similar as before.

Significant difference could exist between different prefecture-level cities located within the same province. We use the fixed effect model in Column 4 and 5 when controlling for the effect of time-invariant factors specific to prefecture-level cities. As the results show, the coefficient of house price is −0.23 when attributes other than time fixed effect are not controlled for. However, when these variables are controlled for, the effect of house price actually grows (to −0.25). A likely explanation is that a higher share of migrants often corresponds to an increase in house price and regions with high proportion of migrant population in general have high fertility rates. The negative impact of house price on the TFR is comparatively smaller when the share of migrants is not controlled for and larger (the coefficient is smaller but its absolute value is larger) when controlled for.

Lastly, we estimate the effect of house price changes on the TFR by sex (the number of boys and girls born to a woman over her life course) and by migration status in Table 11. The results first show that per unit increase in the natural logarithm of house price reduces the number of male births by 0.17 and the number of female births by 0.07 (statistically insignificant). This implies that increase in house price may actually help curb sex imbalance caused by prevalent son preference in China. In the same table, we also show the effects of migration status on the TFR. For the non-migrant subsample, the effect of house price increase is similar to those reported in Table 10. For the migrant subsample, however, the effect is statistically insignificant.

5. House price and reproductive intentions

In this section, we use micro data from the CSS database to examine the relationship between house price and families' reproductive intentions. Our model takes on the following functional form:

$$Outcome_{i,j} = \beta_0 + \alpha lnHP_j + \beta X_{i,j} + \varepsilon_{i,j} \quad (2)$$

In this specification, i denotes a given individual in the population, j denotes the city of current residence. *Outcome* stands for a vector of variables reflecting families' reproductive intentions, including the ideal number of children, that of boys, and that of girls. City house price is represented by $lnHP$ and $X_{i,j}$ is a set of variables describing individual and family attributes, which include age, age of the woman (or wife), marital status, education level, party membership, migration status (whether or not a local hukou holder and whether or not the hukou is transferred to the current place of residence), ethnic minority status, personal income (logarithm), other family income (logarithm) and family wealth excluding primary residence (logarithm). Given the reverse causation between families' housing conditions and outcome variables (i.e., families planning to have children may buy house or even big house, and the number of children may affect the price of the house), we use city house price instead of the price of the house a family owns. Additionally, because increase in house price affect families with different housing wealth conditions differently, we include the interaction between house price and the number of houses families own (dummy variable) in our model. This way, the coefficient of house price alone captures the effect of house price on child quantity and fertility intentions of non-home owning families. Table 12 summarizes the key regression outcomes.

In the top panel, we find that higher city house price is associated with lower number of children born to non-home owning families, compared to their counterparts who own more than one house. In Columns 2 and 3, we distinguish between the sex of children and find a negative (positive) association between house price and the number of sons (daughters), though only that for the number of daughters is statistically significant. Specifically, a 1% increase in house price results in 0.17 more girls born per family. The gender gap in births due to house price changes may reflect the effect of marital market. Because houses are traditionally proffered by men as an important asset that signals their marital competitiveness, a rise in house price adds to the burden of families with sons. Consequently, non-home owning families would choose to have more daughters and fewer sons.

Table 12
House price and fertility decisions and intentions.

	Ideal number of children	Ideal number of boys	Ideal number of girls	No gender preference
	(1)	(2)	(3)	(4)
Total				
City house price (logarithm)	0.1580**	−0.0637	0.1740***	0.0229
	(0.065)	(0.0520)	(0.0520)	(0.0981)
Owning one house*logarithm of house price	0.0025	−0.0003	−0.0070	−0.0076
	(0.0059)	(0.0045)	(0.0048)	(0.0046)
Owning more than one house*logarithm of house price	0.0149**	0.0104*	−0.0028	−0.0077
	(0.0065)	(0.0056)	(0.0055)	(0.0064)
Obs.	1302	832	832	1303
R-square	0.13	0.155	0.072	0.07
Migrant population				
City house price (logarithm)	0.2140	0.0808	0.1890	−0.0553
	(0.2630)	(0.1730)	(0.1680)	(0.1560)
Owning one house*logarithm of house price	−0.0113	−0.0077	0.0046	0.0007
	(0.0133)	(0.0207)	(0.0071)	(0.0128)
Owning more than one house*logarithm of house price	0.0018	0.0017	−0.0001	−0.0014
	(0.0245)	(0.0239)	(0.0070)	(0.0163)
Obs.	220	129	129	220
R-square	0.215	0.174	0.237	0.151
Non-migrant population				
City house price (logarithm)	0.1670**	−0.0591	0.1720***	0.0173
	(0.0776)	(0.0625)	(0.0617)	(0.1190)
Owning one house*logarithm of house price	0.0063	0.0036	−0.0113*	−0.0085
	(0.0076)	(0.0068)	(0.0060)	(0.0056)
Owning more than one house*logarithm of house price	0.0187**	0.0139*	−0.0050	−0.0080
	(0.0078)	(0.0081)	(0.0070)	(0.0062)
Obs.	1082	703	703	1083
R-square	0.148	0.178	0.076	0.087

Notes: 1) Controlled variables include personal income, family income, gender of the subject interviewed, age of the woman in the family, marital status, education level, party membership, whether or not holding local hukou, whether or not being born natively, whether or not to be an ethnic minority, and regional dummies.
2) The standard errors are given in the brackets.
3) * significant at 10%; ** significant at 5%; *** significant at 1%.

Next, we group the sample into two subsamples based on residence and hukou registration places, similarly as done before. Corresponding results are presented in the middle and the bottom panels of Table 12, respectively. Among migrant individuals, we find no estimated coefficients with statistical significance, which is possibly due to quite small sizes of the subsamples. As for the non-migrant population, the estimations are quite similar to those in the top panel. That is, families would like to have more children when house price is higher and the positive association is stronger for families with more houses. Besides, compared to those non-home counterparts, the ideal number of sons would be relatively larger whereas that of daughters would be relatively smaller for those home owners.

6. Conclusions

Sustained decrease in fertility rate and increase in house price are two widely discussed topics in China in recent years. Researches show that this phenomenon is not restricted to China, most of the developed countries had similar experience earlier in their development process. Theoretically, because house price could impact family reproductive decision through the dual dimensions of negative price (substitution) effect and positive wealth (income) effect, whether and how it affects family fertility behaviors is undetermined, depending on whether the family owns the house, the conditions of the house, the income elasticity of childrearing, and the substitution elasticity of children, leisure and other consumption goods, among other factors.

Similarly, empirical studies also disagree over whether, how, and how much house price affects fertility decisions. Therefore, an investigation of the effect of house price changes on childbearing behaviors based on the reality in China could provide evidence-based guidance. Furthermore, the focus of the debate on the effect of house price on fertility behaviors lies in whether the exogeneity of change in house price can be captured. China's unique cultural tradition to “build a nest to woo the phoenix” and the housing system reforms implemented in batches and stages across the country have made the change in house price an exogenous shock to childrearing cost and household asset value for most families. From this perspective, empirical evidence from China will supplement literature on house price and fertility.

Using data from the 2005 nationwide population sampling survey, the 2010 national population census, the 2011 Chinese Social Survey, and city statistical year books, this paper chooses house price data aggregated at city level to capture the change in house price exogenous to family or individual decision-making and examines the effect of house price on fertility from multiple dimensions.

Specifically, it first uses individual data and finds that house price negatively influences childbearing likelihood of married women. On average, 1% increase in house price leads to a decrease of 6.4‰ in the likelihood of women delivering births within 12 months prior to the census. The findings are robust to a range of specifications, such as using alternative measures of house price and considering possible bias stemming from endogeneity and poor control group choice. Moreover, inhibitive effect of house price on fertility is found to be more prominent among women aged 30 and under, the group married for 3–5 years, women who have no child and those from downtown areas. Mechanism analysis shows that non-migrants (especially for those currently living in downtown areas) and non-homeowners and owners of self-built homes are the ones that are more likely to lower their reproductive probability due to higher house price. House price increase has a significant and negative effect on male births, but its effect on female births is insignificant. Moreover, increase in house price causes women and men to put off marriage and also delay the reproductive age of married women. It then considers the overall impact of housing wealth on fertility behaviors from TFR, by constructing a panel for fertility rate at city level with data from the 2005 nationwide 1% population sampling survey and the 2010 national population census. The results show that a hike in house price of 1% leads to a decrease of 0.15–0.25 percentage points in TFR; and house price increase has a significant and negative effect on male births while its effect on female births is insignificant. Later, the paper also finds that families in regions with higher house price are more willing to have daughters, whereas those owning more houses tend to have sons.

Our findings may provide some insights into the two much-discussed social topics. On the one hand, although birth control policies play a dominant role in people's reproductive intentions and behaviors, other factors are growing in influence as China undergoes rapid and vast socioeconomic changes. Practices in developed countries show that childbirth policies could serve as a brake when the fertility rate is high, but tend to be ineffective when a shift in people's reproductive attitudes and desires has already occurred. At this point, even the adoption of pro-child birth policies can hardly reverse the downward trend in fertility rate. In addition, identifying the aforementioned other determinants could facilitate the formation of targeted policy for slowing the decline in China's fertility rate. On the other hand, unequal and unfair housing distribution is becoming an increasingly prominent social problem, and soaring house price may further exacerbate the issue. Our analysis suggests that house price hikes are exerting an increasingly larger impact on the Chinese economy and a contraceptive-like effect on the Chinese society. Stabilizing real estate price and bringing house price back to a reasonable range could reduce the pressure on the already falling fertility rate and secure a sustainable future for social and economic development.

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