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Do housing options affect child birth decisions? Evidence from Taiwan

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Abstract
This study aims to empirically test the effects of various housing options, which include renting, owning, living with parents/siblings, living in houses bought by parents and living in staff housing, on fertility decisions of families. This study uses micro-data obtained from the Taiwanese Panel Study of Family Dynamics (PSFD) surveys for the period from 1999 to 2007 to empirically test three hypotheses relating housing options to childbearing decisions. Using families living in rented houses as the control group, we find that homeowners have their first child at an older age, and families living with their parents or sibling become parents at a younger age. The results are robust and consistent after controlling for the district fixed effects and the marriage year fixed effects. We test the housing price shocks on the childbearing decisions for families who were married or bought houses during or after the housing boom period in 1987, and find that the asymmetric housing price effects on fertility decisions are correlated with the marriage event, but not the house purchase event.

Keywords
fertility behaviour, homeownership, housing options, housing price shocks, user costs of housing

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Introduction

In economies with rising education levels, wage rates and female labour participation rates, women either delay childbearing plans or choose to have fewer children. The female labour participation rate has negative effects on fertility rates in many industrialised nations in Western European and American countries. However, the effect of female

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labour participation rate on fertility is relatively weaker in the East Asian economies. In Hong Kong, Yi and Zhang (2010) show that the female labour market activities account for only a 0.52% decline in the fertility rate. They, however, show that housing booms are the dominant factor contributing to a 7.74% decline in the fertility rate.

'Do housing booms affect fertility busts?' The current literature has been inconclusive in explaining the relationships between housing determinants and fertility. Using the cointegration methodology, Yi and Zhang (2010) find housing price has a significant negative effect on fertility rate in Hong Kong. They argue that the result is consistent with the negative income and the compensated substitution hypotheses. However, two issues, if unresolved, may cloud the results. The first issue is related to the endogeneity in housing price and fertility rate, which could influence the direction of causality (Lindh and Malmberg, 2008; Malmberg, 2010, 2012; Mulder, 2006). The second issue concerns the mechanisms via which housing price effects are transmitted into families' childbearing decisions. The literature also shows that three housing-related channels, such as homeownership (tenure), housing type and spatial (housing size), could influence families' decision of wanting to have children (Strom, 2010).

This paper aims to test the causal effects of housing options and housing boom cycles on fertility rates in Taiwan. The household fertility data are obtained from the national surveys known as the Panel Study of Family Dynamics (PSFD) for the period from 1999 to 2007. The PSFD surveys were conducted by the Academia Sinica, the most pre-eminent Taiwanese academic institution, with advice and inputs on the survey design from a team of top demographic and economic scholars including the Nobel Laureate, Gary Becker (University of Chicago) and others. The PSFD project collects data on interactive relationships and behaviours of members in families, and also develops a research agenda to examine if the existing theories of family are applicable to the Chinese society.

The study makes two contributions to the literature on demographics and housing. First, we find significant effects of housing tenure choices on childbearing decisions of families. Our empirical results show that homeowners have their first child at an older age relative to renters, and that families living with parents or siblings became parents at a younger age compared with families living in rented houses. The results are robust and consistent after controlling for the district fixed effects and the marriage year fixed effects. Second, we test if housing price shocks have differential effects on childbearing decisions of families. We sort the samples based on the timing of their marriage and house purchase events, either 'before' or 'after' the housing boom period in 1987, and find differential fertility patterns between families who married before and after the housing boom in 1987. However, we find no evidence to suggest that buying houses during or after the housing boom years causes homeowners to delay childbearing plans.

Past studies on fertility and housing

The causal link between housing and fertility (demographic changes) is a research area that has been relatively underexplored. The research agendas could be broadly divided into two groups. The first group tests the direction of causality of housing and demographic changes. Mankiw and Weil (1989) argue that baby cycles drive booms and busts in US housing markets. However, Mulder (2006) argues that the relationships between housing and demographic changes are two-sided. Lindh and Malmberg (2008), and Malmberg (2010, 2012) find that the

causal effects are time-dependent and cyclical. Malmberg (2010) shows that population aging has stronger impact on housing price in the first decades of the 21st century than in the last decades of the 20th century. Enstrom Ost (2012) observes significant feedback (simultaneity) effects in the relationships between child birth rate and housing prices.

The second group examines how housing market activities are correlated with changing fertility rate and childbearing decisions of families. Yi and Zhang (2010) use macrodata to test the cointegration relationships of housing price, female labour participation rate and total fertility rate. They found that housing price appreciation is the dominant factor causing the low total fertility rate in Hong Kong. Using the US survey data at the Metropolitan Statistical Area (MSA) level, Simon and Tamura (2009) and Clark (2012) find significant spatial variations in the fertility rates. They show that housing rents, as a proxy of user costs of housing, have significant positive effects on female age at the birth of the first child. Sato (2006) and Kulu et al. (2009) find that regional (spatial) variations in fertility rates are correlated with population density and migration in urban and rural areas.

'Do renters and owners behave differently in their preference for a child?' Some studies use micro-level data to examine how heterogeneity in individual behaviours affects child birth decisions. When housing prices and rents are perfectly correlated, high housing price increases financial stresses for both renters and owners. In markets with rising housing prices, owners have to pay higher debt services; whereas, renters pay higher rents for the same living space. However, the literature is muted on the impact of housing-induced wealth effects on child birth decisions between owners and renters. Simon and Tamura (2009) conjecture that weaker housing price effects on fertility are expected in cities experiencing high housing price inflation. However, the hypothesis was not empirically tested in their study.

Housing market effects on child birth decisions are generally channelled through three mechanisms: homeownership (tenure), housing type and dwelling space (housing size) (Mulder, 2006; Strom, 2010). Homeownership rates have positive impact on fertility. In West Germany and the Netherlands, Mulder and Wagner (1998) find that the family's life course consists of a sequence of events, such that the first child birth is conditional on becoming homeowners. Mulder and Wagner (2001) show that more Dutch families make the transition to home ownership before becoming parents than the families in West Germany. When examining the cross-country evidence in the Europe, Mulder (2006) find strong negative correlations between home ownership rate and fertility rate in Italy, Spain and Greece. Mulder and Wagner (1998), Murphy and Sullivan (1985) and Kulu and Vikat (2007) find that housing type could also influence families' fertility rate. They show that families living in detached and terraced houses have the higher propensity to having first child birth relative to families living in apartments. Based on a study of Swedish households, Strom (2010) finds that dwelling size has positive impact on child birth rate.

Yen et al. (1989) find that working mothers having extended family supports as a substitute for childrearing services have more children in Taiwan using data from 1965 to 1980. However, they did not explicitly connect fertility decisions with homeownership. This study aims to fill the two gaps in the literature by testing the effects of different housing options – renters (control) versus families living in other housing options (owning, living with extended families, living in houses bought by parents and living in staff housing) (treatment) on child birth

decisions of families. We also test if owners' child birth decisions change in a rising housing price regime vis-à-vis a stable housing price regime. The structural break in Taiwan housing prices in 1989, which was caused by the expansionary monetary policies of the Taiwanese Central Bank in the late 1980s (Chang and Chen, 2011), is used as a natural experiment to test exogenous variations in homeowners' child birth decisions.

Housing markets and population policies in Taiwan

Housing markets in Taiwan

Taiwan, the Republic of China (ROC), is an island located in the southeastern side of the mainland China. It has a land area of 36,000 m^2, and a population size of approximately 23 million (as of 2010). The average population density of the island is about 639 people/km^2. It is composed of eight cities and 16 counties (see Appendix). The five biggest cities are Taipei, New Taipei City, Taichung, Tainan and Kaohsiung. Taipei is the capital and the administration centre. It is also the largest city with a population of 2.6 million.

Taiwan is an export-led economy that has undergone rapid industrialisation in the post-war period. It has registered a strong economic growth at an annual rate of 9% in 1960s and 1970s, culminating in the peak of 12% in 1987. As the economy matures and consolidates, the growth rate has slowed down in 1990s and thereafter. The strong economic growth has propelled the island into one of the richest countries in the world with its per capita GNP (at current price) increases from US$158 in 1951 to US$21,042 in 2012.[1]

Taiwan has one of the highest homeownership rates of 87.36% as in 2008, mainly because of the government's policies that promote homeownership. In 1999, the Taiwanese government allocated New Taiwanese Dollar (NTD) 150 billion (about US$4.5 billion) from the budget to provide mortgage-interest rate subsidies for the first-time home buyers.[2] As of 2008, the total housing stock in Taiwan was estimated at 7.77 million units, and the average dwelling space was 143 m^2. Based on an average household size of 3.35 persons, the average living space per person works up to be 42.5 m^2 per person (Chang and Chen, 2011).

Driven by the strong economic fundamentals, Taiwanese housing prices have experienced significant growth in the last 40 years from 1973 to 2012. Figure 1 shows that housing prices in Taipei City grew at an average year-on-year rate of 13.6%. Chang and Chen (2011) identify four distinct phases of housing growth in Taiwan: 1972–1974, 1978–1980, 1987–1989 and 2004–2010. The expansionary monetary supply policies in the 1980s underpinned the strong housing price growth from 1987 to 1989. The expansionary macroeconomic policies, which include the relaxation of bank lending to housing sector and the removal of exchange rate control, have attracted large inflows of capital into the housing market. Housing prices increased by an average annual rate of 90.6% in the three-year period from 1987 to 1989. The 1988 growth rate was as high as 147.5%.

Population policies and total fertility rate

In a sharp contrast to the housing price growth, the total fertility rates (TFRs) in Taiwan have sharply declined over the period from 1973 to 2012 (Figure 1). The TFR of Taiwan (per 1000 women population) declined from 7.04 to just above the replacement level of 2.055 in 1984 before hitting an alarming level of 0.895 in 2010. However, the phenomenon is not unique to Taiwan alone. The negative housing price and total fertility rate relationship was also observed in Hong Kong (see Yi and Zhang, 2010: figure 1).

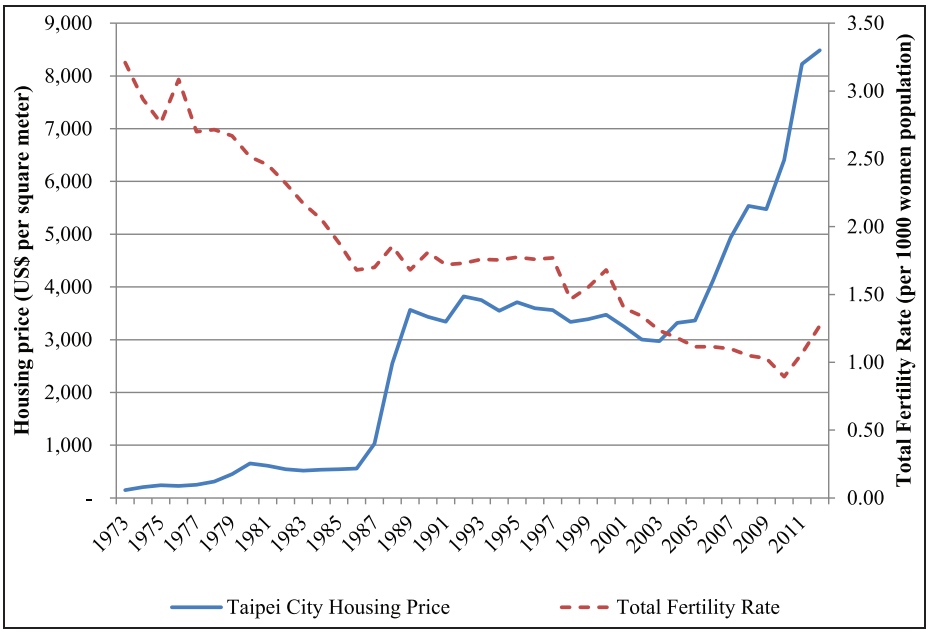

Figure 1. Housing price and total fertility rate: 1973–2012. The figure plots the housing price in Taipei City (green line) and the total fertility rate (red line) for the periods from 1973 to 2012. The Taipei City housing price is used as a proxy of the general housing price trends in Taiwan, because there are no other city-level housing price data that have long enough time-series trends for our illustration.

Source:

1. Data on total fertility rate are obtained from Department of Household Registration Affairs, Ministry of Interior.
2. Data on Taipei City housing price (NT$ per ping) are obtained from Taiwan Real Estate Research Center at National Cheng-chi University, and they are converted into US$/$m^2$ using the exchange rate data from the National Statistics of the Directorate General of Budget, Accounting and Statistics, Executive Yuan, Republic of China (ROC) (Taiwan).

The Taiwanese government has implemented the family planning programmes aimed at restraining population growth between the 1940s and the 1970s. In 1948, the then President of ROC (Taiwan) mandated the establishment of the ROC Rural Rejuvenation Joint Committee. With technical assistance from the USA, the family planning programmes were implemented in three phases: starting from the inception phase from 1949 to 1959, the experimental phase from 1959 to 1964, to the full implementation phase from 1964 to 1969. During the implementation phase, Schultz (1973) and Schultz and Zeng (1995) found that educated female workforce moving out of agricultural sector into non-agricultural sectors and deploying fieldworkers, such as Village Health Education Nurse (VHEN) and Pre-Pregnancy Health Worker (PPHW), to promote family planning are the two factors that were effective in reducing birth rates, especially among older women.

In 1967, a new programme with the slogan [5-3] was introduced to encourage families to have no more than three children. Then, the [3-3-3-1] programme was introduced in 1971 advocating that two children are ideal for a family. After the two decades of family planning programmes since 1964, the TFRs have dropped below the replacement level of 1.855 in 1985.

After effectively implementing the family planning programmes for years, the Taiwanese government reversed for the first time the policies of restraining population growth in 1992. However, the policy reversion did not arrest the declines in the TFR. Recognising the serious implications associated with the continuing declining TFRs, the Ministry of the Interior published a population white paper in 2008. It offered a slew of child birth incentives including cash benefits, childcare subsidies, income tax rebates, free pre-school education, delivery subsidies, parental leave, and payment and housing subsidies, to encourage families to have more children. The TFR fell further to the historic low of 0.895 in 2010, before moving up slightly to 1.27 in 2012.

Data sources

The Panel Study of the Family Dynamics (PSFD) is the main data source used in our empirical analyses. The PSFD surveys were conducted by the Academia Sinica, the most pre-eminent Taiwanese academic institution. Started in 1999, the PSFD survey was established with the intention to study type, structure and pattern of family interactions in Chinese societies. Face-to-face interviews with respondents were conducted in the surveys to collect data on demographic traits, work status, job information, marital status of respondents and their family members. They were also asked questions relating to housing and living arrangement, income and expenditure, and childbearing and rearing activities. The first PSFD survey in 1999 covered a random sample of 999 families born in the years between 1953 and 1964. The 1999 samples constitute the base, and new families were randomly selected from different cohorts (year of birth) and added to the base samples in each subsequent survey. Changes in marital status, child birth, job and other information for the 'base' respondents were also tracked in each survey.

We use only the new samples in the surveys to analyse cross-sectional variations in fertility behaviours of families.[3] The PSFD data collected from the six rounds of surveys conducted between 1999 and 2007 are used, which consist of 4898 respondents born between 1935 and 1982. After dropping 557 samples with missing information and another 1149 samples with incomplete data on housing options, we retain a total of 3192 respondents in our samples. Table 1 shows the distributions, average age, average number of children and marital status of the final family samples.

Of the samples, 83% or 3611 respondents in the 1999, 2000, and 2003 surveys were born between 1935 and 1976. The average ages of the female respondents range between 32.15 years and 52.79 years, and the average ages of the male respondents range between 34.39 years and 56.59 years. The married respondents in the two surveys in 1999 and 2000 constitute about 92% and 98% of the full samples, respectively. These groups of older respondents have an average of 2.27 and 3.17 children, respectively. Younger respondents with average ages of between 24.94 years and 26.06 years were covered in the 2004, 2005 and 2007 surveys.

Measures of fertility rates

Different fertility measures have been proposed in the literature (Clark, 2012; Simon and Tamura, 2009; Strom, 2010; and others). We use the Taiwan's PSFD data to construct three fertility measures to represent cross-section variations in families' childbearing decisions. The three fertility measures include (1) female's age at the first child birth ('ffirstc_age'), (2) duration (in year) from the marriage to the first child birth ('fc_dur')[4], and (3) lifetime fertility of families at the female's age at 45 years and

Table 1. Structure of the Panel Study of Family Dynamics (PSFD) surveys.

Year	Year of birth of primary respondents	Original sample size	Sample used	Average male age	Average female age	Proportion of married respondents
1999	1953–1964	999	830	43.19	39.71	1.00
2000	1935–1954	1960	1597	56.66	52.82	1.00
2003	1964–1976	1152	694	35.59	32.46	0.96
2004	1977–1979	298	34	27.21	25.25	1.00
2005	1980	167	14	28.14	24.64	0.14
2007	1981–1982	322	23	29.50	25.90	1.00
Total		4898	3192			

Note: The table summarises the sample structure of the Panel Study of Family Dynamics (PSFD) surveys conducted by the Academia Sinica of the Republic of China (Taiwan). There were six rounds of surveys conducted in 1999, 2000, 2003, 2004, 2005 and 2007. The year of birth of primary respondents and original sample size are information contained in the PSFD survey. Out of the total sample of 4898 respondents, we use only 3192 after dropping data with missing information. The average age of male and female respondents and the proportion of married respondents are computed from the final sample retained in our analyses.

above ('childno').[5] From the descriptive statistics in Table 2, the average female's age at the first child birth was estimated at 24.82 years, and the oldest first child birth age for the female respondent was at 44 years. The time taken from the marriage to the first child birth for the average Taiwanese families in the sample was 1.748 years. For women at 45 years old and above, the lifetime fertility as represented by the average number of children in the families was estimated at 2.271.

Housing options and timing of housing purchase

Based on the housing options indicated at the point of survey, we group the respondents into five groups, which include (1) renters ('home_rent'), (2) homeowners ('home_own'), (3) families living with parents or siblings ('home_support'), (4) families living in houses bought by parents ('home_gift') and (5) families living in staff housing ('home_work'). We define five binary housing option variables, ['home_rent', 'home_own', 'home_support', 'home_gift', 'home_work], which have a value of 1, if the respective housing option is indicated; and 0 otherwise. Table 2 shows that living with extended families (parents/siblings) is the most common housing option represented by 60.8% of the respondents. 20.3% of the samples live in rented housing, 8.8% of them live in owned houses, and 3.9% of them live in houses bought by their parents. The samples living in housing provided by employers constitute only 2.2%. Using the renters as the reference ('control') group, we test if housing options matter in predicting families' childbearing decisions.

We created three time dummy variables to represent the timing of housing purchase and the marriage events, with particular reference to positive housing price shocks in 1987. For the homeowners, 'home_own' = 1, we identify the timing of housing purchases using a dummy variable 'buyaft87', which has a value of 1, if he/she bought a house during or after 1987; and 0 otherwise. For married respondents, we use the time dummy, 'marafter87', to identify if a respondent were married in or after 1987 ['marafter87' = 1]; and 0 otherwise. The summary

Table 2. Descriptive statistics.

Variable	Symbol	Mean	Standard eviation	Minimum	Maximum
(A) Fertility measures:					
Female age at the birth of first child	ffirstc_age	24.826	3.717	18.000	44.000
Time from marriage to first child birth	fc_dur	1.748	1.449	1.000	15.000
Number of child/children	childno[a]	2.271	1.806	0.000	10.000
(B) Male and female respondents' characteristics					
Female age	fage	44.298	10.541	19.000	67.000
Female education	fedu	5.403	3.502	0.000	14.000
Female job	fjob_group	4.762	2.577	0.000	8.000
Male age	mage	47.652	11.100	25.000	85.000
Male education	medu	6.001	3.845	0.000	15.000
Male job	mjob_group	4.782	2.430	0.000	8.000
Age gap at marriage	diff_mrage	9.884	20.262	−10.000	95.000
(C) Housing options					
Renting (control group)	home_rent	0.243	0.429	0.000	1.000
Owned house	home_own	0.088	0.283	0.000	1.000
Living with parents/siblings	home_support	0.608	0.488	0.000	1.000
Living in house bought by parents	home_gift	0.039	0.193	0.000	1.000
Living in staff housing	home_work	0.022	0.145	0.000	1.000
(D) Timing of housing purchase/marriage					
Bought house during boom years	buyaft87	0.703	0.457	0.000	1.000
Married during boom years	marriageaft87	0.361	0.480	0.000	1.000
(E) Regional housing price					
Dummy on high housing price cities	tophip	0.184	0.388	0.000	1.000

Notes: The table computes the summary statistics of all the variables used in the empirical analyses. The statistics include variable name, symbol, number of observation, mean, standard deviation, minimum and maximum.

[a]The children number statistics are computed for the female sample who are 45 years and above, and the numbers are based only on children born in the current marriage. The children born in the previous marriage are not counted in the measure.

statistics show that 70.3% of the respondents bought their houses after the housing boom years in and after 1987. For the married respondents, 36.1% of them were married during and after the high housing price periods in 1987.

Other control variables

We obtain the data describing the social and demographic profiles (including age, educational level and job type) of the male and female respondents. Table 2 shows that the average male age (mage) is estimated at 44.336 years, which is higher than the average female age (fage) of 42.171 years. The two categorical variables – 'medu' and 'fedu' represent the education levels of male and female respondents, respectively. There are 15 categorisations for education in the PSFD data (following an ascending order with the largest number indicating the highest level of education): [1 = 'no formal education'; 2 = 'self-study'; 3 = 'primary school'; … ; 13 = 'Bachelor degree'; 14 = 'Master degree'; 15 = 'PhD']. The summary statistics (Table 2) show that the average education level of the male respondents of 5.877 was higher than that of the female respondents (5.151). The PSFD records the job type of respondents using the four-digit job codes. We use the first digit of the PSFD job codes to sort the job type into nine categories. The job types were not significantly

different between the female respondents (3.501) and the male respondents (3.519).

The average age gap between husbands and wives at the year of marriage is estimated at 9.884 years. We obtain the housing price to income ratio ('hpi') data by city/county from the Construction and Planning Agency Ministry, ROC, and use the dummy variable 'tophip' to identity the top 20th percentile regions (four regions) by 'hpi', where ['tophip' = 1 for New Taipei City, Taipei City, Taichung City and Hsinchu County; and 0 otherwise].

Empirical methodology and design

Testable hypotheses

Yi and Zhang (2010) show that high housing prices significantly dampen the fertility rate using time-series data in Hong Kong. Their results are consistent with the negative income and compensated substitution hypotheses proposed in the Beckerian fertility model (Becker, 1992). Many studies in Western Europe and America find close correlations between housing and childbearing decisions. The objectives of our study are two-fold: (1) to test various mechanisms through which housing activities (demand for space) influence fertility (demand for children); and (2) to test if families' childbearing decisions are adversely affected in a high housing price regime using the structural break in Taiwanese housing price cycle in 1987 as a natural experiment.

For the objective (1), we revisit the three testable hypotheses linking housing options to fertility decisions. Using the renters as the control group, we use families' alternative housing options as the treatments to test if different housing mechanisms drive their childbearing decisions. First, we test if economic benefits of homeownership, such as wealth effects, quality of dwelling space and security of tenure (Mulder, 2006; Mulder and Wagner, 1998, 2001), represented by families living in owned home ('home_own') could improve childbearing decisions. Second, we test the opportunity cost hypothesis as found in Yen et al. (1989) that families living with extended families (parents and siblings) have higher utility in childbearing and lower opportunity costs in childrearing relative to renters. Third, we test the compensated substitution story as argued by Yi and Zhang (2010) by comparing childbearing decisions of families with low (near zero) user costs of housing (living in houses bought by parents and staff housing) vis-à-vis families with fixed housing consumption costs (renters).

Our second objective (2) is to test the asymmetric effects of booms and busts in housing cycles on fertility decisions. We use two event dummies defined around the structural break in Taiwanese housing prices in 1987[6] to test temporal variations in fertility. The first event dummy, 'buyaft87', identifies families who bought their house during and after the housing boom in 1987; and the second event dummy, 'marriageaft87', identifies families that married during and after the housing boom in 1987. The two event dummies, if significant and negative, could infer that high housing price pressure reduce fertility rates.

Model specification

The fertility behaviours are represented by the three outcome variables, [y_i = 'ffchild_age', 'fc_dur', 'childno']. The fertility regression models are specified as follows:

$$y_i = \alpha_i + \boldsymbol{X}_i\beta_i' + \sum_{k=1}^{4} \delta_k HOME(k)_i + \lambda_i + \tau_t + \varepsilon_i \quad (1)$$

where $\boldsymbol{X_i}$ is a vector of demographic and social characteristics of the respondents, which include education level, ('g'edu), job

type, ('g'job), where [g = (male, female)], and age gap between wife and husband at marriage ('diff_mrage'). A high price city/county dummy ('tophpi'), representing the four most expensive areas, (New Taipei City, Taipei City, Taichung City and Hsinchu County), is included to control for housing price variations. HOME$(\phi)_i$ is a vector of treatment variables identifying different housing options of the respondents i, where [k = ('home_own', 'home_support', 'home_-gift', 'home_work')]; such that the renting option, ('home_rent') is used as the control group. If δ_k is statistically different from zero, we expect fertility behaviours of families living in alternative housing options to be significantly different from those living in rented houses. We include the county/city fixed effects, λ_i, to control for unobserved spatial variations in the 24 counties/regions (see Appendix), and the year of marriage (time) fixed effects, τ_t, in the model. α_i, β_i, and δ_i are the regression coefficients, and ε_i is an *i.i.d.* error term.

The previous literature has not examined the asymmetric effects of high housing prices on fertility rate. We test if high housing prices in and after 1987 could influence fertility behaviours of homeowners and also married couples. Two conditional event variables, ('eventaft87|ϕ'), where [ϕ = (home_owner =1); and (mar_yes =1)], and 'mar_yes' indicates married couples, are added to the model specification:

$$y_i = \alpha_i + \boldsymbol{X}_i\beta_i' + \gamma_{k,i}(eventaft87|\phi)_k + \lambda_i + \tau_t + \varepsilon_i \quad (2)$$

where the first conditional event variable, 'marriageaft87|(mar_yes =1)', has a value of 1, if a couple was married in and after 1987; and 0 otherwise; and the second conditional event variable, 'buyaft87| (home_own =1)' has a value of 1, if a homeowner bought his/her house during or after the boom market in 1987.

Empirical results

Housing options and fertility

The regression results for the fertility models as in equation (1) are summarised in Table 3. The adjusted R^2 for the models on the female's age at the first child birth ('ffirstc_age') (columns 1 and 2), and the lifetime children number ('childno') (columns 5 and 6) were higher than the adjusted R^2 for the models on the time from marriage to first birth ('fc_dur') (columns 3 and 4). The results show the covariates on demographic and age gap at marriage are statistically significant in explaining the female's age at the first child birth. The education levels of the male and female respondents are positively correlated with the female's age at the first child birth. Female and male, who work in the industries that structured and technical skill sets, such as the manufacturing sector, and couples with small age gap at marriage are found to have their first child at an early age. Female's education and male's job type will affect the time from the marriage to having the first child. Couples with higher education levels are likely to have fewer children in their lifetime fertility cycle (45 years and beyond).

The impact of housing on fertility outcomes varies by type of housing options and fertility measures used in the study. Using the renters as the control group, we find that homeowners have their first child at an older age, and the families living with their parents or sibling first become parents at a younger age. The impact of living in houses bought by parents or in staff housing on the first child birth year is insignificant. The results are robust and consistent when the marriage year fixed effects are controlled for in addition to the district fixed effects.[7] In columns (3) and (4), housing factors have no significant impact on time to give birth to the first child after marriage. When we examine the effects on the lifetime fertility for the female

Table 3. Effects of housing options on fertility.

Model	(1)	(2)	(3)	(4)	(5)	(6)
Married?[a]	Yes	Yes	Yes	Yes	Yes	Yes
Female age					≥45 years	≥45 years
Dependent variable	Female age at first child birth (ffirstc_age)		Marriage to first child birth year (fc_dur)		Children number (childno)	
Female education (fedu)	0.318***	0.153***	0.028	0.034	−0.107***	−0.039**
	(0.036)	(0.038)	(0.017)	(0.019)	(0.017)	(0.017)
Female job (fjob_group)	−0.075**	−0.084**	0.020	0.021	−0.014	−0.006
	(0.036)	(0.035)	(0.018)	(0.018)	(0.014)	(0.013)
Male education (medu)	0.070**	0.056*	−0.018	−0.010	−0.038***	−0.034**
	(0.032)	(0.031)	(0.016)	(0.016)	(0.014)	(0.014)
Male job (mjob_group)	−0.086**	−0.132***	−0.051**	−0.044**	−0.000	0.016
	(0.040)	(0.040)	(0.020)	(0.020)	(0.018)	(0.018)
Age gap at marriage (diff_mrage)	−0.248***	−0.235***	−0.010	−0.007	0.007	−0.000
	(0.019)	(0.018)	(0.010)	(0.010)	(0.007)	(0.007)
Owned house (home_own)	1.062***	0.713***	0.009	−0.068	0.225	0.333**
	(0.278)	(0.273)	(0.137)	(0.138)	(0.141)	(0.139)
Living with parents/siblings (home_support)	−0.496***	−0.573***	−0.043	−0.106	0.320***	0.245***
	(0.178)	(0.176)	(0.087)	(0.088)	(0.075)	(0.073)
Living in house bought by parents (home_gift)	0.572	0.269	0.271	0.188	0.231	0.118
	(0.375)	(0.366)	(0.180)	(0.181)	(0.228)	(0.219)
Living in staff housing (home_work)	0.275	0.199	0.464	0.300	0.046	−0.052
	(0.518)	(0.510)	(0.261)	(0.261)	(0.210)	(0.205)
Dummy for high housing price cities (tophip)	1.705***	1.268**	0.374	0.451	−0.352**	−0.208
	(0.526)	(0.515)	(0.302)	(0.302)	(0.176)	(0.169)
Constant	22.903***	23.503***	1.697***	2.110**	3.941***	2.381**
	(0.656)	(3.052)	(0.358)	(1.067)	(0.245)	(1.092)
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Marriage year fixed effects	No	Yes	No	Yes	No	Yes
Observations	1791	1791	1627	1627	1351	1351
R^2	0.330	0.404	0.030	0.086	0.177	0.288

Notes: The table shows the results of the regressions. The dependent variables include the female's age at the first child birth ('ffirstc_age'), the time from marriage to first child birth ('fc_dur'), and the number of children for female of 45 years and above ('childno'). The independent variables include education levels of female ('fedu') and ('medu'), job type of female ('fjob_group') and male ('mjob_group') and age gap ('diff_mrage') and the high housing price to income cities/counties ('tophip'). The four housing option variables include owning ('home_own'), living with parents/sibling ('home_support'), living in house bought by parents ('home_gift') and living in staff housing ('home_work'). The control group is the rented housing families. The models include the district fixed effects and marriage year fixed effects.

[a]Only married respondents are included in the analyses.

Standard errors are given in parentheses. ***$p < 0.01$, and **$p < 0.05$.

samples of 45 years and above, we find that families living in owned house and those living with parents and siblings have more children than those living in rented houses.

The above results provide useful explanations to the three housing-related hypotheses discussed in section 'Testable hypotheses'. First, our results show that economic benefits associated with homeownership, such as wealth, tenure security and better quality of space, encourage homeowners to have more children at the lifetime fertility cycle than renters. However, the high user costs of owning houses delays the first child birth age of females. Second, we find evidence that family supports when living with parents and/or siblings increase the fertility rate, in terms of having the first child at a younger age and also more children at the end of the fertility cycle. The results support the opportunity cost hypothesis of Yen et al. (1989). Third, unlike the negative relationships between housing's user costs and fertility predicted by the compensated substitutions hypothesis, we find no significant variations in the fertility behaviours of families with low (zero) user costs of housing (living in houses bought by parents or subsidised staff housing) vis-a-vis families, who consume part of their income for housing rents.

Cohort effects

In an early study, Schultz (1973) shows that the family planning programmes implemented since 1964 have been effective in reducing fertility rate in Taiwan. We hope to find more evidence to test if the early family planning programmes and public campaigns in 1967 and 1971 have influenced the links between housing options and fertility rates. Based on the birth year of the primary respondents, we sort the samples into two distinct cohorts: (1) between 1935 and 1964; and (2) between 1964 and 1976.[8] The first cohort (1935–1964) was directly impacted by the fertility control programmes since 1964. The second cohort (1964–1976) consists of families born during the implementation phase. The marriage and childbearing activities of these families may have occurred at the end of the family programmes and campaigns in 1980s. The family planning programmes are expected to have the least, if any, effects on the housing and fertility links for this cohort.

The results in Table 4 show that housing options only affect the first child birth age of females, who were born between 1935 and 1964. The results for this older cohort are consistent with those found in the main results in Table 3. Homeowners and families living with parents and/or siblings, who were born before and have lived through the population control regime in the 1960s and 1970s, are more likely to have different fertility behaviours than families living in rented houses. For this older family cohort, owning a home delays the first child birth years relative to renters. However, for these older families who live with parents and/or siblings, they had their first child earlier relative to families in the same cohort but living in the rented houses. The cohort effect is consistent with the age structure effects on housing demand and fertility rate argued by Malmberg (2010, 2012).

Housing booms and fertility

The second objective of the paper is to test if sharp increases in housing prices in the boom market have impact on fertility decisions of families in different housing options. We use the event dummy variable year, ('marriageaft87| mar_yes =1'), to identify couples who married in and after the 1987 housing booms years in Taiwan (Chang and Chen, 2012), and compare their fertility behaviours with those who married before 1987 (the control group). The results in Table 5 show that for couples married before the housing

Table 4. Cohort effects of housing options on fertility.

	(7)	(8)	(9)	(10)
Married[a]	Yes	Yes	Yes	Yes
Survey wave	1999 & 2000		2003	
Cohort[b]	1935–1964		1964–1976	
Dependent variable	*Female age at first child birth (ffirstc_age)*			
Female education (fedu)	0.340***	0.142***	0.219***	0.139
	(0.043)	(0.043)	(0.078)	(0.077)
Female job (fjob_group)	−0.023	−0.046	−0.291***	−0.217***
	(0.042)	(0.039)	(0.075)	(0.075)
Male education (medu)	0.080**	0.060	0.054	0.018
	(0.037)	(0.034)	(0.071)	(0.070)
Male job (mjob_group)	−0.076	−0.103**	−0.059	−0.066
	(0.048)	(0.045)	(0.079)	(0.078)
Age gap at marriage (diff_mrage)	−0.234***	−0.221***	−0.337***	−0.367***
	(0.021)	(0.020)	(0.045)	(0.044)
Owned house (home_own)	1.125***	0.634**	0.697	0.660
	(0.332)	(0.314)	(0.547)	(0.538)
Living with parents/siblings (home_support)	−0.505**	−0.492**	−0.492	−0.430
	(0.204)	(0.192)	(0.406)	(0.405)
Living in house bought by parents (home_gift)	0.604	0.148	0.275	0.252
	(0.478)	(0.449)	(0.624)	(0.615)
Living in staff housing (home_work)	−0.016	0.161	0.519	0.897
	(0.585)	(0.556)	(1.174)	(1.168)
Dummy for high housing price cities (tophip)	1.661***	1.191**	5.358	5.425
	(0.558)	(0.525)	(2.857)	(2.795)
Constant	22.390***	23.054***	21.182***	19.423***
	(0.726)	(3.024)	(2.956)	(4.185)
District fixed effects	Yes	Yes	Yes	Yes
Marriage year fixed effects	No	Yes	No	Yes
Observations	1384	1384	385	385
R^2	0.317	0.441	0.376	0.454

Notes: The table shows the results of the regressions with the female's age at the first child birth ('ffirstc_age') as the dependent variable. The independent variables include education levels of female ('fedu') and ('medu'), job type of female ('fjob_group') and male ('mjob_group') and age gap ('diff_mrage') and the high housing price to income cities/counties ('tophip'). The four housing option variables include owning ('home_own'), living with parents/sibling ('home_support'), living in house bought by parents ('home_gift') and living in staff housing ('home_work'). The control group is the rented housing families. The models include the district fixed effects and marriage year fixed effects.

[a]Only married respondents are included in the analyses.

[b]Cohort is defined based on the year of birth of the primary respondents as indicated in the PSFD surveys. The younger cohort born after 1980 was excluded in the tests.

Standard errors are given in parentheses. ***$p < 0.01$, and **$p < 0.05$.

bubble period, living with extended family members could encourage them to have the first child birth in a younger age relative to the renting option (column 11). The housing options have no impact on the fertility decisions for couples married before the housing boom years (column 12). However, homeownership and supports from extended families have significant and positive effects on the number of children of the couples married in the pre-boom years (column 13). For couples married during and after the housing boom year in 1987, we find that home-owning families have their first child

Table 5. Interactive effects of housing options and marriage during housing boom years.

	(11)	(12)	(13)	(14)	(15)
Married?[a]	Yes	Yes	Yes	Yes	Yes
Married during boom years?[b]	No	No	No	Yes	Yes
Female age			≥45 years		
Dependent variable	Female age at first child birth ffirstc_age	Marriage to first child birth fc_dur	Children number childno	Female age at first child birth ffirstc_age	Marriage to first child birth fc_dur
Female education (fedu)	0.192***	0.033	−0.040**	0.114	0.038
	(0.046)	(0.024)	(0.017)	(0.070)	(0.029)
Female job (fjob_group)	−0.057	0.015	−0.007	−0.110	0.038
	(0.040)	(0.022)	(0.013)	(0.074)	(0.032)
Male education (medu)	0.058	−0.013	−0.033**	0.038	−0.004
	(0.036)	(0.020)	(0.014)	(0.062)	(0.026)
Male job (mjob_group)	−0.098**	−0.062**	0.014	−0.166**	−0.012
	(0.048)	(0.026)	(0.018)	(0.075)	(0.031)
Age gap at marriage (diff_mrage)	−0.201***	0.000	−0.001	−0.300***	−0.022
	(0.021)	(0.013)	(0.007)	(0.039)	(0.017)
Owned house (home_own)	0.296	−0.100	0.328**	1.061**	−0.015
	(0.346)	(0.195)	(0.140)	(0.475)	(0.199)
Living with parents /siblings (home_support)	−0.548***	−0.120	0.243***	−0.578	−0.072
	(0.200)	(0.110)	(0.073)	(0.366)	(0.153)
Living in house bought by parents (home_gift)	−0.100	−0.110	0.111	0.498	0.475
	(0.505)	(0.271)	(0.218)	(0.577)	(0.243)
Living in staff housing (home_work)	0.035	0.275	−0.056	−0.015	0.195
	(0.571)	(0.321)	(0.204)	(1.137)	(0.475)
Dummy for high housing price cities (tophip)	0.958	0.503	−0.211	1.721	−0.208
	(0.531)	(0.341)	(0.169)	(1.861)	(0.777)
Constant	22.295***	2.166	2.407**	26.766***	2.117**
	(3.005)	(1.130)	(1.088)	(2.120)	(0.886)
District fixed effects	Yes	Yes	Yes	Yes	Yes
Marriage year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1237	1086	1340	553	541
R^2	0.360	0.084	0.276	0.312	0.118

Notes: The table shows the results of the regressions. The dependent variables include the female's age at the first child birth ('ffirstc_age'), the time from marriage to first child birth ('fc_dur'), and the number of children for female of 45 years and above ('childno'). The independent variables include education levels of female ('fedu') and ('medu'), job type of female ('fjob_group') and male ('mjob_group') and age gap ('diff_mrage') and the high housing price to income cities/counties ('tophip'). The four housing option variables include owning ('home_own'), living with parents/sibling ('home_support'), living in house bought by parents ('home_gift') and living in staff housing ('home_work'). The control group is the rented housing families. The models include the district fixed effects and marriage year fixed effects.

[a]Only married respondents are included in the analyses ('mar_yes =1').

[b]Based on the dummy 'marriageaft87|(mar_yes=1)', the samples are sorted into two groups, which include respondents who were married before (columns 11–13) or after (columns 14–15) the housing booms in 1987. The number of coupled who were married after 1987 and were 45 years was small, and the lifecycle fertility model for this group is not estimated.

Standard errors are given in parentheses. ***$p < 0.01$, and **$p < 0.05$.

later in their life than families living in rented houses (column 14). The results show that housing options have no direct impact on time between the first child birth and marriage (column 15).

We conduct further tests to evaluate housing boom effects on the fertility rate and marriage event relationship. We use the event variable, 'marriageaft87|(mar_yes = 1)' to identify couples who were married during and after the housing boom period in 1987. We test the effects of the high housing price regime on fertility behaviours of the homeowner group. The results in Table 6 show significant asymmetric effects associated with the housing booms in and after 1987 on the first child birth years (column 16) and the lifetime fertility cycle (column 20) of the home-owning families. We find that homeowners experiencing high housing price periods after marriage have the first child birth later, and fewer children at the end of the fertility cycle (age $\geq$ 45 years) than renters. The effects were stronger for those couples married during and after the high housing price regime. However, the asymmetric effects disappear after controlling for marriage year fixed effects in the models (columns 17 and 21). The high housing prices have no impact on the fertility rate of couples married before and after the housing boom periods (columns 18 and 19).

We next test if the housing purchasing event occurring in the housing boom periods is significant in explaining the variations in fertility decisions of homeowners. We use the second event dummy variable, ('buyaft87|(home_own = 1)'), which has a value of 1 for homeowners who bought their houses in or after the housing boom period in 1987; and 0 otherwise. The results in Table 7 show no significant evidence to support the hypothesis that buying houses during the housing boom periods could affect fertility behaviours. The results imply that the timing of housing purchase, whether a house is bought in the boom or bust cycles of the housing markets, does not affect fertility decisions of home-owning families.

Conclusion

Researchers have found significant evidence supporting causal links between housing market activities and fertility rates (Enstrom Ost, 2012; Kulu and Vikat, 2007; Mulder and Wagner, 1998, 2001; Simon and Tamura, 2009; Strom, 2010; Yi and Zhang, 2010; and others). However, the mechanisms through which the housing effects (via home ownership, housing type and size of dwelling space) are transmitted to fertility decisions of families are still not clear in the literature (Mulder, 2006; Strom, 2010). This study aims to test how housing options could affect fertility rates, which are measured by female's age at the first child birth, time from the marriage to the first child birth, and number of children in the end of the lifetime fertility cycle. We also examine if housing price effects on fertility are asymmetric in the housing boom and bust cycles.

We use the micro-data of Taiwanese families in the PSFD surveys conducted by the Academic Sinica from 1999 to 2007. We tested three hypotheses that connect housing demand with fertility rate. First, using renters as the control group, our results show that homeownership has positive effects on the number of children in families, but negative effects on the female age at the first child birth. Second, we find that families living with parents and/or siblings have the first child birth at a younger age and also more children at the end of the fertility cycle. Third, we find that families with low (zero) user costs of housing (living in houses bought by parents or subsidised staff housing) have no significant variations in fertility behaviours relative to families living in rented houses.

Table 6. Interactive effects of marriage and housing booms on fertility.

Model	(16)	(17)	(18)	(19)	(20)	(21)
Married?[a]	Yes	Yes	Yes	Yes	Yes	Yes
Owned home?[b]	Yes	Yes	Yes	Yes	Yes	Yes
Female age					≥ 45 years	≥ 45 years
Dependent variable	Female age at first child birth (ffirstc_age)		Marriage to first child birth year (fc_dur)		Children number (childno)	
Female education (fedu)	0.298**	0.248	−0.038	−0.044	−0.028	0.004
	(0.119)	(0.144)	(0.045)	(0.059)	(0.070)	(0.110)
Female job (fjob_group)	0.337**	0.309	0.010	0.015	0.062	0.091
	(0.147)	(0.175)	(0.059)	(0.072)	(0.067)	(0.096)
Male education (medu)	0.035	0.065	0.063	0.085	−0.047	−0.024
	(0.114)	(0.135)	(0.043)	(0.056)	(0.060)	(0.093)
Male job (mjob_group)	−0.160	−0.186	−0.004	−0.016	0.049	0.053
	(0.143)	(0.157)	(0.055)	(0.065)	(0.073)	(0.105)
Age gap at marriage (diff_mrage)	−0.252***	−0.201***	0.027	0.029	0.017	−0.045
	(0.055)	(0.070)	(0.024)	(0.033)	(0.022)	(0.035)
Married during boom years (marriageaft87)	2.448***	0.624	0.175	0.519	−1.396***	−1.108
	(0.561)	(5.597)	(0.210)	(1.967)	(0.499)	(2.093)
Dummy for high housing price cities (tophip)	3.170	1.042	0.630	1.106	0.112	1.224
	(1.726)	(2.560)	(0.729)	(1.185)	(0.629)	(1.027)
Constant	19.981***	21.973***	0.476 (0.855)	−1.912	2.971***	4.100**
	(2.111)	(3.946)		(1.899)	(0.817)	(1.589)
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Marriage year fixed effects	No	Yes	No	Yes	No	Yes
Observations	171	171	157	157	76	76
R^2	0.484	0.635	0.330	0.461	0.472	0.738

Notes: The table shows the results of the regressions. The dependent variables include the female's age at the first child birth ('ffirstc_age'), the time from marriage to first child birth ('fc_dur'), and the number of children for female of 45 years and above ('childno'). The independent variables include education levels of female ('fedu') and ('medu'), job type of female ('fjob_group') and male ('mjob_group') and age gap ('diff_mrage') and the high housing price to income cities/counties ('tophip'). The interactive variable 'marriageaft87' has a value of 1, if a respondent was married after the housing booms in 1987; and 0 otherwise. The models include the district fixed effects and marriage year fixed effects.

[a]Only married respondents are included in the analyses.

[b]Only homeowners are included in the analyses.

Standard errors are given in parentheses. ***$p < 0.01$ and **$p < 0.05$.

Table 7. Effects of housing price booms on fertility of homebuyers.

	(22)	(23)	(24)	(25)	(26)	(27)
Married?[a]	Yes	Yes	Yes	Yes	Yes	Yes
Owned home?[b]	Yes	Yes	Yes	Yes	Yes	Yes
Female age					≥45 years	≥45 years
Dependent variable	Female age at the birth of first child (ffirstc_age)		Time from marriage to first child birth (fc_dur)		Number of child/ children (childno)	
Female education (fedu)	0.280	0.251	−0.028	−0.025	−0.039	0.018
	(0.142)	(0.162)	(0.048)	(0.068)	(0.074)	(0.117)
Female job (fjob_group)	0.280	0.405**	0.054	0.108	0.118	0.148
	(0.173)	(0.198)	(0.062)	(0.084)	(0.072)	(0.102)
Male education (medu)	0.072	−0.007	0.086	0.120	−0.009	−0.014
	(0.136)	(0.154)	(0.046)	(0.066)	(0.065)	(0.113)
Male job (mjob_group)	−0.140	−0.198	0.016	0.036	0.038	0.040
	(0.177)	(0.179)	(0.060)	(0.076)	(0.081)	(0.115)
Age gap at marriage (diff_mrage)	−0.263***	−0.159**	0.016	0.031	−0.004	−0.050
	(0.065)	(0.078)	(0.025)	(0.040)	(0.023)	(0.037)
Bought house during boom years (buyaft87)	0.619	3.800	0.041	−0.142	−0.583	−0.986
	(2.242)	(3.398)	(0.972)	(1.928)	(0.570)	(0.828)
Dummy for high housing price cities (tophip)	3.068	−3.288	0.576	−0.706	0.175	1.425
	(2.243)	(4.601)	(0.966)	(2.742)	(0.737)	(1.158)
Constant	20.844***	16.523***	0.102	−0.375	3.071***	4.788**
	(2.963)	(5.482)	(1.061)	(2.236)	(0.922)	(1.815)
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Marriage year fixed effects	No	Yes	No	Yes	No	Yes
Observations	135	135	123	123	71	71
R^2	0.436	0.705	0.425	0.547	0.436	0.777

Notes: The table shows the results of the regressions. The dependent variables include the female's age at the first child birth ('ffirstc_age'), the time from marriage to first child birth ('fc_dur'), and the number of children for female of 45 years and above ('childno'). The independent variables include education levels of female ('fedu') and ('medu'), job type of female ('fjob_group') and male ('mjob_group') and age gap ('diff_mrage') and the high housing price to income cities/counties ('tophip'). The interactive variable 'buyaft87' has a value of 1, if a respondent bought his/her house after the housing booms in 1987; and 0 otherwise. The models include the district fixed effects and marriage year fixed effects.

[a]Only married respondents are included in the analyses.

[b]Only homeowners are included in the analyses.

Standard errors are given in parentheses. ***$p < 0.01$ and **$p < 0.05$.

We use the two event variables, which use the timing of marriage and housing purchases during and after 1987 housing booms, to test if housing price shocks could have asymmetric effects on fertility decisions homeowners and renters. Our results show that families married in the high housing price regime have the first child birth at an older age, and fewer children at the end of fertility cycle (age $\geq$ 45 years). However, the asymmetric effects disappear after controlling for the marriage year fixed effects. We find buying houses in the housing boom periods has no impact on families' fertility decisions.

One policy implication is that promoting homeownership in countries with high user costs of housing may not be effective in encouraging families to have more children. However, policies targeted at building extended family networks and supports, such as providing monetary incentives and tax rebates to encourage families to live with and near to parents/siblings, are expected to have positive impact on fertility rates.

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Notes

1. Based on the International Monetary Fund (IMF) World Economic Outlook Database-April 2013, the island ranks the 38th richest country in the world by the per capital GDP (nominal) measure as accessed on 16 April 2013.
2. Under the mortgage-interest rate subsidy scheme, qualified first-time home buyers are allowed to take mortgage loans of New Taiwanese Dollar (NTD) of 2 to 2.5 million (about US$60,000 to US$75,800) at a subsidised interest rate of about 0.25% lower than the market rate.
3. The tracked samples are not used because testing temporal effects of the fertility behaviours are not within the scope of the current study.
4. The time taken for the female to have their first child after getting married is defined as ['fc_dur = ffchild_age – mar_age'], where 'ffchild_age' is the female's first child birth age, and 'mar_age' is the female's age at marriage. The child born from the previous marriages were not taken into account in this measure.
5. As young families may not have completed their lifetime fertility, and the number of children is not representative for the young families. In Simon and Tamura (2009), they use the number of children for female who are above 40 years old as the measure of lifetime fertility. In our context, we use 45 years as the cut-off in our proxy for the lifetime fertility.
6. Chang and Chen (2011) show that housing bubbles were formed during the 3-year periods from 1987 to 1989, where the annual average growth rate was estimated at 90.6% in Taipei.
7. As indicated by one of the referees, families in the younger cohort (especially those who were born after 1980) may not have completed the full fertility cycle at the time of the survey. The power of the tests, especially for the first child birth age could bias the results downward by including this cohort of family. We will further test the cohort effects of families by removing the younger families in the next section.
8. The younger cohort of families born between 1980 and 1982 was dropped in the analyses because of the small number of families in this cohort who were married during the PSFD surveys.

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Appendix 1.

List of counties/cities in Taiwan and housing to income ratios.

District code	Region name		2009 Housing price to income ratio
1	New Taipei City	新北市	7.40
2	Taipei City	臺北市	12.27
3	Taichung City	臺中市	7.62
4	Tainan City	臺南市	6.63
5	Kaohsiung City	高雄市	6.59
6	Taiwan Province	臺灣省	n.a.
7	Yilan County	宜蘭縣	5.66
8	Taoyuan County	桃園縣	5.41
9	Hsinchu County	新竹縣	7.74
10	Miaoli County	苗栗縣	7.26
11	Changhua County	彰化縣	6.49
12	Nantou County	南投縣	6.92
13	Yunlin County	雲林縣	7.13
14	Chiayi County	嘉義縣	5.91
15	Pingtung County	屏東縣	5.42
16	Taitung County	臺東縣	5.62
17	Hualien County	花蓮縣	5.88
18	Penghu County	澎湖縣	7.26
19	Keelung City	基隆市	3.86
20	Hsinchu City	新竹市	6.36
21	Chiayi City	嘉義市	6.45
22	Fujian Province	福建省	n.a.
23	Kinmen County	金門縣	n.a.
24	Lienchiang County	連江縣	n.a.

Notes: The table shows a list of regions in Taiwan that are used in controlling for the district fixed effects in the regression models. The 2009 housing price to income ratio (hpi) for each region is used to identify the four most expensive cities in Taiwan, which are represented by a dummy 'tophip' in the regression models.
Source: The Construction and Planning Agency Ministry, Republic of China (ROC) (Taiwan).