The Effect of House Prices on Fertility: Evidence from House Purchase Restrictions

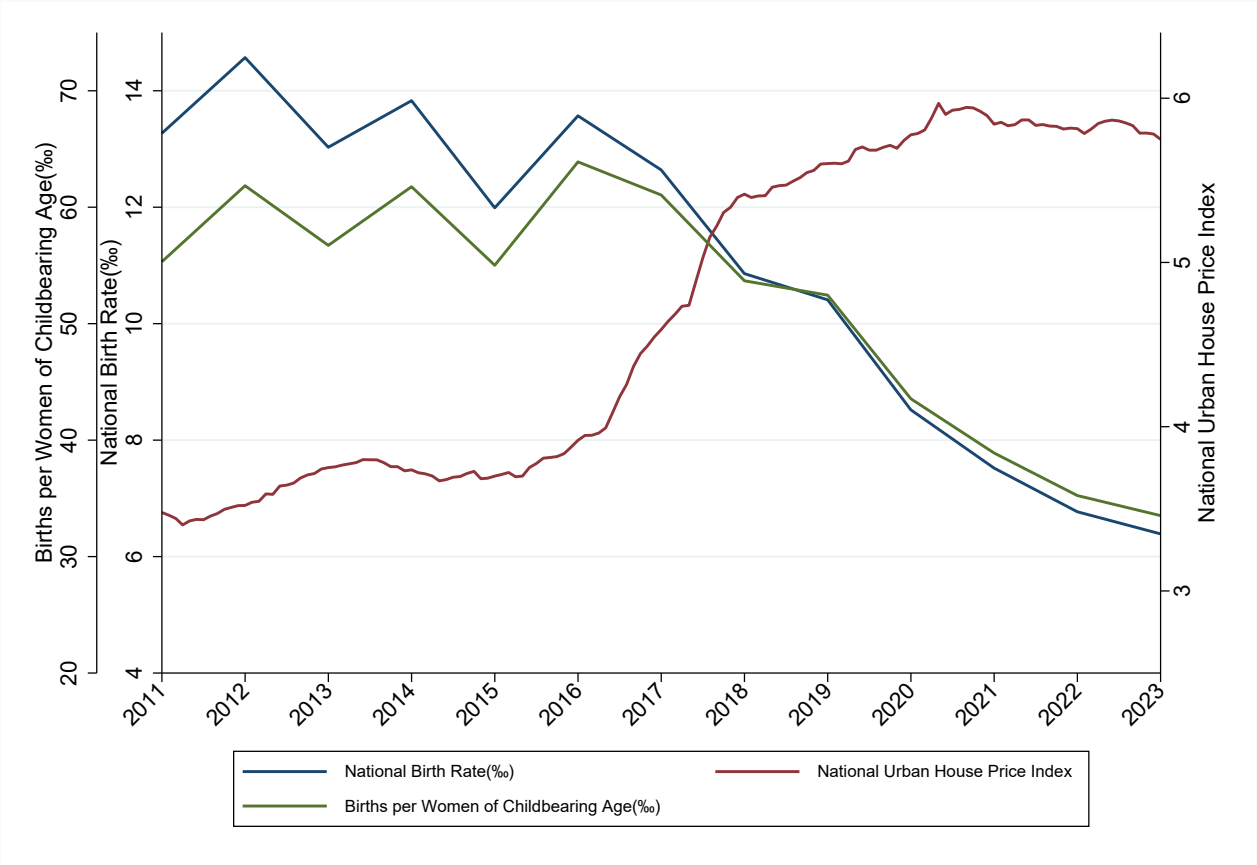
Ziqian Liu[1] Yu Zhang[2]

[1]Foster School of Business, University of Washington, zl17@uw.edu

[2]Guanghua School of Management, Peking University, yuzhang@gsm.pku.edu.cn

Motivation

- The birth rate declined amid a surge in urban house prices in China from 2016 onward.



- Assessing the causal impact of house prices on fertility during this period is **critical yet challenging**.

Motivation

- The birth rate declined amid a surge in urban house prices in China from 2016 onward.
    - urban house prices increased by 54% from 2016 to 2021.
    - raw birth rate dropped by 45%, and the birth rate among women of childbearing age fell by 39% during the same period.
    - this great birth decline sparked concerns of a looming demographic crisis: labor shortages, increased burden of elderly care, slow down economic growth.
    - globally, it could affect global demographics, and shift patterns of economic and political power patterns.
- Assessing the causal impact of house prices on fertility during this period is **critical yet challenging**.

Motivation

- Assessing the causal impact of house prices on fertility during this period is **critical yet challenging**:
  - demographic shifts can influence house prices, which in turn reflect future expectations.
  - the 1st generation of studies directly assumes that indices of local house prices, external to an individual, is exogenous to fertility.
  - the 2nd generation of studies adopt the Saiz (2010) supply elasticity strategy.
  - but superstar cities tend to be inelastic cities. They behave differently (Van Nieuwerburgh and Weill, 2010, Gyourko, Mayer, and Sinai, 2013, Davidoff, 2016).

What We Do

- We use a quasi-experiment, **unintended spillovers from house purchase restrictions**, to estimate the causal effect of house prices on fertility.
  - in 2016, to cool down the overheated housing market, major Chinese metropolises implemented **house purchase restrictions** to curtail local investment purchases.
  - investment demand redirected to nearby unregulated prefectures (**"treated group"**).
  - house prices **increased significantly** compared to farther away unregulated prefectures (**"control group"**).
  - fundamentals did not diverge (**"plausibly exogenous"**).
- We assess **the treatment effect of the house price shock** on:
  (1) the prefecture-level birth rate, (2) individual-level fertility,
  (3) individual-level new marriages, and
  (4) household-level investment on children's education.

What We Find: 1

- The house price shock accounted for a **non-negligible part** of the aggregate birth rate decline.
    - We estimate the policy alone led to 2.46 million fewer births in the nearby unregulated prefectures, accounting for 10.4% of the aggregate reduction in births.

What We Find: 2

- The treatment effect came from a group that is **unexpected** but not surprising.
  - fertility declined for ruralites with no urban homeownership, despite any changes in rents and costs of space.
  - **hard to get married**
    (more salient when competitive).
  - **educational opportunities**
    (more salient when lacking public educ. resources; adapt by increasing private educ. investment on existing children).
- Our results suggest **a new channel** through which house prices impact fertility:
  - by affecting the price of educational resources and marriage market benefits associated with homeownership.
  - not the traditional cost of space channel or wealth effect.

Literature

- Causally estimate real effect of house prices—Here: DiD, investment in children:
  - **consumer spending**: Mian et al. (2013), Aladangady (2017), Guren et al. (2021), Deng et al. (2022), Sodini et al. (2023).
  - **investment**: Chaney et al. (2012), Martin et al. (2021). Qian et al. (2020).
  - **entrepreneurship**: Adelino et al. (2015), Schmalz et al. (2017).
  - **labor productivity**: Berstein et al. (2021), Gu et al. (2021).
- New channel in the interaction between housing and demographics:
  - **effect on house prices**: e.g. Mankiw and Weill (1989).
  - **effect on fertility**: **(–) space cost** e.g. Becker (1960), Yi and Zhang (2010), Clark (2012), Dettling and Kearney (2014), van Doornik et al. (2024). **(+) wealth effect** e.g. Lovenheim and Mumford (2013), Daysal et al. (2021), Ang et al. (2024).
  - **Here: (–) increasing barriers to marriage & restricting access to public education.**
  - **links to competitive savings motive**: Wei and Zhang (2011), Wei et al. (2017).
  - **public v.s. private education and fertility:** De la Croix and Doepke (2003).
- Redistributive, intergenerational mobility aspect of housing market:
  - **upward mobility in "high-opportunity" areas**: e.g. Chetty et al. (2014).
  - **residential decision often before children's birth**: e.g. Heckman and Landerso (2022).
  - **Here: rising homeownership costs in "high-opportunity" areas→ strategic effcts.**

Ruralites and Urban Homeownership in China

- Ruralites **buy urban homes** for **marriage** and **education prospects**:
  - Urban homeownership is crucial.
  - **Marriage prospects**: urban homeownership signals **financial stability** for men in marriage markets.
  - **Education prospects**: quality schools prioritize children based on homeownership within their **catchment areas**.
  - **83%** of rural respondents view urban homeownership necessary for marriage in 2023 survey result by Weibo, Xinhua, WHU, CASS.
  - **17%** of rural vs. 85% of urban subjects own urban homes in our microdata.
- Urban homes are tradable; rural homes are not.
  - Rationale for rural homes' non-tradability: Ruralites are **entitled** to **land for shelter** in village born, a feature not shocked by the quasi-experiment.
  - Jointly they mean that the ruralites with only rural homes are not directly affected in terms of living space costs or wealth effects.
  - Nevertheless, rising urban house prices disproportionately hinder rural residents by increasing barriers to marriage and limiting access to education opportunities.

Background: House Purchase Restrictions

Empirical Strategy: We study the impact of plausibly exogenous spillovers, from the imposition of restrictions on housing asset purchases in certain large Chinese metropolises, on nearby unregulated prefectures.

Origin of the House Purchase Restrictions:

- During 2012-2016, house prices grow at a high speed of 14.9% annually in Tier 1 prefectures, but slower than 3% in Tier 3 prefectures.
- In September 2016 and March 2017, two rounds of policy changes named House Purchase Restrictions were implemented in all Tier 1 and many Tier 2 metropolises to contain surging house prices.

  ▸ list of regulated metropolises
- The policy changes targeted curbing housing market speculators and include:
  - raising down payment requirement to higher levels for 2nd homes
  - outright forbidding the purchase of 2nd, 3rd houses by one family

The Treatment: the HPR spillover shocks

Simultaneous with the imposition of HPRs in the regulated metropolises, the **nearby unregulated prefectures** appeared to experience a sharp increase in home sales and house prices.

- Immediately after 2016m9, house prices and transactions surge in the nearby unregulated prefectures. ▸ examples ▸ volume patterns
- Out-of-town web searches from regulated metropolises for real estate in nearby unregulated prefectures also increase. ▸ search patterns
- We define the **treatment group** as the **nearby unregulated prefectures**.
- We define the **control group** as the **far away unregulated prefectures**.
- We define 2017 as the first full year when house prices in treatment group were impacted.
- We define 2018 as the first full year when fertility in treatment group were impacted, considering the pregnancy period.

The Treatment: the HPR spillover shocks

Treatment designation:

- We define the **treatment group** as the **nearby unregulated prefectures**.
- We define the **control group** as the **far away unregulated prefectures**.

More specifically:

- If a prefecture is within 250 km of a regulated metropolis, then it belongs to the treatment group.
- Otherwise, it belongs to the control group. (Deng et al., 2022)
- Quintessentially, we adopt a spatially heterogeneous treatment effect strategy.
- One concern is the arbitrariness of the 250 km cutoff or the discrete treatment designation. Robustness checks:
    - alternative discrete cutoffs: 300 km, 200 km, or
    - model the treatment effect to decay continuously with distance.

Regression Model

- Because the prefectures are inherently different in distance from the regulated prefectures, the urban literature has shown such initial conditions may predict growth rate differences (Glaeser, Scheinkman, and Shleifer, 1995). Thus, we adopt a difference-in-differences specification that explicitly takes this into account (Wolfers, 2006, and Bilinski and Hatfield, 2019):

$$Y_{i,t} = \sum_{\tau \leq k \leq T} \beta_k \times Treat_i \times \mathbb{I}_{t=k} + \Gamma X_{i,t} + \gamma(i)t + \alpha_i + \delta_t + \epsilon_{i,t}.$$

  The coefficient of interest is the mean of the post-period $beta_k$'s, which measure the average treatment effect after the house purchase restriction spillover shock.The specification imposes little structure on the response dynamics while allowing the estimated group-specific (or prefecture-specific) time trends to identify preexisting trends.

- We also find no evidence that GRP growth, public education expenditures, or number of hospital beds diverge between the treatment and control groups.

- The outcome variable $Y_{i,t}$ can be (1) the prefecture-level birth rate, (2) individual-level fertility, (3) individual-level new marriage, or (4) household-level educational investments.

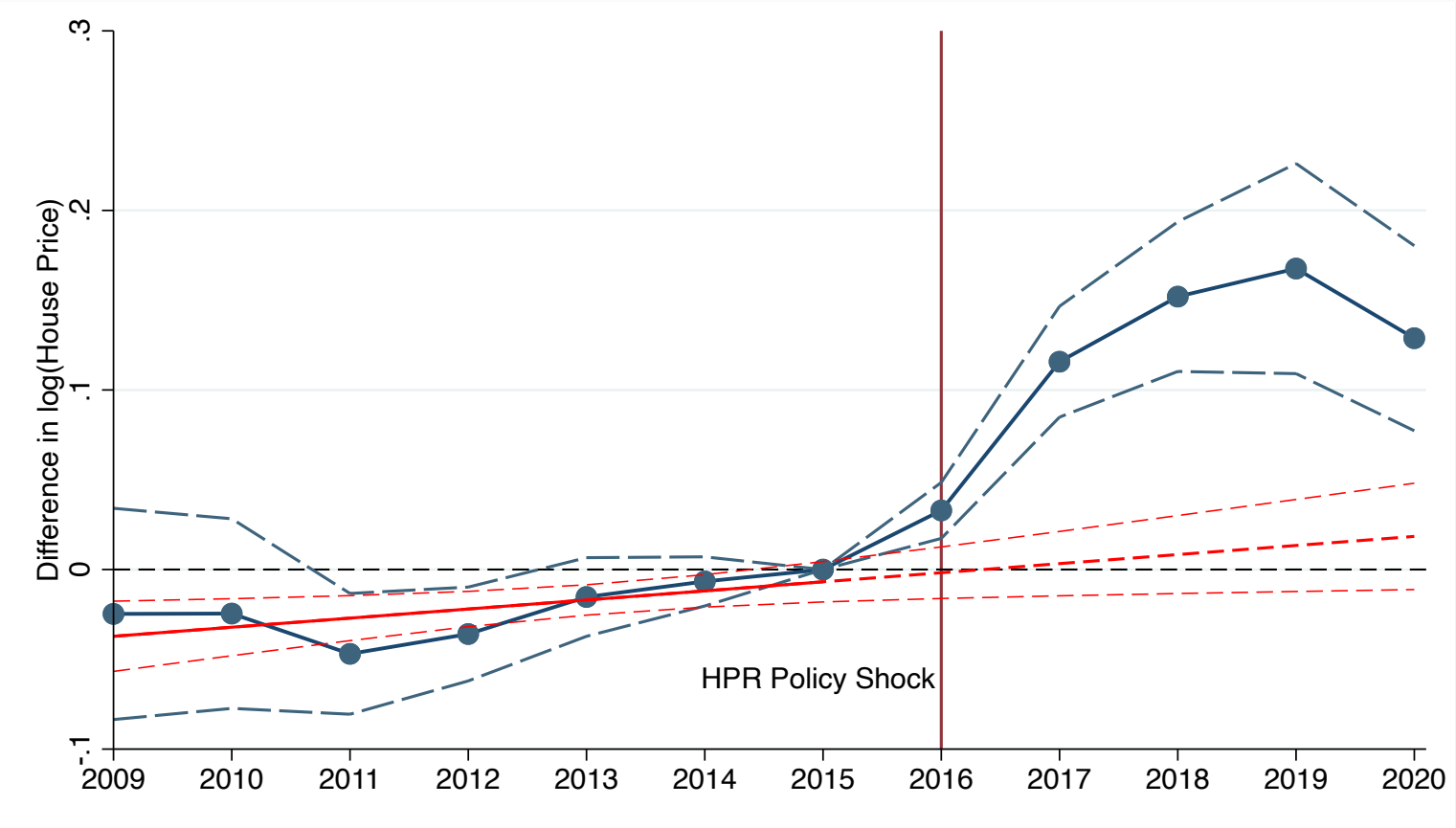
Assessing both prefecture-level and individual-level data

Data sources:

- Prefecture-level:
  - Annual birth rates, scraped from Statistical Communiqués (2009-2021).
  - Prefecture-level urban house price indices from CityRE.
  - Control variables from Prefectural Statistical Yearbooks.
- Micro-level:
  - Data from China Family Panel Studies (CFPS), six waves: 2010, 2012, 2014, 2016, 2018, 2020.
  - Focus on women of childbearing age (15 to 44).
  - Meticulously reconstructed records of births at the annual level.
  - Meticulously reconstructed records of new marriages at the biennial level.
  - Household educational expenditures at the biennial level.
  - Demographic, economic, and social controls include age, education level, marital status, party membership, urban residence, migratory status, health score, housing tenure, per capita family net income, and mortgage debts.

The House Price Shock

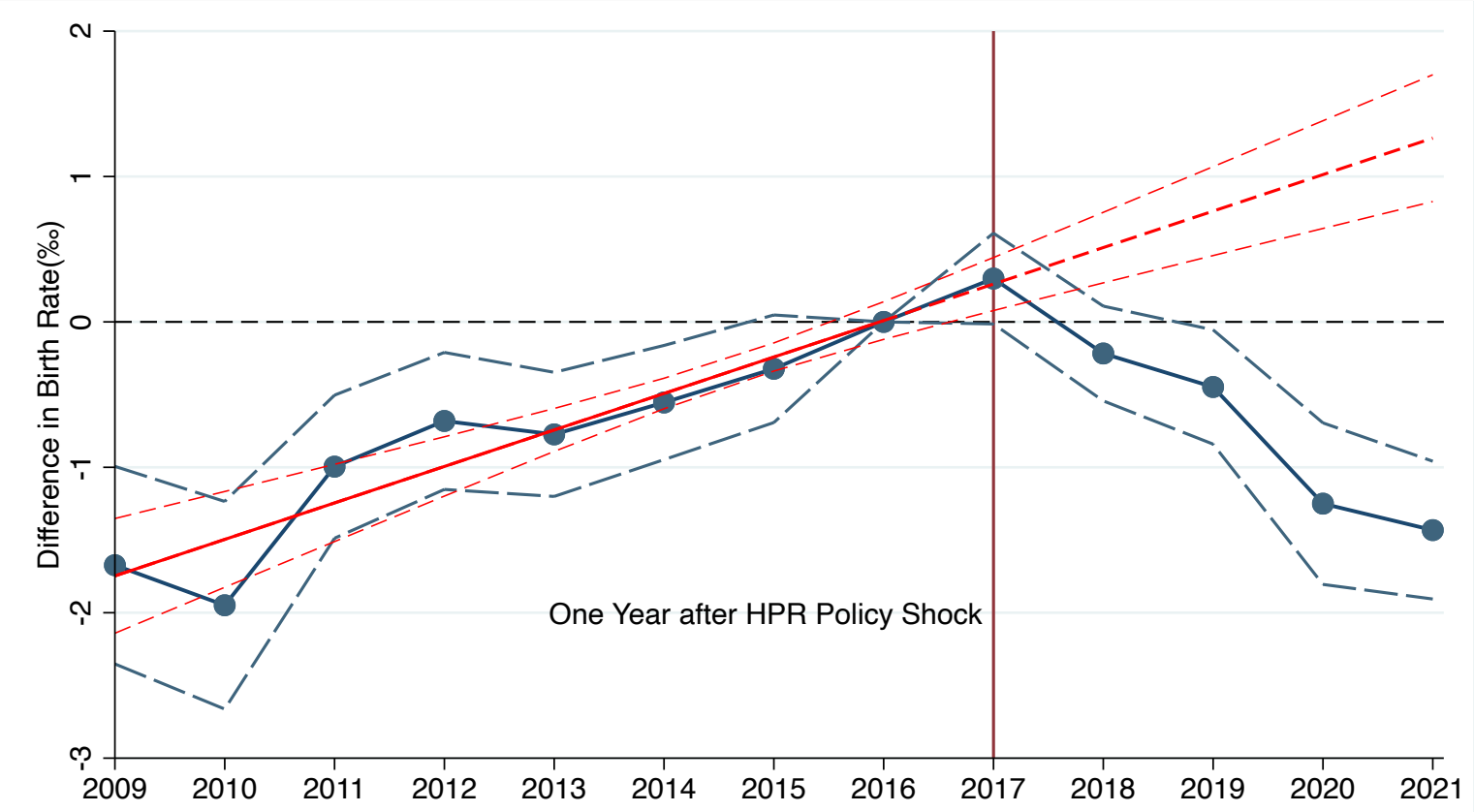
- Urban house prices in treated prefectures (nearby unregulated prefectures) diverged from the trend, shortly after the quasi-experiment—the house purchase restriction spillover shock.
- Urban house price gap between treated and control prefectures:
  - 9% above trend in 2017.
  - 12% above trend in 2018 and 2019.



Average Treatment Effects

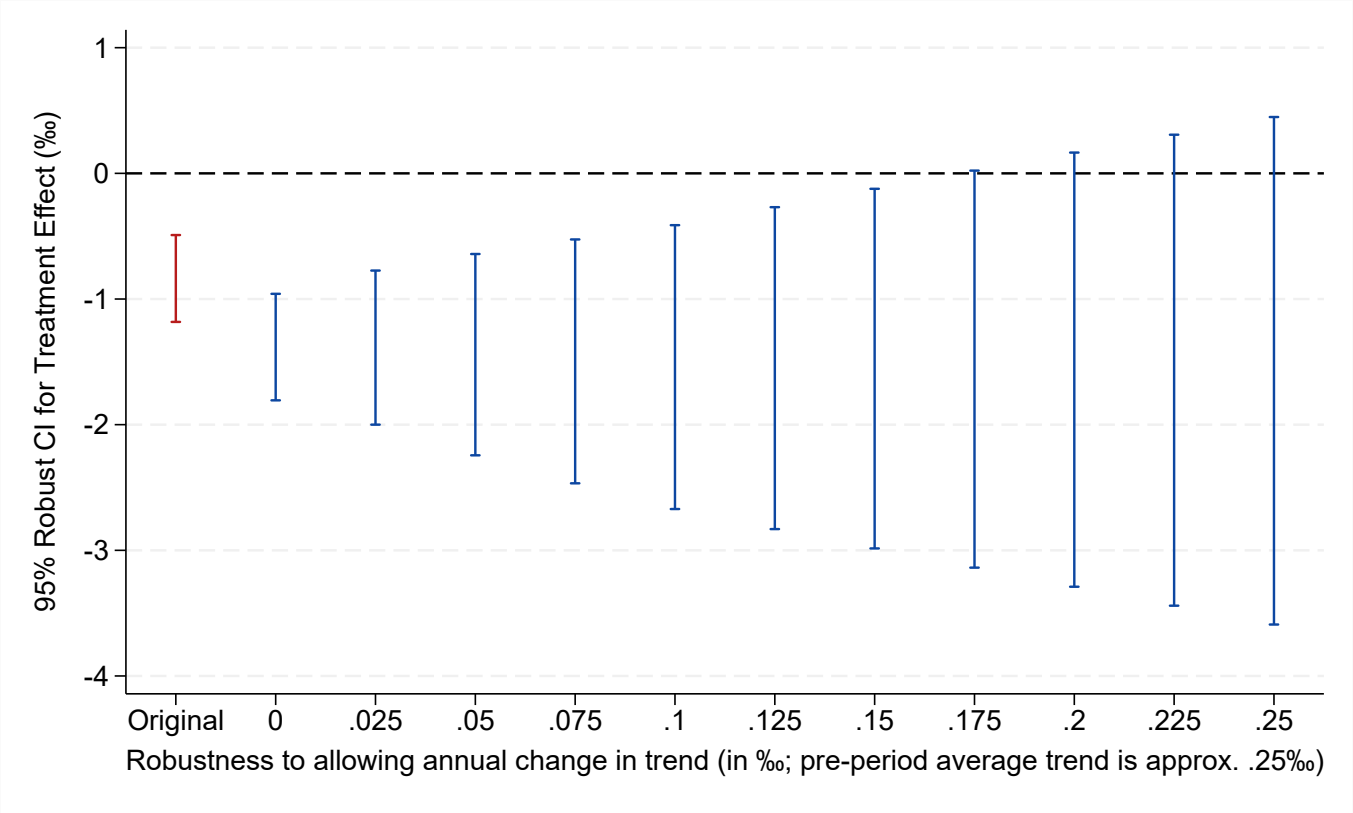
Treatment Effect of House Price Shock on Prefecture-level Birth Rates

- The birth rate in the treated prefectures (nearby unregulated prefectures) diverged from the trend, declining sharply and persistently compared to control prefectures, one year after the quasi-experiment that abnormally increased urban house prices.
- Reduction on average 1–2‰.



Treatment Effect of House Price Shock on Prefecture-level Birth Rates: Pre-Trend Sensitivity Test

- The treatment effect estimate is robust to changes in the group-specific trend in birth rates (Rambachan and Roth, 2023).
- Even allowing the group-specific trend to change annually by a bulk (2/3) of the entire pre-period average trend difference, the treatment effect is significant.



Semi-elasticity of Birth Rates to House Prices

- To sum, birth rate decreased in treated prefectures (95% CI: [-21%,-10%] of sample mean) after the house price shock triggered by house purchase restriction spillovers.
- The semi-elasticity in col. (6) suggests a 10% exogenous house price increase, fundamentals unchanged, reduces the birth rate by 0.876‰.

Table 2: DID Estimated Effects of HPR Spillovers on Birth Rates and House Prices (City-level)

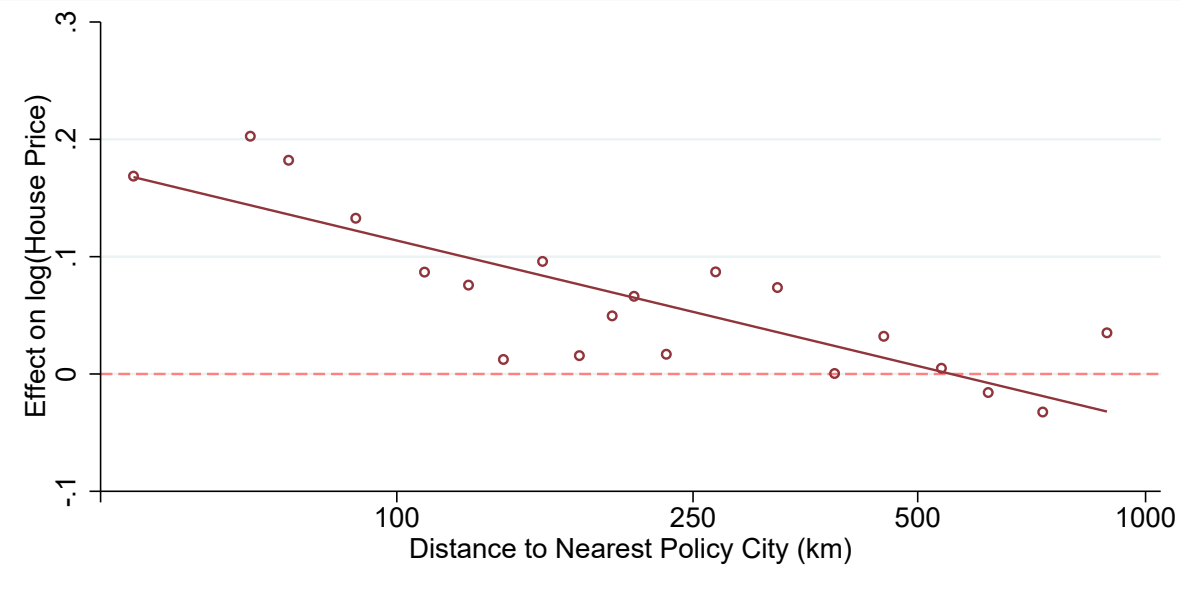
	(1) log(House Price)	(2) log(House Price)	(3) Birth Rate(‰)	(4) Birth Rate(‰)	(5) Birth Rate for the Next Year (IV)	(6) Birth Rate for the Next Year (IV)
Treat × Post	0.138***	0.124***	-1.557***	-1.683***		
	(0.030)	(0.030)	(0.305)	(0.293)		
log(House Price)					-7.099***	-8.760***
					(2.233)	(2.555)
Mean	8.544	8.544	10.723	10.723	8.544	10.723
R^2	0.971	0.940	0.877	0.820	-0.392	-0.540
Observations	2589	2589	2589	2589	2589	2589
City FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
City Trend	yes	no	yes	no	yes	no
Group Trend	no	yes	no	yes	no	yes
City Controls	yes	yes	yes	yes	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

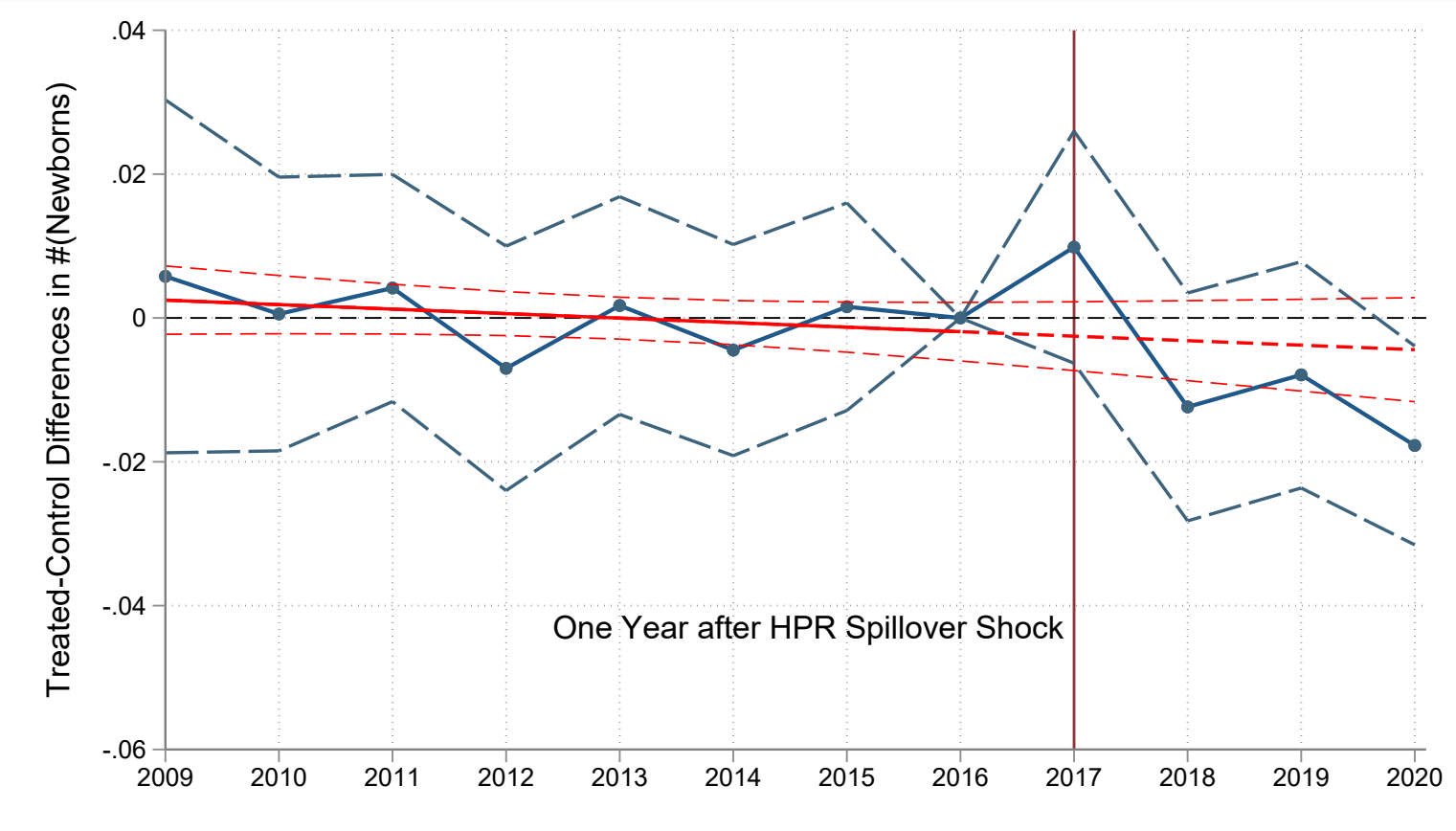
Aggregating treatment effects over unregulated prefectures

- identification assumption: house prices and fertility would have continued along pre-existing trends.
- prefectures within 551 km of a regulated metropolis displayed higher than trend house prices.
- average house price increase 8.4%. combined population 840 million.
- average birth rate reduction 0.73‰ ($= 0.084 \times -8.76$).
- birth shortfall of 2.46 million babies (0.73‰$\times$ 840 million $\times$ 4 years).



Fertility reduction consistent in the microdata

- Among the CFPS panel individuals (women of childbearing age), the number of newborns also decreased (95% CI: [-76%, -6%] of sample mean, overlapping with the prefecture-level CI) in treated prefectures after the house price shock triggered by house purchase restriction spillovers.



Fertility reduction consistent in the microdata

- Among the CFPS panel individuals (women of childbearing age), the number of newborns also decreased (95% CI: [-76%, -6%] of sample mean, overlapping with the prefecture-level CI) in treated prefectures after the house price shock triggered by house purchase restriction spillovers.

Table 3: DID Estimated Effects of HPR Spillovers on the Number of Newborns (Individual-level)

	(1) Newborns	(2) Newborns	(3) Newborns	(4) Newborns
Treat × Post	-0.023**	-0.026**	-0.022**	-0.025**
	(0.010)	(0.010)	(0.010)	(0.011)
Mean	0.061	0.061	0.061	0.061
R^2	0.041	0.037	0.045	0.042
Observations	80177	80177	80177	80177
Individual FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Prefecture Trend	yes	no	yes	no
Group Trend	no	yes	no	yes
Individual Controls	no	no	yes	yes
Family Controls	no	no	yes	yes

Standard errors in parentheses

$^{*}\ p < 0.1,\ ^{**}\ p < 0.05,\ ^{***}\ p < 0.01$

Fertility reduction consistent under alternative distance cutoffs

(a) DID robustness check of using alternative distance cutoff: 200 km

	(1) log(House Price)	(2) log(House Price)	(3) Birth Rate(‰)	(4) Birth Rate(‰)	(5) Newborns	(6) Newborns
Treat×Post	0.151***	0.142***	-1.349***	-1.454***	-0.020*	-0.022**
	(0.029)	(0.029)	(0.324)	(0.310)	(0.010)	(0.010)
Mean	8.544	8.544	10.723	10.723	0.061	0.061
R^2	0.971	0.940	0.875	0.819	0.045	0.042
Observations	2589	2589	2589	2589	80177	80177
Prefecture FE	yes	yes	yes	yes	no	no
Individual FE	no	no	no	no	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Prefecture Trend	yes	no	yes	no	yes	no
Group Trend	no	yes	no	yes	no	yes
Prefecture Controls	yes	yes	yes	yes	no	no
Individual Controls	no	no	no	no	yes	yes
Family Controls	no	no	no	no	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(b) DID robustness check of using alternative distance cutoff: 300 km

	(1) log(House Price)	(2) log(House Price)	(3) Birth Rate(‰)	(4) Birth Rate(‰)	(5) Newborns	(6) Newborns
Treat×Post	0.160***	0.142***	-1.564***	-1.610***	-0.021**	-0.023**
	(0.030)	(0.030)	(0.305)	(0.291)	(0.011)	(0.011)
Mean	8.544	8.544	10.723	10.723	0.061	0.061
R^2	0.971	0.940	0.877	0.819	0.045	0.042
Observations	2589	2589	2589	2589	80177	80177
Prefecture FE	yes	yes	yes	yes	no	no
Individual FE	no	no	no	no	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Prefecture Trend	yes	no	yes	no	yes	no
Group Trend	no	yes	no	yes	no	yes
Prefecture Controls	yes	yes	yes	yes	no	no
Individual Controls	no	no	no	no	yes	yes
Family Controls	no	no	no	no	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

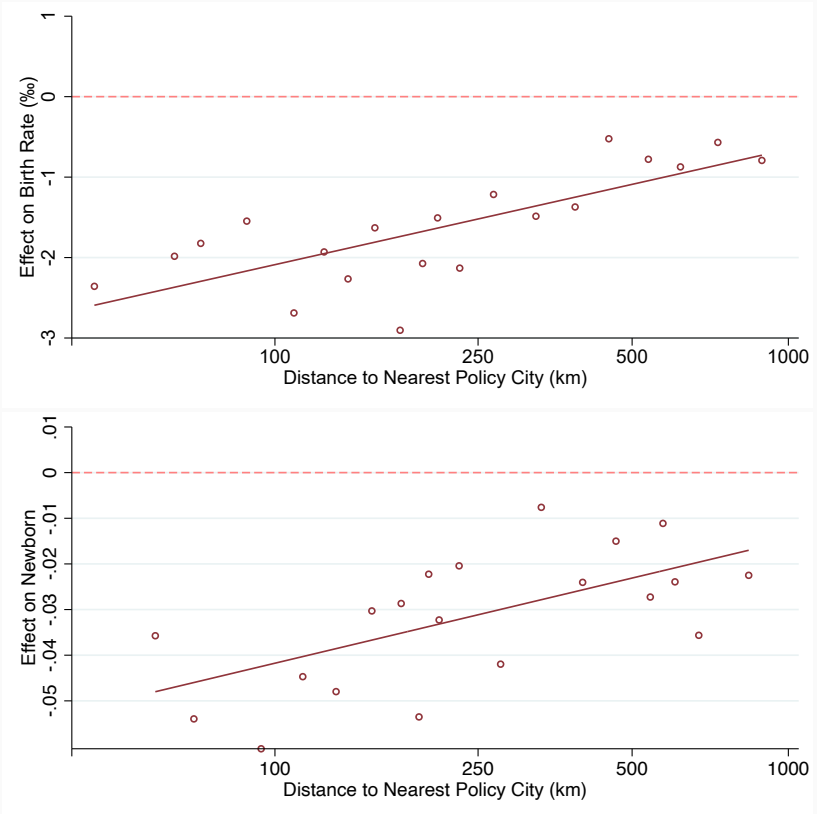
Fertility reduction consistent under continuous distance specification

(c) DID robustness check of using continuous distance specification

	(1) log(House Price)	(2) log(House Price)	(3) Birth Rate(‰)	(4) Birth Rate(‰)	(5) Newborns	(6) Newborns
log(Distance)×Post	-0.125***	-0.113***	0.884***	0.953***	0.012*	0.011**
	(0.016)	(0.016)	(0.173)	(0.170)	(0.007)	(0.005)
Mean	8.544	8.544	10.723	10.723	0.061	0.061
R^2	0.973	0.944	0.876	0.819	0.045	0.042
Observations	2589	2589	2589	2589	80177	80177
Prefecture FE	yes	yes	yes	yes	no	no
Individual FE	no	no	no	no	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Prefecture Trend	yes	no	yes	no	yes	no
Group Trend	no	yes	no	yes	no	yes
Prefecture Controls	yes	yes	yes	yes	no	no
Individual Controls	no	no	no	no	yes	yes
Family Controls	no	no	no	no	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$



Fertility reduction consistent under matching-DID

(a) DID robustness check: Treatment Prefectures and Matched Control Prefectures

	(1) log(House Price)	(2) log(House Price)	(3) Birth Rate(‰)	(4) Birth Rate(‰)	(5) Birth Rate for the Next Year (IV)	(6) Birth Rate for the Next Year (IV)
Treat × Post	0.103***	0.101***	-1.288***	-1.514***		
	(0.029)	(0.030)	(0.285)	(0.292)		
log(House Price)					-6.706**	-10.028***
					(2.766)	(3.35)
Mean	8.544	8.544	11.156	11.156	11.156	11.156
R^2	0.969	0.939	0.877	0.811	/	/
Observations	2953	2953	2953	2953	2953	2953
Prefecture FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Prefecture Trend	yes	no	yes	no	yes	no
Group Trend	no	yes	no	yes	no	yes
Prefecture Controls	yes	yes	yes	yes	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(b) Balance Test of Treatment Prefectures and Matched Control Prefectures

	Before Matching				After Matching			
Variable	**T Mean**	**C Mean**	**Std-diff**	**Var-ratio**	**T Mean**	**C Mean**	**Std-diff**	**Var-ratio**
$log(HousePrice)$	8.537	8.416	0.395*	1.138	8.537	8.498	0.132	1.285
	(0.315)	(0.296)			(0.315)	(0.278)		
$log(Population)$	15.167	14.826	0.555*	0.579	15.167	15.118	0.098	1.334
	(0.526)	(0.692)			(0.526)	(0.456)		
$GRPGrowth$	0.050	0.017	0.501*	0.301*	0.050	0.046	0.083	1.125
	(0.045)	(0.082)			(0.045)	(0.042)		
$log(AverageWage)$	10.849	10.867	-0.113	0.802	10.849	10.843	0.039	1.601
	(0.152)	(0.169)			(0.152)	(0.120)		
$log(FiscalExpenditure)$	8.928	9.116	-0.616*	0.820	8.928	8.955	-0.106	1.646
	(0.291)	(0.321)			(0.291)	(0.226)		

Fertility reduction not driven by out-of-prefecture migration

- Potentially, individuals, particularly women of childbearing age, migrated out after the positive house price shock, leading to a composition change in the remaining population and fertility decline.
- We find no significant evidence for out-of-prefecture migration.

Dependent Variable	(1) Migration Out-of-Prefecture	(2) Migration Out-of-Prefecture	(3) Migration Out-of-Prefecture	(4) Migration Out-of-Prefecture
Treat × Post	0.010	0.009	0.008	0.008
	(0.044)	(0.044)	(0.045)	(0.044)
Mean	0.084	0.084	0.084	0.084
R^2	0.581	0.505	0.626	0.548
Observations	38125	38125	38125	38125
Individual FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Prefecture Trend	yes	no	yes	no
Group Trend	no	yes	no	yes
Individual Controls	no	no	yes	yes
Family Controls	no	no	yes	yes

Standard errors in parentheses

$^{*}\ p < 0.1,\ ^{**}\ p < 0.05,\ ^{***}\ p < 0.01$

Fertility reduction not driven by local migration—the possibility of treatment prefectures potentially urbanizing faster

- Instead, we find faster urbanization prefectures to have higher birth rates, consistent with urban living facilitating producing and raising offsprings.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Alternative "Treatment Designation": $\Delta X_{2016-2021}$ >Median($\Delta X_{2016-2021}$)	$X =$ Urbanization Rate		$X =$ Share of Primary Industry GDP		$X =$ Share of Primary Industry GDP (Incl. Agri. Services)		$X =$ Share of Primary Industry Emp.	
Dependent Variable: Birth Rate(‰)								
$\text{Treat}_{Alternative} \times \text{Post}$	0.627*	0.738**	0.200	-0.101	0.002	0.003	-1.294**	-1.304**
	(0.352)	(0.339)	(0.331)	(0.318)	(0.504)	(0.439)	(0.535)	(0.505)
R^2	0.876	0.828	0.872	0.825	0.872	0.825	0.872	0.824
Obs	2658	2658	2658	2658	2658	2658	2658	2658
City FE	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes
City Trend FE	yes	no	yes	no	yes	no	yes	no
Group Trend FE	no	yes	no	yes	no	yes	no	yes
City Control	yes	yes	yes	yes	yes	yes	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Fertility reduction not related to One-Child Policy relaxation

- Potentially, treated prefectures had OCP relaxation birth waves before the shock, and births fell down after.
- We find no evidence that treated prefectures had any larger OCP relaxation birth waves before the shock. They were no different.

	(1) Birth Rate(‰)	(2) Birth Rate(‰)	(3) Newborns	(4) Newborns
$\text{Treat}_{HPRSpillover} \times \text{Post}_{OCP}$	0.029	-0.263	-0.003	-0.005
	(0.321)	(0.293)	(0.016)	(0.016)
Mean	11.347	11.347	0.066	0.066
R^2	0.875	0.806	0.053	0.049
Observations	1799	1799	48022	48022
City FE	yes	yes	no	no
Individual FE	no	no	yes	yes
Year FE	yes	yes	yes	yes
City Trend	yes	no	yes	no
Group Trend	no	yes	no	yes
City Controls	yes	yes	no	no
Individual Controls	no	no	yes	yes
Family Controls	no	no	yes	yes

Standard errors in parentheses

$^{*}\ p < 0.1, ^{**}\ p < 0.05, ^{***}\ p < 0.01$

Mechanisms

Overview of Mechanism Tests

- We next assess whether cost for living space or other costs urban house price represents, such as access to education or signaling devices in marriage competition, is related to the fertility effects.
- To do so, we first estimate heterogeneous treatment effects across housing tenure groups.
- We then test whether local scarcity of educational resources and local sex ratio imbalances amplify the treatment effect differences.
- We also analyze marriage rates and fertility conditional on marriage to study the marriage formation and within-marriage margins of the fertility decline.
- Finally, from the perspective of human capital formation, we explore whether there is an intensive margin response in parents' expenditure on children's education that accompanies the extensive margin fertility decline.

Recall: Ruralites and Urban Homeownership in China

- Ruralites **buy urban homes** for **marriage** and **education prospects**:
  - Urban homeownership is crucial.
  - **Marriage prospects**: urban homeownership signals **financial stability** for men in marriage markets.
  - **Education prospects**: quality schools prioritize children based on homeownership within their **catchment areas**.
  - **83%** of rural respondents view urban homeownership necessary for marriage in 2023 survey result by Weibo, Xinhua, WHU, CASS.
  - **17%** of rural vs. 85% of urban subjects own urban homes in our microdata.
- Urban homes are tradable; rural homes are not.
  - Rationale for rural homes' non-tradability: Ruralites are **entitled** to **land for shelter** in village born, a feature not shocked by the quasi-experiment.
  - Jointly they mean that the ruralites with only rural homes are not directly affected in terms of living space costs or wealth effects.
  - Nevertheless, rising urban house prices disproportionately hinder rural residents by increasing barriers to marriage and limiting access to education opportunities.

Fertility effect of house price shock not simply driven by cost of shelter

- The significant reduction in fertility was concentrated among rural dwelling owners with no urban homeownership (column 2). This is not fully expected if urban house prices affected fertility only through the cost of shelter channel or wealth effects, for which the rural dwelling owners were not directly shocked.

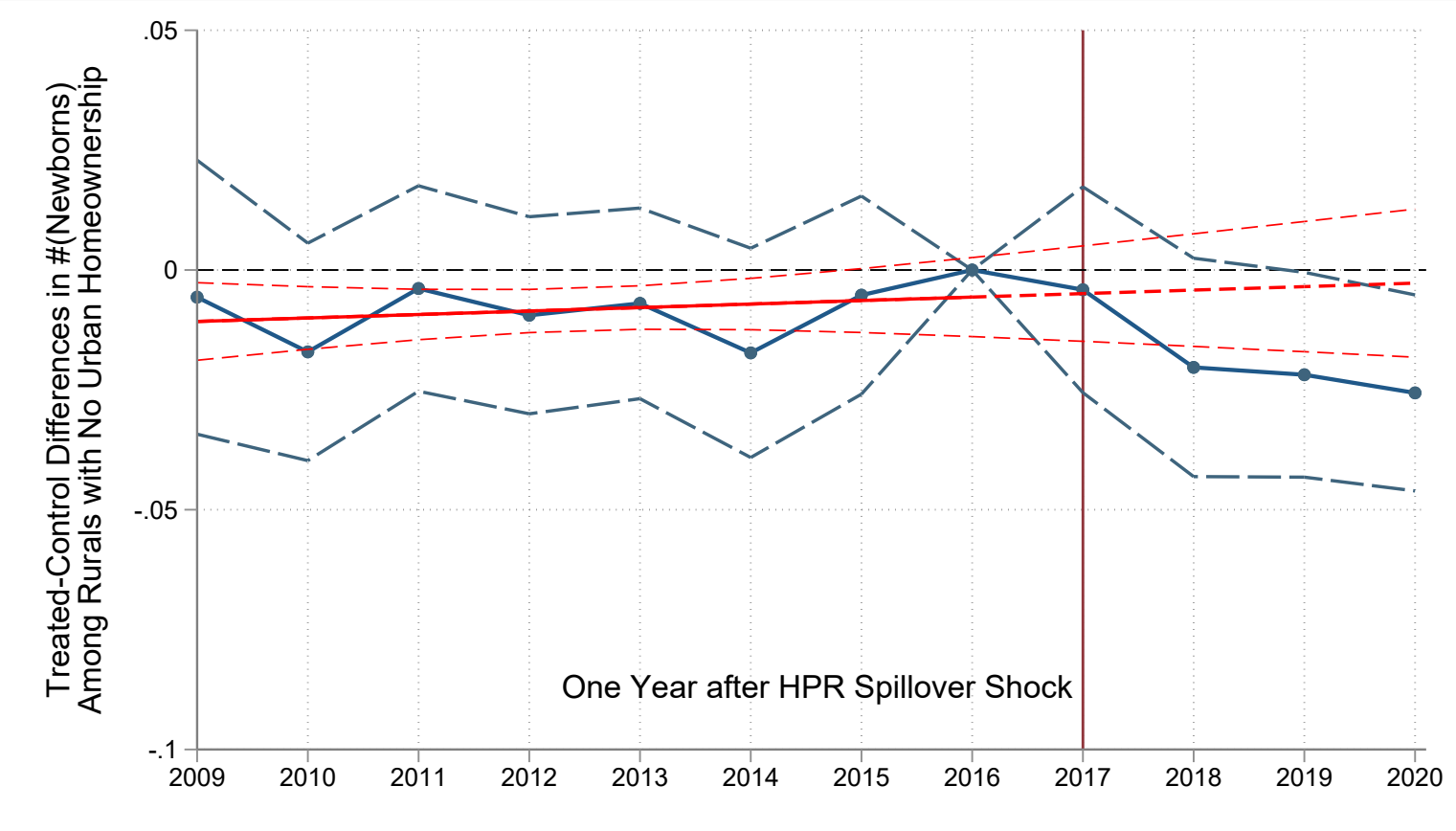
	(1)	(2)	(3)	(4)
		Rural Dwel. Owner	Rural Dwel. Owner	Urban
	Does Not Own Any	(Does Not Own Urban Home)	(Does Own Urban Home)	(Does Own Urban Home)
Dependent Variable: Number of Newborns				
Treat × Post	-0.031	-0.038***	0.007	0.002
	(0.044)	(0.012)	(0.053)	(0.018)
R^2	0.047	0.058	0.006	0.017
Observations	6621	47715	7446	18078
Individual FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Prefecture Trend	no	no	no	no
Group Trend	yes	yes	yes	yes
Individual Controls	yes	yes	yes	yes
Family Controls	yes	yes	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Fertility effect of house price shock not simply driven by cost of shelter

- The significant reduction in fertility was concentrated among rural dwelling owners with no urban homeownership (column 2). This is not fully expected if urban house prices affected fertility only through the cost of shelter channel or wealth effects, for which the rural dwelling owners were not directly shocked.



(1) Gap in education resources is related to fertility response

- among rural dwelling owners with no urban homeownership, the fertility reduction has a larger point estimate in counties with long rural school distances.
- moreover, only in counties with long rural school distances, one can reject they had the same fertility response with urban homeowners.
- these results are consistent with the idea that one factor driving the rural individuals' fertility reduction response to an positive urban house price shock is the gap in education resources.

	Rural Dwel. Owner (Does Not Own Urban Home)	
	(1)	(2)
	Schools Distant	Schools Nearby
Dependent Variable: Number of Newborns		
Treat × Post	-0.059***	-0.035*
	(0.022)	(0.019)
R^2	0.061	0.066
Observations	11924	12218
Individual FE	yes	yes
Year FE	yes	yes
Prefecture Trend	no	no
Group Trend	yes	yes
Individual Controls	yes	yes
Family Controls	yes	yes
p-value ($\beta_{Group} = \beta_{UrbanOwner}$)	0.092*	0.341

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(2) Increasing difficulty to get married for ruralites after shock

- We find rural dwelling owners with no urban homeownership to be the only group to have a significant marriage rate decline among women of childbearing age after the urban house price shock.

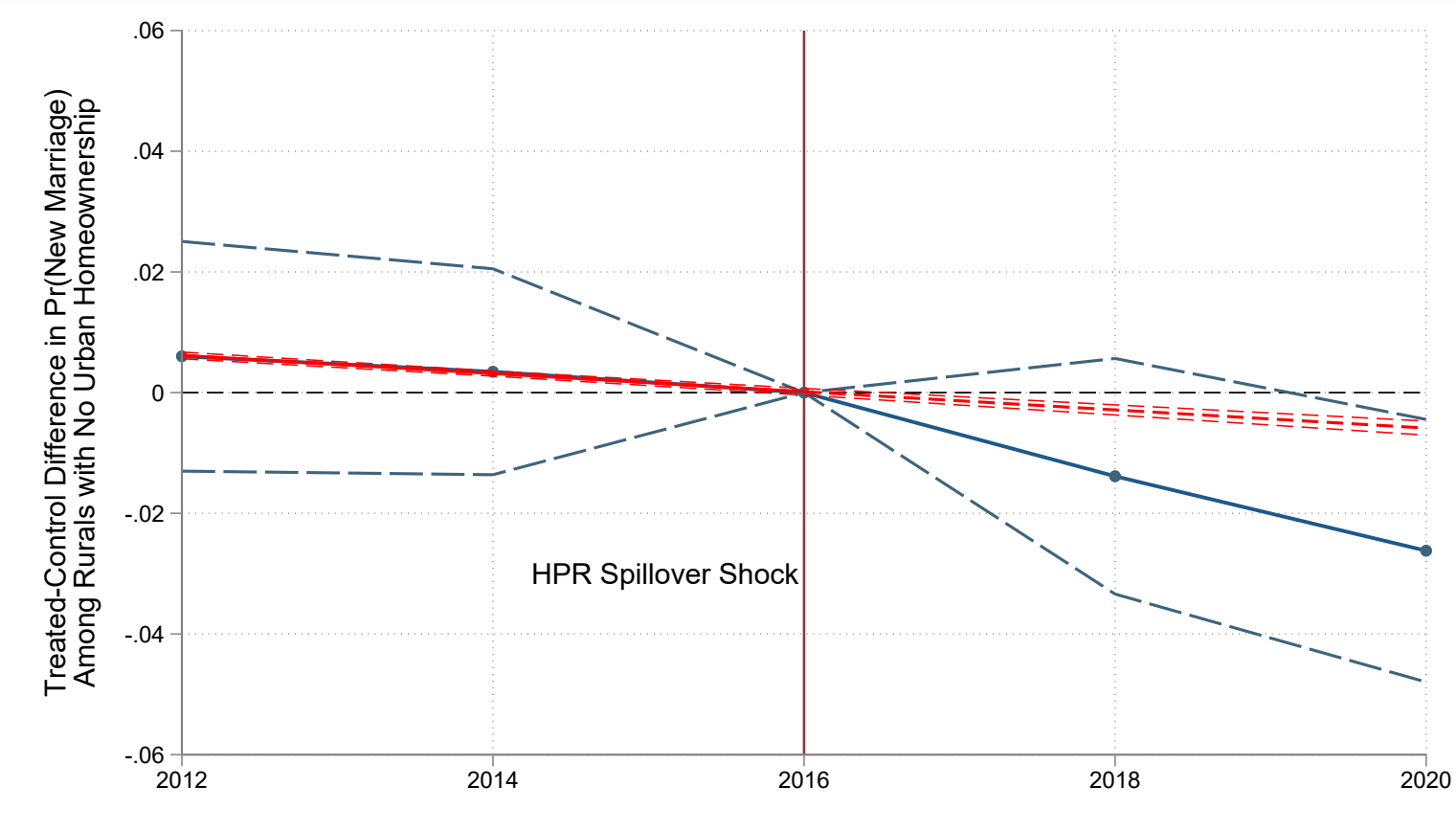
	(1)	(2)	(3)	(4)
		Rural	Rural	Urban
	Does Not	(Does Not Own	(Does Own	(Does Own
	Own Any	Urban Home)	Urban Home)	Urban Home)
Dependent Variable: New Marriage				
Treat×Post	-0.121	-0.033***	0.030	0.001
	(0.084)	(0.017)	(0.060)	(0.031)
R^2	0.103	0.078	0.153	0.070
Observations	1471	16835	1655	5770
Individual FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
Prefecture Trend	no	no	no	no
Group Trend	yes	yes	yes	yes
Individual Controls	yes	yes	yes	yes
Family Controls	yes	yes	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(2) Increasing difficulty to get married for ruralites after shock

- We find rural dwelling owners with no urban homeownership to be the only group to have a significant marriage rate decline among women of childbearing age after the urban house price shock.



(2) Increasing difficulty to get married for ruralites after shock

- Prefectures with a higher local men-to-women sex ratio is associated with a stronger fertility reduction among rurals with no urban homeownership.
- These areas also experience a sizable reduction in new marriage among the rural male, consistent with competition primarily being among men...
- and reduction in fertility among the rural married, consistent with in higher-competition areas, women may have greater autonomy in fertility decisions.
- These findings suggest that social norms highlighted in Wei and Zhang (2011) interacted with the house price shock to amplify the effect of the urban house price rise on fertility among these individuals.

Dependent variables	Newborn		New marriage		New marriage (men)		Newborn (married)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Local sex ratio	High	Low	High	Low	High	Low	High	Low
Treat×Post	-0.061***	-0.018	-0.038**	-0.035	-0.057	-0.015	-0.053**	-0.012
	(0.018)	(0.017)	(0.017)	(0.029)	(0.042)	(0.032)	(0.023)	(0.022)
Individual FE	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture Trend FE	no	no	no	no	no	no	no	no
Group Trend FE	yes	yes	yes	yes	yes	yes	yes	yes
Individual Control	yes	yes	yes	yes	yes	yes	yes	yes
Family Control	yes	yes	yes	yes	yes	yes	yes	yes
R2	0.061	0.048	0.064	0.091	0.074	0.123	0.082	0.070
Obs	22159	25556	7762	9073	8207	9263	15449	17738

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(3) Parents' investment on children's education

- Ruralites with no urban homeownership increased private educational investment, possibly as a strategic adaptation to limited resources and public education opportunities in face of higher urban house prices.
- Groups with urban homeownership reduced private educational investment, albeit statisically insignificantly. Possibly, housing and human capital investment act as substitutes.

	(1)	(2)	(3)	(4)
		Rural	Rural	Urban
	Does Not Own Any	(Does Not Own Urban Home)	(Does Own Urban Home)	(Does Own Urban Home)
Dependent Variable: Educational Investments				
Treat×Post	0.605	0.582***	-0.636	-0.269
	(0.962)	(0.153)	(1.039)	(0.610)
R^2	0.640	0.287	0.406	0.321
Observations	734	15285	1733	4217
Household FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
City Trend	no	no	no	no
Group Trend	yes	yes	yes	yes
Family Controls	yes	yes	yes	yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Model as micro-foundation and a lens to interpret result

- We construct an OLG model to analyze the effects of urban house prices on decisions regarding fertility, marriage, and educational investments.
- We borrow from the frameworks of Barro and Becker (1989) and De la Croix and Doepke (2003).
- Individuals live for three periods: young, mid, and old age.
  - young: resolution of marriage uncertainty.
  - mid-age: work, purchase housing, produce offspring, and decide children's educational investments.
  - old age: divide property among their children (if any).
- Bellman equation for mid-age:

$$V(q_t, h_{t-1}^{ur}, h_{t-1}^{ru}, M_t) = \max_{\{c_t, h_t^{ur}, n_t, e_t\}} \ln(c_t) + \gamma \ln(h_t) + \alpha M_t + \beta a(n_t) n_t E_t V(q_{t+1}, (1-\delta)\frac{h_t^{ur}}{n_t}, h_t^{ru}, M_{t+1}).$$

where q is human capital, n is number of offsprings, and M is marriage.

Model as micro-foundation and a lens to interpret result

We capture how urban housing ownership relates to **offspring's education quality and marriage prospects**.

- In urban areas, public school catchment is often linked to property ownership, affecting the educational opportunities of entering better schools.

$$\bar{q}_t = \bar{q}, h_t^{ur} \in \{0\} \quad \text{versus} \quad \bar{q}_t = \bar{q}(1+\kappa) > \bar{q}, h_t^{ur} \in [\underline{h}, \infty)\,.$$

- Private investments (paid by household) and public investments (school quality) in education combine to produce human capital (De La Croix and Doepke 2003 and De la Croix and Doepke 2004).

$$q_{t+1} = (e_t)^{\mu} \cdot (\bar{q}_t)^{1-\mu}$$

- Urban housing ownership improves relative attractiveness for marriage, therefore affecting an offspring's probability π of getting married (Wei and Zhang 2011 and Wei, Zhang, and Liu 2017).
- Rural housing only produces housing consumption.

$h_t^{ut} \uparrow$ shock: Not only (1) marginal rise in shadow cost and reduction in dynastic utility, but (2) inframarginal exit from urban housing.

Model as micro-foundation and a lens to interpret result

- Simplified model with $\gamma = 0, \phi = 0, n_t \in \{0, 1\}$, and generation $t + 1$ being the last generation.
- **Proposition 1** *A sufficiently large increase in the* **urban house price** *causes inframarginal responses on* **housing tenure**, **fertility**, *and* **private educational investment** *in the simplified model focusing on* **school quality** *and* **marriage prospects**. *Furthermore, there is a one-to-one mapping between generation t rural individuals' preferences and endowment parameters and one of two* **strategic responses**: *(1) exit the urban housing market, with fertility unchanged, but* **increase private educational investment** *in children, (2) exit the urban housing market and* **reduce fertility**.
- Given **Proposition 1**, with heterogeneity in rural individuals' preferences and endowments, this simplified model **analytically generates** that after a $h_t^{ut} \uparrow$ shock, **fertility on average declines**, but **private educational investment in children born on average rises**. Both reflect strategic adaptation to more prohibitive costs of better marriage prospects and alternative urban educational opportunities.

Conclusion

- Chetty et al. (2014) indicate that a child's prospects for upward mobility in the U.S. are greatly influenced by relocating to the right areas and are negatively impacted by residential segregation.
- Heckman and Landerso (2022) show that family residential decisions in Denmark are typically made early in children's lives, often before their birth.
- Our findings, in the context of China's great birth decline, is consistent with a previously underexplored channel through which house prices impact fertility outcomes: by affecting the price of educational resources and marriage market benefits associated with homeownership. In our case, this channel was especially pronounced for rural individuals.
- Policymakers need to consider these unintended consequences when designing housing regulations. Moreover, (a) decoupling school enrollment from homeownership and (b) providing alternative means of financial stability (if homeownership serves as a proxy for financial security in marriage markets) may reduce the reliance of fertility on homeownership.
- An open question is how China's birth rate will evolve as housing market cools. Local government intervention in house prices (Chang et al., 2023), ambiguous effects on perceived user costs of housing ownership, and shifting social norms create multiple uncertainties and room for future research.

Thank you!

Background: House Purchase Restrictions

Table 2: First Round of House Purchase Restrictions

City	Policy Shock	Date Effective
Beijing	• Raise the down payment: from 35% to 40% for the 1st house; from 35% to 50%-70% for the 2nd house.	2016.9.30
Changsha	• Price-cap regulation: the average transaction price cannot increase further.	2016.11.25
Chengdu	• Raise the down payment: from 35% to 40% for the 2nd house.	2016.10.9
Fuzhou	• Raise the down payment: to 30% for the 2nd house .	2016.10.14
Guangzhou	• Restrictions on non-resident purchases: cannot own more than 1 house. • Restrictions on resident purchases: cannot own more than 2 houses.	2016.10.1
Haikou	N/A	N/A
Hangzhou	• Restrictions on non-resident purchases: cannot own more than 1 house in city center areas. • Raise the down payment: from 30%-40% to 50% for the 2nd house.	2016.9.20
Hefei	• Restrictions on resident purchases: cannot own more than 2 houses. • Raise the down payment: to 40%-50% for the 2nd house.	2016.10.1
Huizhou	N/A	N/A
Jinan	• Raise the down payment: from 20% to 30% for the 1st house; from 20% to 30%-40% for the 2nd house.	2016.10.2
Nanchang	• Restrictions on non-resident purchases: cannot own more than 1 house. • Restrictions on resident purchases: cannot own more than 2 houses.	2016.10.8
Nanjing	• Restrictions on non-resident purchases: cannot own more than 1 house. • Restrictions on resident purchases: cannot own more than 2 houses.	2016.9.25
Qingdao	N/A	N/A
Sanya	• Restrictions on non-resident purchases: cannot own more than 1 house. • Restrictions on resident purchases: cannot own more than 2 houses.	2016.10.1
Shanghai	• Decrease credit supply (by rationing).	2016.10.19
Shenzhen	• Restrictions on purchases: cannot own more than 1 house. • Raise the down payment: to 30%-50% for the 1st house.	2016.10.4
Shijiazhuang	• Raise the land tax: to 3% for the 2nd house.	2016.10.1
Tianjin	• Restrictions on non-resident purchases: cannot own more than 1 house. • Raise the down payment: to 40% for the 1st house purchased by nonresidents.	2016.9.30
Wuhan	• Restrictions on non-resident purchases: cannot own more than 1 house. • Raise the down payment: to 25% for the 1st house; to 50% for the 2nd house.	2016.10.3
Wuxi	• Raise the down payment: to 40% for the 2nd house.	2016.10.2
Xiamen	• Restrictions on non-resident purchases: those who own 1 house can only purchase additional houses with areas larger than 180 m^2. • Restrictions on resident purchases: those who own 2 houses can only purchase additional houses with areas larger than 180 m^2. • Raise down payment: to 30% for the 1st house; to 40% for the 2nd house.	2016.10.5
Zhengzhou	• Restrictions on non-resident purchases: those who own 1 house can only purchase additional houses with areas larger than 180 m^2. • Restrictions on resident purchases: those who own 2 houses can only purchase additional houses with areas larger than 180 m^2. • Raise down payment: to 30% for the 1st house; to 40% for the 2nd house.	2016.10.2

▸ back

Background: House Purchase Restrictions

Table 3: Second Round of House Purchase Restrictions

City	Policy Shock	Date Effective
Beijing	• Raise the down payment: to 60%-80% for the 2nd house. • Decrease credit supply: stop providing mortgages lasting longer than 25 years.	2017.3.17
Changsha	• Restrictions on non-resident purchases: cannot own more than 1 house. • Restrictions on resident purchases: cannot own more than 2 houses. • Raise the down payment: to 30% for the 1st house; to 35%-40% for the 2nd house.	2017.3.18
Chengdu	• Restrictions on purchases: each family can only own 1 house.	2017.3.23
Fuzhou	• Raise the down payment: to 50% for the 2nd house. • Restrictions on resale: owner needs to hold a house for 2 years before resale.	2017.3.28
Guangzhou	• Raise the down payment: from 30% to 40%-70% for families that ever applied for mortgages.	2017.3.17
Haikou	• Restrictions on non-resident purchases: cannot own more than 1 house. • Restrictions on resale: owner needs to hold a house for 2 years before resale.	2017.4.14
Hangzhou	• Restrictions on non-resident purchases: cannot own more than 1 house in the city area. • Restrictions on resident purchases: cannot own more than 2 houses in the city area.	2017.3.3
Hefei	• Increase mortgage rate by 10%.	2017.3.20
Huizhou	• Increase mortgage rate by 10%.	2017.3.20
Jinan	• Raise the down payment: to 60% for the 2nd house . • Increase the mortgage rate by 10%. • Restrictions on resale: owner needs to hold a house for 2 years before resale.	2017.4.19
Nanchang	• Restrictions on non-resident purchases: raise the criteria for the purchases. • Restrictions on resident purchases: cannot own more than 1 house.	2017.3.8
Nanjing	• Restrictions on non-resident purchases: raise the criteria for the purchases. • Raise the down payment: from 30%-40% to 50% for the 2nd house.	2017.3.15
Qingdao	• Raise the down payment: from 20 to 30% for the 1st house; from 30 to 40% for the 2nd house.	2017.3.16
Sanya	• Raise the down payment: from 30%-40% to 50% for the 2nd house.	2017.3.11
Shanghai	• Decrease credit supply (by stricter rationing).	2017.3.17
Shenzhen	• Increase mortgage rate by 10%.	2017.3.20
Shijiazhuang	• Raise the down payment: to 30%-40% for the 1st house; to 50%-60% for the 2nd house.	2017.3.17
Tianjin	• Restrictions on non-resident purchases: raise the criteria for the purchases. • Restrictions on resident purchases: each individual cannot own more than 1 house. • Raise the down payment: to 40% for the 1st house purchased by nonresidents.	2017.3.31
Wuhan	• Increase mortgage rate by 10%.	2017.3.20
Wuxi	• Increase mortgage rate by 10%.	2017.3.20
Xiamen	• Restrictions on resident purchases: an individual can only own 1 house.	2017.3.24
Zhengzhou	• Restrictions on non-resident purchases: raise the criteria for the purchases.	2017.3.17

▸ back

Example: HPR Spillovers

Three pairs of prefectures illustrates the effect of policy spillover shocks on regulated (first) and neighboring (second) prefectures: Beijing–Tangshan, Hefei–Bengbu, and Wuhan–Xiangyang.

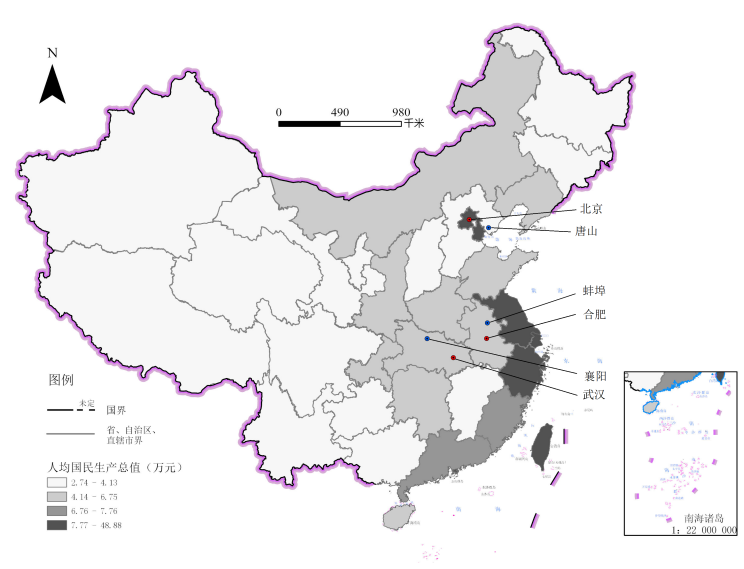
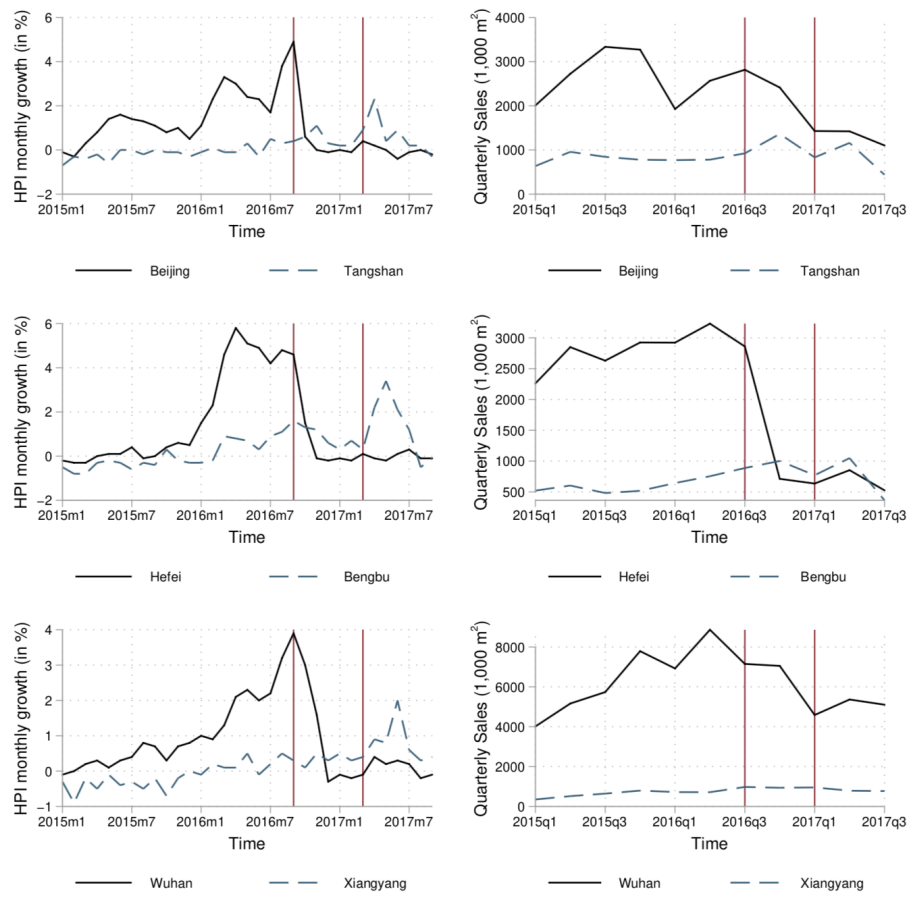
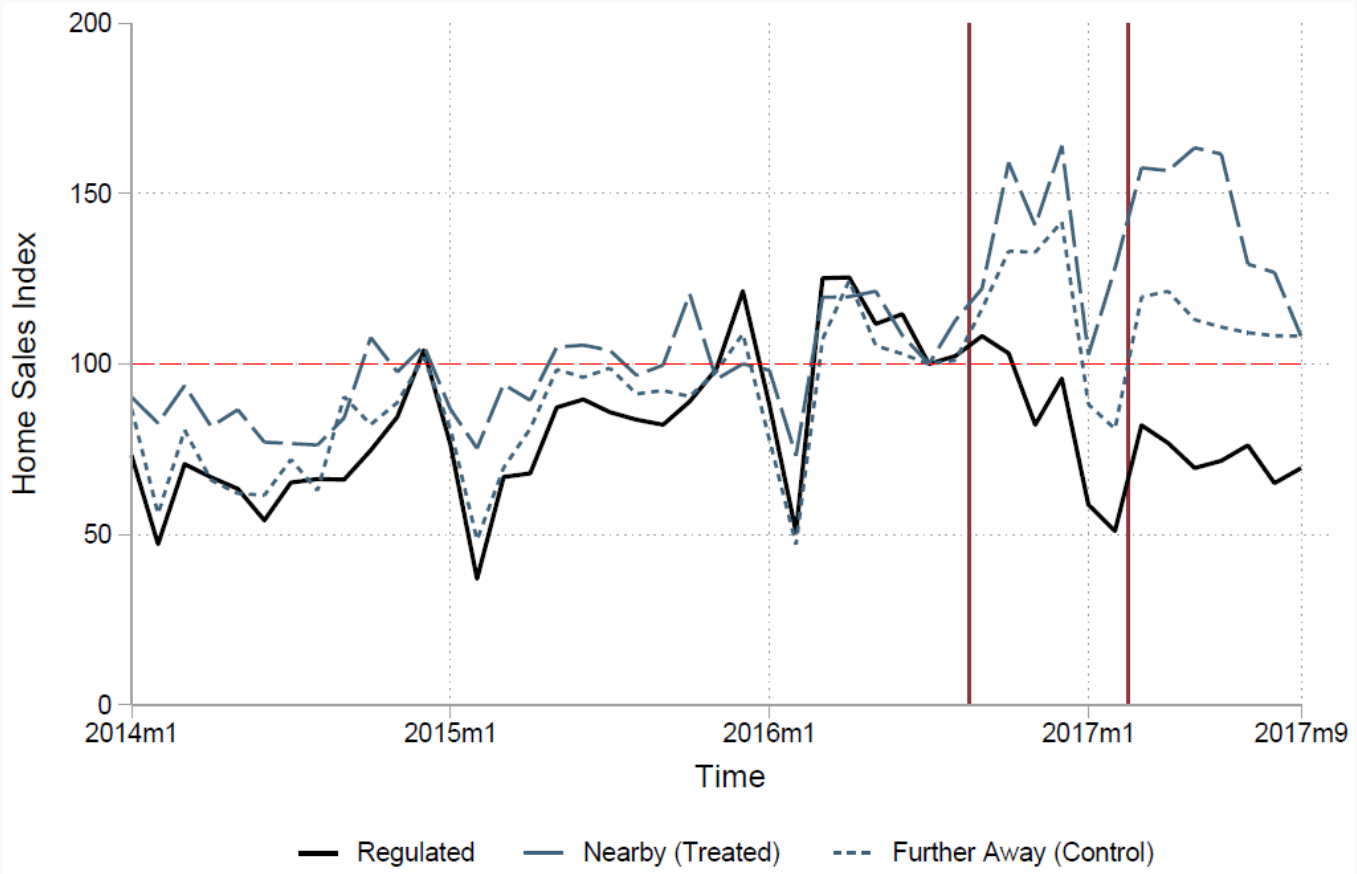


Figure 3: Reactions of House Prices and House Sales to the Restrictions - Some Examples



Example: Transaction Volumes Wanes and Waxes

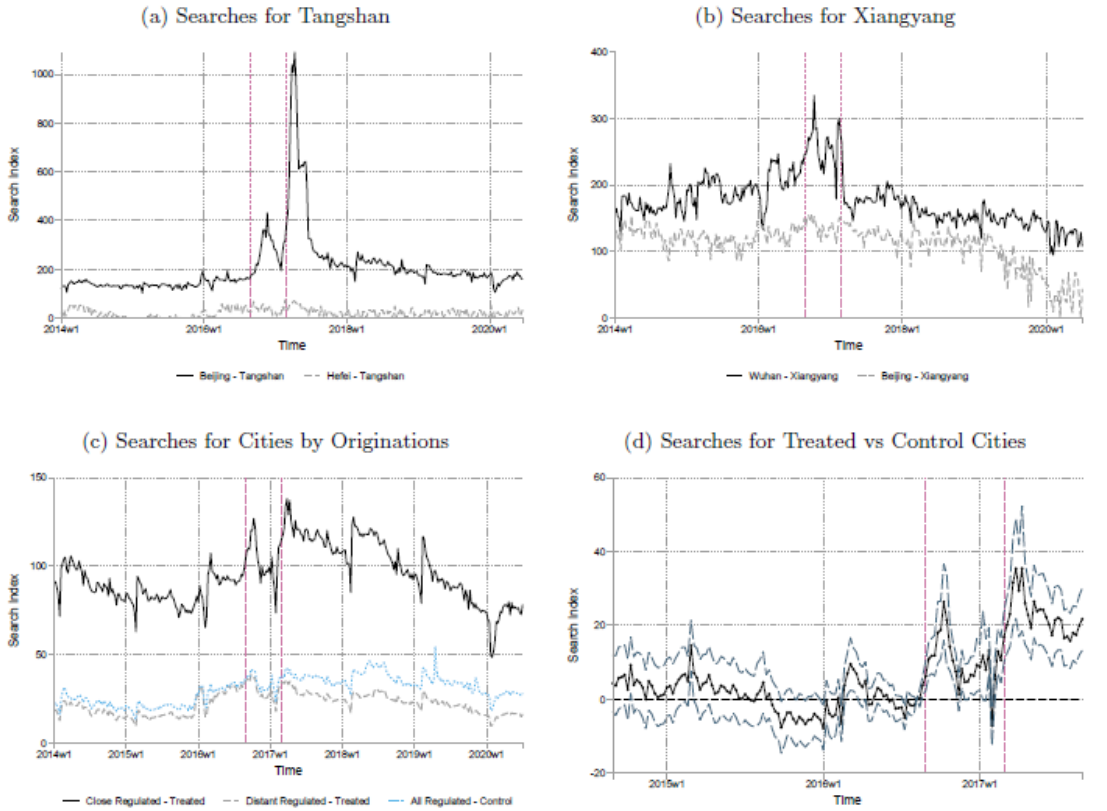
In Deng, Liao, Yu, and Zhang (2022), we also find motivating evidence that reductions in volumes in the regulated metropolises are consistent with the increase in volumes in the nearby non-regulated prefectures.



back

Example: Additional Patterns in Out-of-Town Searches

Figure 3: Web Searches of House Prices – Evidence of Out-of-Town Buyers



Notes: This figure plots the intensity of web searches of keywords related to house price and house market of the non-regulated cities originated from regulated cities, to show evidence of out-of-town buyers. We use Baidu search index to measure the intensity of web searches from one city to another. Panel (a) plots the intensity of searches for Tangshan originated from Beijing and Hefei. Both Beijing and Hefei are regulated cities, but Beijing is close to Tangshan and Hefei is distant. Panel (b) plots the intensity of searches for Xiangyang originated from Wuhan and Beijing. Both Wuhan and Beijing are regulated cities, but Wuhan is close to Xiangyang and Beijing is distant. Panel (c) plots the average intensity of searches for treated cities originated from close (<250km) regulated cities, from distant (≥250km) regulated cities, and average intensity of searches for control cities originated from all regulated cities. Treated cities are defined as non-regulated cities within 250km from the closest regulated city and the rest non-regulated cities are control cities. Panel (d) plots the estimated difference in intensity of searches for treated cities and control cities originated from all regulated cities, based on coefficients from a difference-in-differences regression.

back