Housing Bubble and Government Regulation: Evidence from China

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ABSTRACT

Facing rampant real estate price surge, Chinese government imposed the home purchase restriction policy to dampen the speculation activity in major cities in 2010. Using a comprehensive dataset covering the real estate markets across various cities, we find that the policy triggered substantial decline in the property price and transaction volume. Cities having higher reliance on real estate sector for fiscal revenue and economic growth experienced greater drop in housing prices following the policy implementation. However, the policy had no measurable effects on the construction boom, hinting the limitation of the policy to correct the housing bubble. These evidences are robust to endogeneity concerns addressed by both two-step difference-in-difference approach and endogeneous treatment effects regressions.

Keywords: home purchase restriction policy, housing bubble, China, difference in difference, endogeneous treatment effects

JEL code: G12, G18, H83

1. Introduction

The Great Recession once again showed that real estate boom–bust episodes can have devastating consequences. Considerable evidences indicate that collapses of debt-laden housing bubble are the main cause of many financial crises (Reinhart and Rogoff, 2009). After investigating bubbles in housing and equity markets in 17 countries over the past 140 years, Jorda, Schularick and Taylor (2015) concluded that housing bubbles fueled by credit booms are the most dangerous and costly while equity bubbles that do not rely on debt are the least troublesome. This fact has triggered renewed attention on the necessity and effectiveness of public policy to contain real estate bubbles. Mian and Sufi (2009 & 2014) argue that monetary policies like low interest rate and easy credit caused the bubble and its bust. [1] Glaeser (2013) finds that housing bubbles often occurred when government intervention is minimal. Given that real estate market fluctuations could wreak havoc on financial and economic system, more and more economists and policymakers are now in favors of early interventions to curtail housing bubbles (Glaeser and Nathanson, 2014; IMF, 2011). An emerging literature has begun to investigate the effects of government interventions on the property market. [2] Examining 400 years of asset-price bubbles, Brunnermeier and Schnabel (2015) show that monetary policy and macroprudential measures that lean against inflating bubbles can and sometimes have helped deflate bubbles and mitigate the associated economic crises. However, we still know little about the

[1] In addition to Mian and Sufi (2009 & 2014), there is a rapidly growing literature examining the linkage between monetary policy, mortgage borrowing and housing price appreciation, including Jorda, Schularick and Taylor (2014), Del Negro and Otrok (2007), Goodhart and Hofmann (2008), Jarocinski and Smets (2008), Allen and Rogoff (2011), Glaeser, Gottlieb and Gyourko (2010), Williams (2011), Kuttner (2012), Adam and Woodford (2013), Leamer (2007), Taylor (2007), and Bernanke (2010).

[2] See Allen and Carletti (2011), Almeida et al., (2006), Crowe et al., (2013), Igan and Kang (2011), Kannan et al., (2012), and Wong et al., (2011) for the studies of government regulations on the real estate sector.

effectiveness and difficulties in implementing various policy tools, especially from an empirical perspective.

China provides a compelling setting to explore the role of government policies in reining in the housing bubble for several reasons. First, within less than two decades, Chinese real estate market has experienced skyrocketing price growth with occasional ups and downs. The drastic surge of prices attracts concerns on a possible housing bubble in China. MacDonald, Sobczak and Mussita (2012) show that property prices in China have increased at a compound annual growth rate (CAGR) of around 16% between 2005 and 2011, much higher than the 13% recorded in the U.S. housing market between 2000 and 2005. Following Himmelberg, Mayer, and Sinai (2005)'s approach, both studies by Wu, Gyourko and Deng (2012) and Ren, Xiong and Yuan (2012) find no conclusive evidence of the housing bubble in China, but they both raise great concerns over the over-valuation of housing prices. More recently, Fan, Gu, Xiong Zhou (hereafter FGXZ) (2015) show it is difficult to identify a bubble but they acknowledge that the rampant price run-up and speculations present a significant challenge to Chinese economy.

Second, despite its short history, the implication of Chinese housing market however cannot be underestimated. Real estate sector is one of the main drivers for Chinese economic growth. It accounts for roughly one-sixth of GDP growth, 25% of total fixed asset investment, 14% of total urban employment and around 20% of bank loans (IMF, 2014). Furthermore, the sector has strong linkage effects on both upstream and downstream industries. Many consider that Chinese housing market is too important to fail because local governments rely heavily on real estate-related income, land sales in particular as a source of fiscal revenue. As the second largest economy and the largest trading nation, a

sharp slowdown in the property sector may have a domino effect on the world economy. Ahuja and Myrovda (2012) predict that a 10% reduction in China's real estate investment would shave about 1% off China's real GDP within the first year and cause global output to decline by roughly 0.5% from the baseline.

Third, facing the rampant price surge and speculations, Chinese government has been actively intervening in the housing market through various policy tools, including the increase of minimum down payment ratio, cap on the loan-to-value ratio, higher mortgage rate for the second house, taxes on capital gains, and so on. When the effectiveness of these measures diminished, Chinese government resorted to the heavy-handed restriction on home purchase to curtail the speculation. This policy was first implemented in Beijing in May 2010 and then adopted by other 45 major cities. The main feature of this policy is that it allows those having local household registration (or *hukou*) or those with working records in their cities for certain consecutive years to purchase one or second homes. Different from the implementation of other cooling measures, HPR policy is decentralized and voluntary.[3] This provides a rare opportunity to study such a unique macroprudential tool and its impact on the real estate sector.

Using a detailed city-level quarterly panel data for the years of 2008-2013, we systematically assess the effects of government intervention on the housing market in China. The data file we constructed covering various real estate indicators including housing price (or index), sales of new homes, investment and construction by the developers, and land sales price and revenue received by the local authorities in around

[3] The central government only provides guidelines that the policy should be implemented in the first-tier cities and can be extended to the second- and even third-tier cities on a need basis, rather than mandated by all cities.

140 cities. To our knowledge, none of researchers have assembled a comparable city-level dataset on Chinese housing market.

The autonomous and heterogeneous adoption of the HPR policy in each city enables us to perform the empirical analysis with the two-step difference in difference (DID) approach developed by Donald and Lang (2007) and Greenstone and Hanna (2014). Under this approach, we treat the cities without adopting the HPR policy as a control group to draw the causal inference of the policy effect on the property market. Further, we perform a structural break test as a robustness check on the validity of the DID design.

In addition to the DID approach, we employ the endogenous treatment effects model to solve the endogeneity concerns arising from the non-random adoption of HPR policies. Under this identification strategy, the implementation of HPR policy is instrumented by the political connections of each city's top leader (party secretary) with the central government. This model not only captures the role of political factors in implementing HPR policy but also meets exclusion conditions.

We find that the HPR policy has a moderately negative impact on the official housing price index released by the National Bureau Statistics (NBS). Considering the potential manipulation concerns of NBS data,[4] we alternatively investigate the policy impact on the hybrid housing price index recently composed by FGXZ (2015). Further, we resort to an alternative source -- transaction prices of secondary houses compiled by a nationwide private agent, the City House. We discover large decrease in the housing price following the HPR policy. The HPR policy causes a significant and sharp plunge in the transaction

[4] As criticized byAhuja, Cheung, Han, Porter, and Zhang (2010), Wu, Gyourko and Deng (2012), Wu, Deng and Liu (2014), and Fang, Gu, Xiong and Zhou (2015), NBS is likely to underestimate the housing price appreciation.

volume of new homes. This evidence is consistent with the policy motivation of curbing speculative demand in the property market. However, the policy does not address the problem of excessive supply. The growing trends of property investment and construction did not alter after the policy enforcement. These findings suggest that property developers largely ignore the intention of HPR policy in curbing property boom. Instead, they continue to increase investments in property market, which aggravate the oversupply of houses. Both the DID approach and endogenous treatment effects regressions yield robust results, confirming that our evidence is free from the endogeneity concerns.

More importantly, we investigate the varying effects of the HPR policy across different cities that exhibit dramatic heterogeneities in the fiscal reliance on land sales, economic dependence on real estate investment and pace of urban expansion. We find that cities having higher reliance on land sales, real estate investment and radical urban sprawl experience greater decline in housing prices and sales following the policy adoption. Further we show that these cities do not experience significant fall in property investment or construction. The latter finding suggests that HPR policy's effectiveness is limited due to local authorities' misaligned incentives and circumvention. With heavy reliance on real estate sectors, local governments are in the dilemma of correcting housing bubbles and maintaining economic growth via property investment. This indicates a lingering oversupply problem in the housing market.

Our research sheds new lights on how to design effective macroprudential measures to dampen the asset bubbles, the bust of which is catastrophic to the whole economic system. An efficient way to curb housing bubble could significantly improve well-being. The Chinese government has tried various cooling measures including purchase

restrictions. The HPR policy provides an ideal setting to understand Chinese housing market and the effectiveness of government policy in controlling the market mania. There are a growing number of governments in the world attempting to rein in housing price surge by restricting or even forbidding the purchases, especially on foreign buyers.[5] Our study thereby provides a comparison of the efficacy of similar regulations across different markets.

This study also contributes to the literature of the political economy. We relate political connections to the implementation of HPR policy and associate the effectiveness of the policy to government incentives. Several papers on the Chinese cadre system have linked Chinese economic success with incentive system for its local leaders (Maskin, Qian and Xu, 2000; Li and Zhou, 2005). However, few researches have associated the enforcement of public policy with the political factors. This is of particular importance for a transitional economy like China where the regulatory institutions are weak while its unique political system grants the top city leaders with powers that far exceed their Western counterparts. The success of a public policy hence relies largely on the incentives of local governments in implementing the regulations.

The rest of paper is organized as follows. The next section summarizes the evolution of government policies toward residential property market and reviews the relevant literature. Section 3 presents the data source and summary statistics. Section 4 outlines the two-step DID approach and section 5 reports the main empirical results. Section 6 presents

[5] For example, Singapore and Hong Kong governments have implemented several demand-managing measures to restrict the property purchase by foreign buyers, including higher down payment ratio, a higher rate of buyer stamp duty on property transactions, etc. Australian government has strengthened the restrictions on property buying by foreigners since 2010. Under those rules, temporary residents were allowed to buy established homes with approval from the foreign-investment regulator, but had to sell when their temporary visas expired.

the endogeneous treatment effects model and its estimation results. Section 7 demonstrates the cross-sectional identification test results on the effect of HPR policy across cities. Section 8 concludes the paper.

2. Background: Chinese Government Regulations on Housing Market

Chinese government has interfered actively and significantly in the private housing market. Ahuja, Cheung, Han, Porter, and Zhang (2010) found that over the past decade, any misalignment in house prices would be corrected relatively quickly due to government intervention. FGXZ (2015) also pointed out that Chinese government through its heavy interventions played a more important role in affecting housing market than the counterparties in the rest of world.

Since the mid-1990s, Chinese government has made great efforts to promote housing finance and hence stimulate the growth of real estate sector, in order to support the housing reform and fight against the adverse economic impacts of 1997 Asian Financial Crisis. For example, between 1998 and 2002, the central government lowered the mortgage rate five times to encourage home purchases. By 2005, China has become the largest residential mortgage market in Asia, with an outstanding balance exceeding RMB two trillion (USD 300 billion), almost 89 times the 1997 balance (Deng and Liu 2009; Zhu 2006). Meanwhile, the government rolled out various policies favoring housing development, such as broadening the scope of development loans and allowing pre-sales. As a result, the annual housing investment increased by around six times from 1997 to 2005 (Ye and Wu, 2008).

The housing market started to experience a rapid boom starting in 2004. In response, the government implemented a series of policy tools to curtail speculative activities. For example, the minimum down payment ratio was raised to 40% in September 2007 and

mortgage rate set 10% higher than the benchmark rate. Personal income taxes were levied on corporate purchasing properties for individuals in 2008. These measures worked well for a short period, partially aided by the global financial crisis broken out in 2007.

In order to avoid the paramount threat of political instability triggered by the global financial crisis, the government reversed its housing policies in October 2008. This included a series of measures to support the housing market growth. Among them, the minimum mortgage rates were adjusted downwards to 70% of the benchmark rate and the down-payment ratio was lowered to 20%. Preferential policies were also introduced for first-time home buyers. Fueled by lax credit and easy monetary policy, the housing market regained momentum in mid-2009 and started a new round of price run-up and massive construction boom across the nation.[6]

In response to the continuing surge in housing prices, the government stepped up a campaign against the overheated property market in the early 2010. Besides the traditional policy tools, various less standard tightening measures, such as raising the down-payment ratio, prohibiting mortgage on the second home purchase, and imposing business tax and personal income taxes on housing transactions came in place. However, none of these measures can be compared to the most stringent policy instrument -- home purchase restriction adopted by various Chinese local municipalities. Taking Beijing as an example, the policy dictates that each family with Beijing *hukou* can own a maximum of two homes. Families without local *hukou* are not allowed to buy any unless they can provide documents to prove payment of taxes and social security contributions for five consecutive years in the past.

[6] According to Smil (2013), between 2011 and 2013, China used 6.6 gigatonnes of cement, 1.1 gigatonnes more than what the US used between 1901 and 2000.

The goal of HPR policy is to curtail the speculative housing demand, although it does not touch the fundamentals driving the speculative demand, e.g., shortage of investment tools for Chinese residents.[7] Such restrictions on home purchase substantially alter the demand in the housing market, which are often criticized by economists for unfairness, discrimination against migrants, and inefficiency.

Since the late 2013, an alarming economic slowdown emerged with residential property market receding. Housing prices started to decline in an increasing number of cities while the residential property inventories have increased sharply. Not affording to sit idle and watch the free fall of housing price, most municipal authorities abolished HPR policy in the mid-2014. Currently, the policy is only in force in four megacities of Beijing, Shanghai, Guangzhou and Shenzhen.

Not surprisingly, China's housing market has been the topics of many empirical investigations. Zhou (2005), for example, attempts to explain the underlying factors of the house price movement. Others focus on the price misalignment and the sustainability of China's housing boom (Economic Intelligence Unit 2011; Wu, Gyourko and Deng, 2012; Chivakul, 2015). Huang, Zhang and Lai (2014) investigate the relationship between Chinese stock and housing market, and others look at the association of housing price with land policy (Cai, Henderson, and Zhang, 2013; Du, Ma and An, 2010; Peng and Thibodeau, 2009). Fang, Gu and Zhou (2014) measure the corruption of home purchase in China. Although Chinese government has actively intervened in the real estate sector, especially

[7] Real estate is the most preferred asset class for the Chinese thanks to the shortage of other investment options and a lack of property taxes. According to a Report "China—real estate: Good news in tough times" released by the Standard Chartered on 4 July 2013, residential property has made up more than 60% of household assets since 2008, dwarfing the 48 % in the UK, 32 % in Japan, and 26% in the US.

in light of US subprime mortgage crisis, very few studies have examined the effects of government cooling measures.

A few papers focus on the introduction and evolution of HPR policies, such as Wang and Murie (1999), Deng, Shen, and Wang (2011) and Zou (2014). The lack of systematic analysis of the heavy-handed government restriction on home purchase motivates our research. To our knowledge, there are only three papers examining the policy impact but they look at an individual market. Sun, Zheng, Geltner and Wang (2013) investigate the policy effect on Beijing's resale and rental market while Jia, Wang and Fan (2014) focus on the response of Guangzhou's real estate sector to the policy implementation. Using a counterfactual analysis, Du and Zhang (2015) evaluate the effects of HPR policy and trial property taxes on housing prices in Beijing, Shanghai and Chongqing. They find that the HPR policy lowers the annual growth rate of housing prices in Beijing by 7.69% while the trial property tax had no significant effects on the housing price in Shanghai. In this paper, we aim to bridge the gap by assembling a set of empirical analyses about the real estate market dynamics in relation to the HPR policy adopted by many Chinese local municipalities.

3. DATA AND SUMMARY STATISTICS

This section describes the data source, presents the summary statistics, and traces the evolution of the key property market indicators before and after the policy implementation.

3.1 Data

To perform the empirical analysis, we construct a city-level panel data file for the years of 2008-2013 at quarterly frequency from a number of sources, including the official source of NBS, a private data provider *Soufun,* a nationwide independent agent the City

House and the scholars of FGXZ (2015). Our main empirical analysis focuses on the 70 cities across 30 provinces. Their housing prices are regularly surveyed by the NBS.

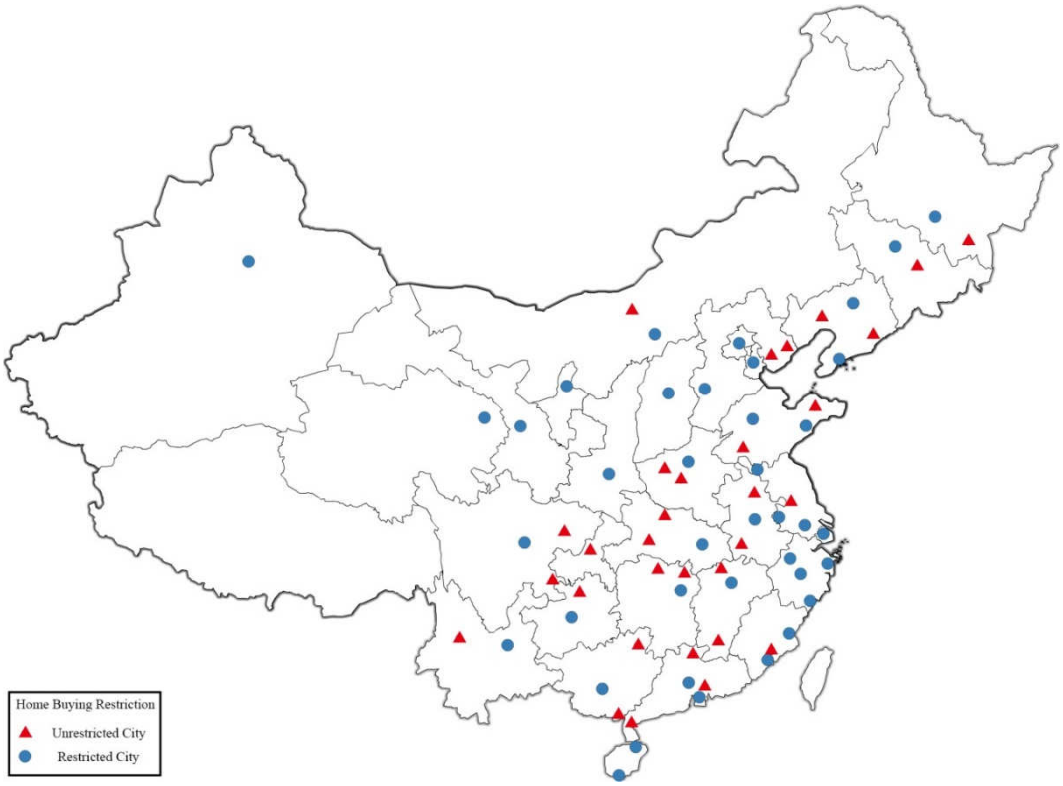
3.1.1 HPR Policy

The HPR policy was initiated by China's central government under the so-called "New National Ten Articles" and "New National Eight Articles" issued in April 2010 and January 2011 respectively.[8] It was afterward implemented in 46 cities. Among the 70 cities that NBS regularly publishes their property price index, 39 of them adopted the policy. Figure 1 plots the location of these 70 cities and classify them into two groups of restricted and unrestricted cities.

Manually collecting the local version of "New National Ten Articles" and "New National Eight Articles", we assemble a comprehensive dataset that traces the policy changes. Appendix A summarizes the policy implementation status of all our sample cities. Beijing was the first city to enforce HPR policy in May 2010, followed by Shenzhen in September, Dalian, Fuzhou, Hangzhou, Xiamen, Guangzhou and Wenzhou in October, and Lanzhou and Zhengzhou in November and December respectively. In the spring of 2011, due to the requirements set by the "New National Eight Articles", the other 29 municipal governments launched the HPR policy in their cities.

8 The full name of "New Ten Clauses" is "Notice of the State Council on Resolutely Curbing the Soaring of Housing Prices in Some Cities" while the full name of "New National Eight Articles" is "Notice of the State Council on Further Problems Related to the Intervention of Real Estate Market".

Figure 1 Location of 70 major cities



We use four types of indicators to capture the dynamics of Chinese residential property market: (1) prices or price indices; (2) housing sales; (3) construction and investment by the real estate developers; and (4) land sales prices and revenue. Appendix B lists the definition, unit and sources of each variable.

3.1.2 Housing price

We obtain the housing price or price index data from several sources. Among them, NBS price indices including the price indices of newly constructed (*PINew.NBS*) and secondary residential property (*PISecond.NBS*) are the most widely used measures in analyzing Chinese real estate markets. The main advantage of this dataset is its wide coverage and long sample period. The starting date of NBS price indices could be traced back to July 2005. NBS reports the year-over-year or quarter-over-quarter house price

growth rate for individual cities. To track the price movement over time, we convert it into the indices with the second quarter of 2005 equal to 100.[9]

One drawback of NBS property price index is the underestimation of the housing price appreciation rate in China (Ahuja, Cheung, Han, Porter, and Zhang, 2010; Wu, Gyourko and Deng, 2012). We hence collect the sales prices of new houses (*Price.CREIS*) from the China Real Estate Index System (CREIS) developed by a private data provider *Soufun* and the transaction prices of secondary houses (*Price.Cityhouse*) from a nationwide independent agent the City House. These two datasets are less likely to have manipulation problem. We also adopt the City House's quarterly rental price to measure the dynamics of rental market.

An accurate housing price index should reflect evolution of prices of the same or similar houses over time. NBS price indices or sales price released by private sectors simply compare the mean or median sale prices per square meter. Without adjusting for property features, they represent not only the changes in the prices of similar homes, but also the changes in the quality and composition of transacted homes (FGXZ, 2015). However, there are few home sales data that could be used to compose the Case-Shiller type repeated sales housing price indices due to the short history of Chinese housing market. In US a hedonic price approach is often used to derive housing price indices that regresses sales prices on a set of variables characterizing housing units. This approach is not feasible for Chinese real estate market due to the dramatic unobserved time-varying characteristics caused by the rapid expansion of urban residential land parcels. To address these concerns, FGXZ (2015) employ a hybrid approach to construct a monthly housing price index using

[9] The base period could be set as other periods, but the evolutions of the price index are the same and hence the empirical results would not be affected.

the sequential sales of new homes within same housing development projects in 120 cities for the years of 2003 to 2013. As a comparison, we also use this new housing price index (*PI.FGXZ*) to study the effects of HPR policy.

3.1.3 Housing transaction, investment and land sale

We gauge the transaction of residential property with three indicators of sales amount (*SaleAmount*), number of flats sold (*SaleUnit*), and floor space sold (*SaleFloor*) provided by NBS. They refer to the total amount, number of flats or floor area sold for buildings listed in the formal sales contract signed by both parties during the reporting period. They include both the sale of currently completed units and presale units offered by real estate developers. NBS only releases the transaction data for new homes.

We measure the activities of developers with four indicators of real estate investment (*Investment*), floor space started (*FloorStarted*), floor space under construction (*FloorUnderConstruction*) and floor space completed (*FloorComplete*) published by NBS and collected by CEIC database. According to the definition given by CEIC, *Investment* here refers to the investment by real estate development companies, commercialized building construction companies, and other real estate development units of various types of ownership in the construction of buildings. The land transaction is excluded. *FloorStarted* measure the entire floor space of the whole residential buildings newly started by real estate development enterprises during the reference period. [10] *FloorUnderConstruction* refers to the total floor space of all residential buildings under construction by real estate enterprises during the reference period, including the "floor space starts" in current period, floor space of continued construction carried over from

[10] All housing construction begun in previous periods or previously started, but restarted again because of some postponement or stoppage in earlier periods is excluded to avoid double counting.

previous periods, floor space stopped or postponed in the previous period but restarted for construction in the current period, floor space completed during the current year, and newly started floor space in current year but postponed. *FloorComplete* refers to housing construction that has been completed in accordance with the design and approval requirements and can be formally handed over to buyers for use.[11] We collect the land price (*LandPrice*) and land sales revenue (*LandRevenue*) data from the CREIS. The land price is calculated as the ratio of land transaction value to the area of construction land.

3.1.4 Control Variables

Housing price is usually pushed up disproportionately in the time of rapid economic growth because housing demand is often more elastic than housing supply and can remain strong (Economic Intelligence Unit, 2011; Chen, Guo and Wu, 2011). In this paper, demand for housing is proxy by disposable income per capita of urban residents and resident population of each city. Moreover, we use the developed area of city construction published by the CEIC database to reflect the elasticity of housing supply. The data for disposable income is obtained from the CEIC database.

We rely on *changzhu* population instead of *huji* population to measure the housing demand arising from population growth. The *huji* population refers to people who register with the police under the household registration system (*hukou*) but does not include residents living in the city without local *hukou*, whereas the *changzhu* population refers to the resident population that has stayed in the same area for more than 6 months and reflects the migration pattern. For a coastal city with decent manufacturing industry, *huji* population underestimates the real population since it often attracts numerous migrants as

[11] Chivakul et al (2015) provides a detailed description on China's residential real estate statistics, including the price, volume, investment, and inventory data.

residents. For an inland city that is the home of migrants, *huji* population might overestimate its total residents. It is estimated there are currently 53.7% of population leaving in urban area although population with urban *hukou* only account for 36% of total population. Therefore, *changzhu* population instead of *huji* population represents the real and potential demand for urban residential property. We collect the data of *changzhu* population from the yearbooks of each city.

3.2 Summary Statistics

We apply the seasonality adjustment to the series of property investment, floor space started and under construction, land sales revenue and disposable income that show evident seasonal fluctuations. Panel A of Table 1 lists the summary statistics of all variables for the full sample of 70 cities. The mean of property price index (*PINew.NBS* and *PISecond.NBS*) indicates that the housing price on average grows by around 35% since 2005, much lower than the appreciation rate estimated by MacDonald et al. (2012). The mean value of sales price published by the City House is around RMB 7,700 per square meter. In contrast to the high housing price, the average rental price is as low as around RMB 20 per square meter. The transaction volume averages 13,632 units of flats, 1.39 million square meters of floor space valuing for RMB 11,765 million per quarter.

There is a clear pattern of investment and construction boom in the housing market. For example, the quarterly investment by real estate developers averages RMB 12,144 million (slightly below USD 2,000 million) per city. Construction of residential property was growing at an extraordinarily high pace in the sample period. The summary statistics indicate that there is on average around 2 million square meters of floor space started and 22.3 million square meters of floor space under construction per city-quarter. With an

average land price of RMB 4,527 per square meter, the quarterly land sales revenue per city amounts to RMB 3.7 billion. Local governments, the ultimate owner and the only supplier of urban lands, are therefore one of the largest beneficiaries of the skyrocketing property market.

To assess the volatility of the housing market, we normalized standard deviation of each variable by its mean. Among all property market indicators, the investment, floor space started, sales amount, land price and land sales revenue exhibit highest level of volatility as their normalized standard deviation all exceed one.

Panel B of Table 1 presents the mean value of real estate market indicators around the time of policy implementation for adopting cities. Although HPR policy was launched to dampen the rampant housing price appreciation, the official price indicators -- *PINew.NBS* and *PISecond.NBS* declined respectively by only around 1 and 3 point four quarters after the policy implementation. However, the decline in the housing price released by the private agent (*price.Cityhouse*) is remarkable. It fell by RMB 364 four quarters after the policy adoption.

One year after the policy enforcement, the three measurements of new home sales including the *SaleAmount*, *SaleUnit* and *SaleFloor* plummeted by more than 40% relative to their peak value recorded at $\tau = -1$. The dramatic decline in these transaction volumes hints that most of home purchase before the policy adoption might be driven by the speculation purpose, instead of inelastic needs. Cities adopting the policy on average experienced a 60% drop in land sales revenue. On the contrary, the investment and construction of residential properties are unaffected by the policy. They continued their growing trend one year after the policy implementation. This finding suggests that HPR

policy does not tame the investment boom by real estate developers who will release future supply of residential housing in large magnitude.

Table 1 Summary statistics

This table presents the summary statistics of our key variables. Panel A shows the summary statistics of real estate market indicators of all cities. Panel B summarizes the statistics for the adopting cities around the time of policy implementation. Obs, observation; Std. Dev., standard deviation; Normalized Std. Dev. is calculated as the ratio of Std. Dev. to the mean; Min, minimum value; Max, maximum value. Please refer to Appendix A for the detailed description of each variable.

Panel A: Summary statistics for all cities

Variable	Obs	Mean	Std. Dev.	Normalized Std. Dev.	Min	Max
PINew.NBS	1680	138.05	20.21	0.15	90.99	226.49
PISecond.NBS	1680	135.68	22.65	0.17	84.10	234.75
Price.Cityhouse	1550	7730.66	5099.41	0.66	1943.00	37469.00
PI.FGXZ	1050	1.33	0.31	0.23	0.78	2.74
Rental	1585	19.99	9.27	0.46	5.50	65.05
SaleUnit	992	13632.13	12249.75	0.90	571.00	73875.00
SaleFloor	1015	1390.30	1213.42	0.87	55.50	8058.20
SaleAmount	903	11764.59	13965.61	1.19	193.00	101534.00
Investment	1680	12144.03	14448.50	1.19	115.43	93929.22
FloorStarted	1680	2010.10	1906.28	0.95	0.00	16812.08
FloorUnderConstruction	1680	22333.40	21648.64	0.97	234.50	192489.00
FloorCompleted	1653	1176.69	1264.32	1.07	11.43	10561.56
LandPrice	1471	4527.22	5239.26	1.16	4.43	60293.88
LandRevenue	1471	3694.32	6672.21	1.81	0.05	80074.93

Panel B: Mean value of real estate market indicators for the adopting cities around the policy implementation

τ	-4	-3	-2	-1	0	1	2	3	4
PINew.NBS	138.28	139.81	141.22	143.29	145.14	146.07	145.86	144.98	144.15
PISecond.NBS	138.19	139.55	140.78	142.32	143.23	143.39	142.27	141.19	140.09
Price.Cityhouse	9124.90	9555.41	10174.77	10724.21	10977.28	10963.41	10772.95	10770.77	10613.13
PI.FGXZ	1.20	1.30	1.36	1.44	1.51	1.56	1.61	1.62	1.59
Rental	21.97	22.81	23.52	23.65	24.44	24.67	25.06	24.60	24.94
SaleUnit	14880.43	15055.57	17560.71	19765.07	14863.41	12865.93	12978.78	11456.18	10755.12
SaleFloor	1573.20	1607.76	1738.77	1974.80	1492.44	1278.42	1295.46	1130.67	1063.71
SaleAmount	13031.00	13925.27	16108.59	18109.85	14050.19	12876.00	13389.93	11455.48	10624.62
Investment	13648.27	15284.35	15508.42	16920.77	17545.47	18835.70	19823.24	20998.12	21600.04
FloorStarted	2290.80	2621.90	2912.14	2851.10	2848.54	3090.66	3166.57	2739.77	2943.89
FloorUnderConstruction	21655.61	24674.72	28041.27	28562.54	26595.68	30409.93	34059.92	34416.36	31753.29
FloorCompleted	1285.24	1412.78	1484.24	1576.86	1405.69	1491.51	1565.16	1852.15	1841.10
LandPrice	5705.37	6740.24	6723.63	6854.01	6696.27	6680.35	5242.33	5650.43	7035.17
LandRevenue	8273.31	6255.83	6058.68	8655.79	7055.47	5877.19	4238.21	3064.45	4023.23

4. EMPIRICAL STRATEGY

This section describes the two-step DID approach developed by Donald and Lang (2007), and applied by Greenstone and Hanna (2014) to study the casual effects of environmental regulations on pollution abatement across India. We employ it to assess the impact of HPR policy on Chinese residential property market.[12] This approach provides a convenient solution to the problem of intragroup correlation in the unobserved determinants of housing market movement. It is numerically equivalent to the GLS and FGLS approaches widely applied for a single-step DID approach. This two-step DID approach has a great advantage of avoiding the difficulty of collapsing the data into group-level.[13] The first step is a typical event study-style equation:

$$Y_{it} = \alpha + \sum_{\tau} \sigma_{\tau} D_{\tau,it} + \mu_t + \gamma_i + \beta X_{it} + \epsilon_{it} \quad (1)$$

where Y_{it} is real estate market indicators in city *i* at quarter *t*. $D_{\tau,it}$ is a vector composed of a separate indicator for each of the quarters before and after the policy is enforced. τ is normalized to be zero in the quarter when the policy is implemented and ranges from -8 (8 quarters before a policy is adopted) to 8 (8 quarters after its adoption) so that we have enough city-by-quarter observations. τ is set to be zero for the nonadopting cities so as to facilitate the identification of time effects and the coefficients of β on the control variables. The city fixed effects, γ_i, control for all unobserved factors that are time-invariant and peculiar to each spatial unit and prevent the estimates of the treatment effects, σ_{τ}, from

[12] The two-step DID estimation of this paper is based on the stata code written by Jonathan Petkun and provided by Greenstone and Hanna (2014).

[13] We also performed estimation with the single-stage approach for comparison. Results are available upon request. As a standard practice in DID approach, the standard errors from the one-stage approach are clustered at the city-level.

being biased upward by the possibly higher levels of real estate market indicators in the adopting cities, both before and after the policy implementation (Auffhammer and Kellogg, 2011). The inclusion of time effects μ_t which control for all city-invariant variables adjusts for the trends like nationwide legislation or policy changes. The control variables of developed area of city construction, disposable income per capita and resident population (X_{it}) are included to adjust for differential supply and demand factors across cities. The estimating equation is weighted by the GDP per capita to account for differences in precision due to city economic development level.

The parameters, σ_τ, our main estimates, gauge the mean value of various real estate market indicators in the quarters before and after the policy is enforced. The variation in the timing of HPR policy adoption across cities enables us to identify σ_τ and time fixed effects separately. A plot of σ_τ estimated from equation (1) against τ would allow us to visually investigate how the policy changes the real estate market. Additionally, these figures, which lend insights into whether the mean reversion appears in front of the policy's impact, would inform us the choice of the preferred second-step model.

In the second step, we quantitatively test the association of property market dynamics with HPR policy via three alternative models. We first estimate:

$$\hat{\sigma}_\tau = \pi_0 + \pi_1 1(Policy)_\tau + \epsilon_\tau \quad (2A)$$

where $1(Policy)_\tau$ indicates if the policy is in force (i.e., $\tau \geq 1$). π_1 tests whether there is a mean shift in one of the measurements of housing market after the policy adoption. An alternative specification is

$$\hat{\sigma}_\tau = \pi_0 + \pi_1 1(Policy)_\tau + \pi_2 \tau + \epsilon_\tau \quad (2B)$$

that includes a linear time trend, τ, to adjust for differential preexisting trends in the adopting cities.

Equation (2A) and (2B) test for the existence of mean shift in real estate market after the policy's implementation. However, the full impact of the policy may change over time as the individuals may find various niches to avoid the home purchase obstacles set by the government. We therefore estimate the third specification:

$$\hat{\sigma}_\tau = \pi_0 + \pi_1 1(Policy)_\tau + \pi_2 \tau + \pi_3 1((Policy)_\tau \times \tau) + \epsilon_\tau \,. \qquad (2C)$$

From this specification, we report the impact of the policy four quarters after its enforcement as $\pi_1 + 4\pi_3$.[14] For the second stage equations (2A)-(2C), the standard errors are heteroskedastic consistent. Moreover, the equations are weighted by the inverse of the standard error associated with the relevant σ_τ to account for differences in precision in the estimation of these parameters.

5. EMPIRICAL RESULTS

5.1 Event Study Graphical Evidence

We first present the event study graphs. The graphs not only visually depict the evolution of real estate market indicators around the time of HPR policy adoption but also help to identify the most appropriate version of equation (2). In Figure 1, each graph plots σ_τ estimated from equation (1) against τ. The quarter of the policy implementation, $\tau = 0$, is demarcated by a vertical dashed line in all figures. Additionally, all property market

[14] We also test the policy effects eight quarters after the adoption. The results are similar and available upon request.

measurements are normalized to be zero at $\tau = -1$ and noted with the horizontal dashed line for easy comparison.

The figure shows that HPR policy was effective at reversing the upward trend of housing prices, transaction of new residential property and land sales revenue. Most price measurements fell to the lowest level six quarters after the policy adoption. For example, at the sixth quarter of the policy implementation, the NBS price index of newly constructed residential property (*PINew.NBS*, panel a) and secondary residential property (*PISecond.NBS*, panel b) declined slightly by 1.00 point and 2.09 point respectively. The housing price released by the City House (*price.Cityhouse*, panel c) fell considerably by RMB 468 , the price released by the CREIS (panel d) decreased by RMB 167, and the price index calculated by FGXZ (2015) (panel e) dropped by 0.14 points. Rental price (panel f) remains stable within four quarters of policy enforcement, but gains strong growth momentum henceforth.

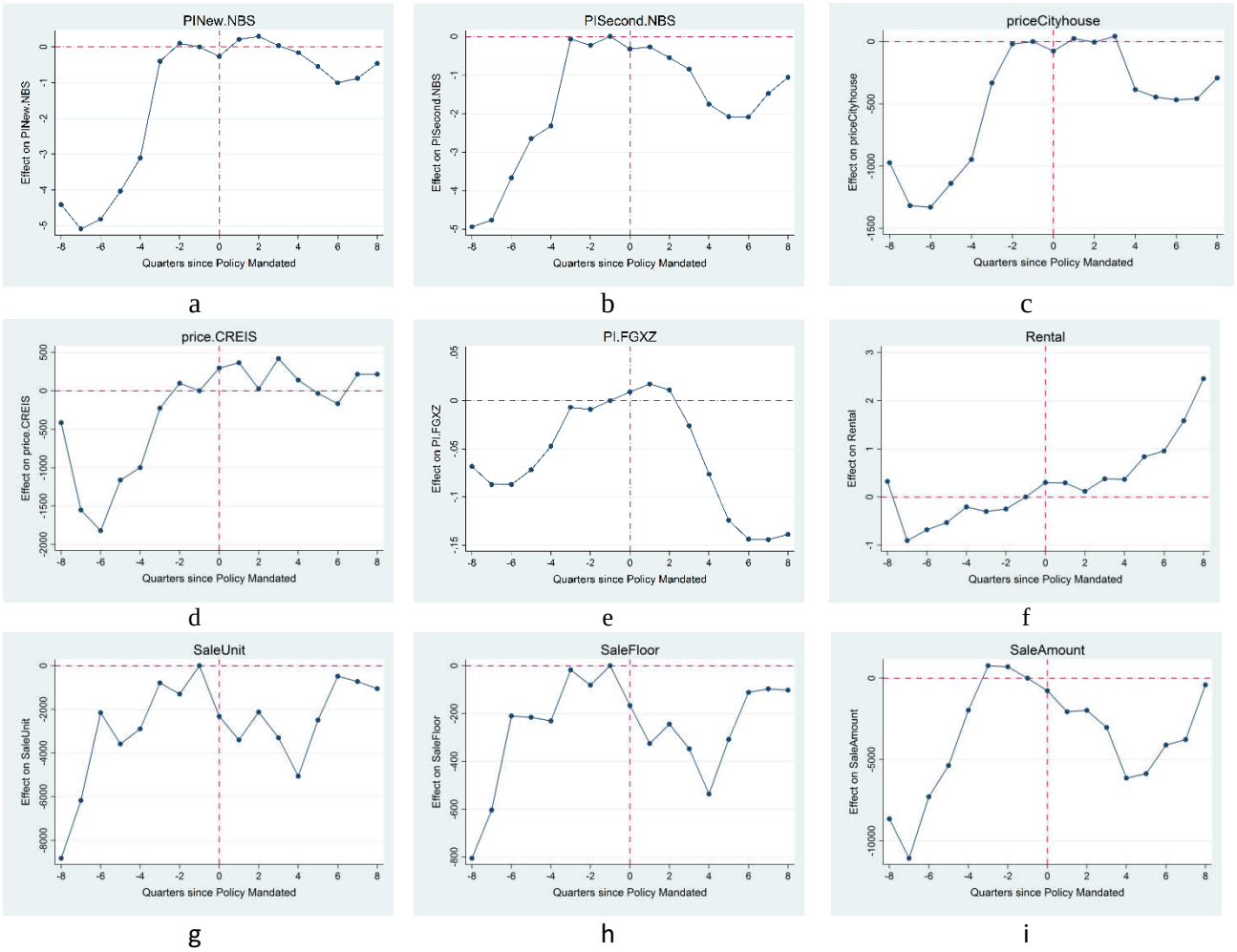
The policy's impacts on the new residential property transaction and land sales revenue are remarkable. Comparing with the quarter preceding the policy implementation, the floor space sold (*SaleFloor*, panel h) slumped by about 537 thousand square meters, the number of flat sold (*SaleUnit*, panel g) plummeted by 5,062 units and the sales amount (*SaleAmount*, panel i) precipitously dropped by RMB 6.43 billion at the fourth quarter of policy adoption. Land price and land sales revenue (panel n and o) plunged by RMB 4225 and RMB 5.40 billion at the fourth quarter of the policy enforcement.

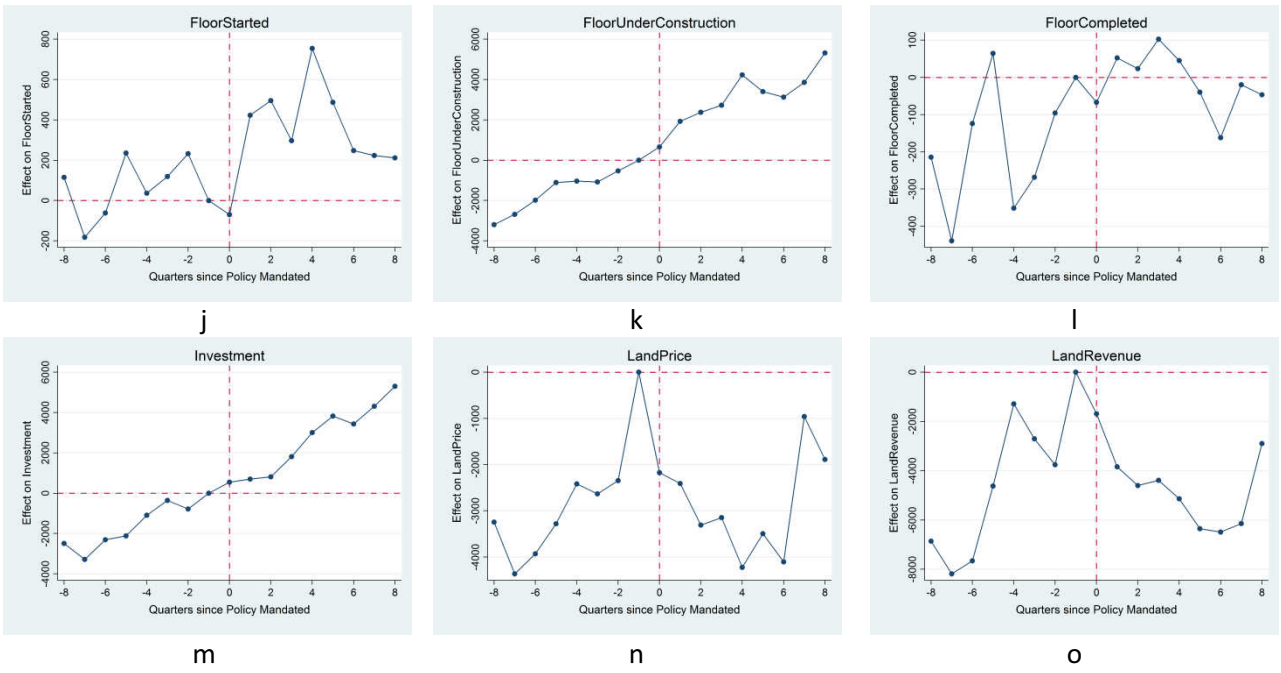
No sizable policy effect is witnessed for real estate investment and floor space under construction. On the contrary, their growth momentum remains strong in our sample period. This is because HPR policy is mainly designed to depress the speculation from demand

side. Moreover, local governments relying heavily on property investment for GDP growth do not have great incentives to suppress the property investment boom, although they are under the political pressure from the central government to control the housing price surge. Excess supply over demand in the housing market is an unavoidable consequence of misaligned incentives. A manifestation of this includes emergence of several ghost cities with empty houses.

Figure 1 Event Study of HPR Policy

The figures provide a graphic analysis of the effect of HPR policy on the housing market indicators by depicting the estimated σ_τ s from equation (1) against the event time τ. The quarter of the policy implementation, $\tau = 0$, is demarcated by a vertical dashed line in all figures. All property market measurements are normalized to equal zero at $\tau = -1$ and noted with the horizontal dashed line.





5.2 Quantitative Evidence

The oscillating trends for almost all real estate market indicators are observed in Figure 1. This suggests that the parallel trends assumption of the simple DID or mean shift model (i.e., equation (2A)) might be violated in many cases. This is particularly true for Chinese housing market where both prices and sales exhibited strong growing trends before the policy's enactment. Therefore, equations (2B) and (2C) that accounts for differential trends are more likely to produce valid estimates.

Tables 2-4 report the policy effects estimated by the two-stage DID approach. Column (1) lists the estimate of π_1 from equation (2A), which tests how σ_τ on average changes after the policy was mandated. Column (2) presents the estimate of π_1 and π_2 from fitting the equation (2B), where π_1 tests for the policy effectiveness by accounting for the trend (π_2). Column (3) shows the results from equation (2C) that allow for a mean shift and trend break after the policy is in force. We also report the estimated effect of the policy four quarters after the implementation, which is equal to $\pi_1 + 4\pi_3$.

The regression results presented in Table 2 confirm the graphical analysis in the previous subsection that the HPR policy dampened the rampant housing price surge. The results estimated from the most comprehensive second-stage specification (equation (2C)) listed in column (3) indicate that four quarters after the policy was in force, the NBS property price index *PINew.NBS* and *PISecond.NBS* declined by 3.81 and 4.76 points respectively, or by 2.8% and 3.5% of sample mean. However, the fall in the price released by the City House is phenomenal, ebbing by RMB 882 or 11.-43% of the sample mean four quarters after the policy is enforced. The price index estimated by FGXZ (2015) fell by 0.1 point or 7.5% of the mean value. No significant policy impact on the rental price is found a year after the policy is implemented.

Table 2 Trend Break Estimates of the Policy Effect on Housing Price and Rental Price

This table presents the regression results for the NBS property prices index, the price index calculated by FGXZ (2015) the housing price by the CREIS, the transaction and rental price released by the City House. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors are given in the parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. PINew.NBS			
π_1: l(*Policy*)	2.42***	0.03	0.06
	(0.77)	(1.41)	(0.68)
π_2: Time Trend		0.28*	0.85***
		(0.14)	(0.11)
π_3: l(*Policy*) × time trend			-0.97***
			(0.14)
4-quarter effect = $\pi_1 + 4\pi_3$			-3.81***
p-value			[0.00]
Observations	17	17	17
Panel B. PISecond.NBS			
π_1: l(*Policy*)	1.17	-0.80	-0.78
	(0.73)	(1.39)	(0.53)
π_2: Time Trend		0.23	0.81***
		(0.14)	(0.08)
π_3: l(*Policy*) × time trend			-1.00***
			(0.11)
4-quarter effect = $\pi_1 + 4\pi_3$			-4.76***
p-value			[0.00]
Observations	17	17	17

Panel C. price.Cityhouse			
π_1: l(*Policy*)	528.96**	146.36	152.17
	(201.41)	(399.92)	(228.44)
π_2: Time Trend		45.05	196.41***
		(40.78)	(36.18)
π_3: l(*Policy*) × time trend			-258.60***
			(47.28)
4-quarter effect = $\pi_1 + 4\pi_3$			-882.20***
p-Value			[0.01]
Observations	17	17	17
Panel D. price.CREIS			
π_1: l(*Policy*)	923.28***	383.60	385.62
	(250.85)	(491.53)	(417.32)
π_2: Time Trend		63.56	192.25**
		(50.13)	(66.26)
π_3: l(*Policy*) × time trend			-219.07**
			(86.45)
4-quarter effect = $\pi_1 + 4\pi_3$			-490.60
p-Value			[0.11]
Observations	17	17	17
Panel E. PI. FGXZ			
π1:*Policy*	-0.02	0.06	0.06**
	(0.03)	(0.05)	(0.02)
π2:Time Trend		-0.01	0.01***
		(0.01)	(0.00)
π3: *Policy** Time Trend			-0.04***
			(0.00)
4-Quarter Effect =π1+4π3			-0.10***
P-Value			[0.00]
Observations	17	17	17
Panel F. Rental			
π_1: l(*Policy*)	1.13***	-0.21	-0.20
	(0.30)	(0.47)	(0.40)
π_2: Time Trend		0.16***	0.03
		(0.05)	(0.06)
π_3: l(*Policy*) × time trend			0.21**
			(0.08)
4-quarter effect = $\pi_1 + 4\pi_3$			0.66
p-Value			[0.23]
Observations	17	17	17

Table 3 presents the estimation results for the new house sales and investment by the developers. The results derived from the equation (2C) with adjustments for differential

pretrends imply that the number of units sold, the floor space sold and the sales amount plummeted averagely by 7,510 units, 783.3 thousand square meters and RMB 12 billion respectively, at the magnitude of 55%, 56.3 % and 102 % compared to the whole sample mean four quarter after the policy adoption. This phenomenal fall in the sales volume hints that the policy enforcement is effective in dampen speculation by non-residents or policy-sensitive buyers. The plunge in both price and transaction volume is consistent with the findings reported by Sun et al. (2013) in their Beijing sample.

Similar to Figure 1, the regression results in Panel D of Table 3 reveal that there is little impact of the policy on real estate investment by property developers. The regression coefficient estimates for the four quarters' policy effect are positive (insignificant), indicating that property developers increased their investment regardless of the policy designed to cool the housing market. These findings are reinforced by the estimation results for the floor space started, under construction and completed presented in Panels A, B and C of Table 4. The overall evidence here suggests that HPR policy is ineffective in taming the massive property construction boom.

Table 3 Trend Break Estimates of the Policy Effect on Housing Sales and Investment

This table presents the regression results for sale unit, sale floor and sale amount for new homes as well as investment by the developers. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. SaleUnit			
π_1: l(*Policy*)	877.99	-4,329.06**	-4,329.75***
	(1,111.68)	(1,644.34)	(1,333.83)
π_2: Time Trend		613.15***	1,081.28***
		(167.64)	(212.06)
π_3: l(*Policy*) × time trend			-795.07**
			(276.36)
4-quarter effect = $\pi_1 + 4\pi_3$			-7510.0***
p-Value			[0.00]
Observations	17	17	17
Panel B. SaleFloor			
π_1: l(*Policy*)	20.04	-442.75**	-449.40***
	(107.97)	(170.65)	(137.68)
π_2: Time Trend		54.48***	104.60***
		(17.37)	(22.17)
π_3: l(*Policy*) × time trend			-83.49**
			(28.61)
4-quarter effect = $\pi_1 + 4\pi_3$			-783.3***
p-Value			[0.00]
Observations	17	17	17
Panel C. SaleAmount			
π_1: l(*Policy*)	972.43	-4,247.24	-4,244.03**
	(1,696.00)	(3,116.36)	(1,944.24)
π_2: Time Trend		614.65*	1,750.73***
		(317.72)	(309.01)
π_3: l(*Policy*) × time trend			-1,930.47***
			(402.80)
4-quarter effect = $\pi_1 + 4\pi_3$			-11965***
p-Value			[0.00]
Observations	17	17	17
Panel D. Investment			
π_1: l(*Policy*)	4,189.16***	-428.02	-432.95
	(725.36)	(478.88)	(434.71)
π_2: Time Trend		543.20***	438.31***
		(48.80)	(68.70)
π_3: l(*Policy*) × time trend			179.55*
			(89.89)
4-quarter effect = $\pi_1 + 4\pi_3$			285.26
p-Value			[0.25]
Observations	17	17	17

The reduction in land price and sales revenue is strongly related with the policy. The results presented in Panels D and E of Table 4 suggest that the land price and land sales revenue slumped by RMB 3483 and RMB 7.8 billion four quarters after the policy was mandated. This implies that the top-down effort in curbing the housing prices surge via HPR policy could hardly be supported by the local authorities that rely excessively on the revenue from land sales to finance their spending and investment in infrastructure.

Table 4 Trend Break Estimates of the Policy Effect on Construction and Land Sales

This table presents the regression results for the floor space started, floor space under construction, land price and land sales revenue. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors are given in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. FloorStarted			
π_1: l(*Policy*)	279.12**	196.87	196.02
	(95.65)	(195.77)	(202.10)
π_2: Time Trend		9.68	18.98
		(19.94)	(32.40)
π_3: l(*Policy*) × time trend			-15.59
			(41.96)
4-quarter effect = $\pi_1 + 4\pi_3$			133.68
p-Value			[0.62]
Observations	17	17	17
Panel B. FloorUnderConstruction			
π_1: l(*Policy*)	4,519.11***	803.13	802.69
	(602.06)	(491.48)	(509.59)
π_2: Time Trend		437.18***	427.82***
		(50.09)	(80.54)
π_3: l(*Policy*) × time trend			16.03
			(105.37)
4-quarter effect = $\pi_1 + 4\pi_3$			866.79
p-Value			[0.36]
Observations	17	17	17
Panel C. FloorCompleted			
π_1: l(*Policy*)	166.49**	120.50	121.58
	(63.87)	(131.57)	(126.17)
π_2: Time Trend		5.41	28.14
		(13.41)	(19.94)
π_3: l(*Policy*) × time trend			-38.91

			(26.09)
4-quarter effect = $\pi_1 + 4\pi_3$			-34.05
p-Value			[0.45]
Observations	17	17	17
Panel D. LandPrice			
π_1: l(*Policy*)	-74.86	-1,941.72*	-1,931.48*
	(583.78)	(1,063.34)	(973.19)
π_2: Time Trend		219.68*	446.40**
		(108.39)	(153.88)
π_3: l(*Policy*) × time trend			-387.93*
			(201.28)
4-quarter effect = $\pi_1 + 4\pi_3$			-3483.00**
p-Value			[0.02]
Observations	17	17	17
Panel E. LandRevenue			
π_1: l(*Policy*)	-221.31	-2,483.84	-2,448.37
	(1,157.04)	(2,292.92)	(1,552.70)
π_2: Time Trend		266.25	1,052.09***
		(233.72)	(245.51)
π_3: l(*Policy*) × time trend			-1,344.65***
			(321.15)
4-quarter effect = $\pi_1 + 4\pi_3$			-7826.00***
p-Value			[0.00]
Observations	17	17	17

5.3 Robustness Check

This section performs two robustness checks to verify the validity of two-step DID method, including the structural break test and different sample test.

5.3.1 Structural Break Test

This subsection employs the structural break test developed by Greenstone and Hanna (2014) to check the robustness of the two-stage DID design. The basic idea is to assess if there is a structural break in the policy parameters (i.e., π_1 and π_3) estimated from the second-stage specification of equation (2C) around the time of policy implementation. The test first identifies the time at which the largest change in parameters (proxied by the largest change in the *F*-statistics) occurs and then generates *p*-values to judge if the changes in

those parameters are different from zero. A significant break around the time of policy implementation, i.e. $\tau = 0$, or some quarters after $\tau = 0$ would prove the existence of a policy effect from the DID results. In contrast, failure to find a break or finding of a break significantly before the time of policy adoption implies the ineffectiveness of the policy.

Greenstone and Hanna (2014) use the Quandt likelihood ratio (QLR) statistic to select the maximum value of the *F*-statistics to test the existence of a break at an unknown date. We use the same method and report the results in both Figure 2 and Table 5. As shown in Figure 2, the structural breaks of NBS price index of newly constructed (*PINew.NBS*) and secondary residential house (*PISecond.NBS*) occur before the policy implementation while the QLR statistic identifies the significant breaks three quarters preceding the event. This finding implies the ineffectiveness of the policy in curbing the growth of housing price, which is also consistent with the small effect of HPR policy on official price index shown in the previous two subsections. However, the test on the price index calculated by FGXZ (2015) is very significant, implying the precipitous drop of housing price three quarters after the policy enforcement, i.e. $\tau = 3$. The evidence is consistent with FGXZ (2015) in the sense that their housing price index has better quality than NBS data.

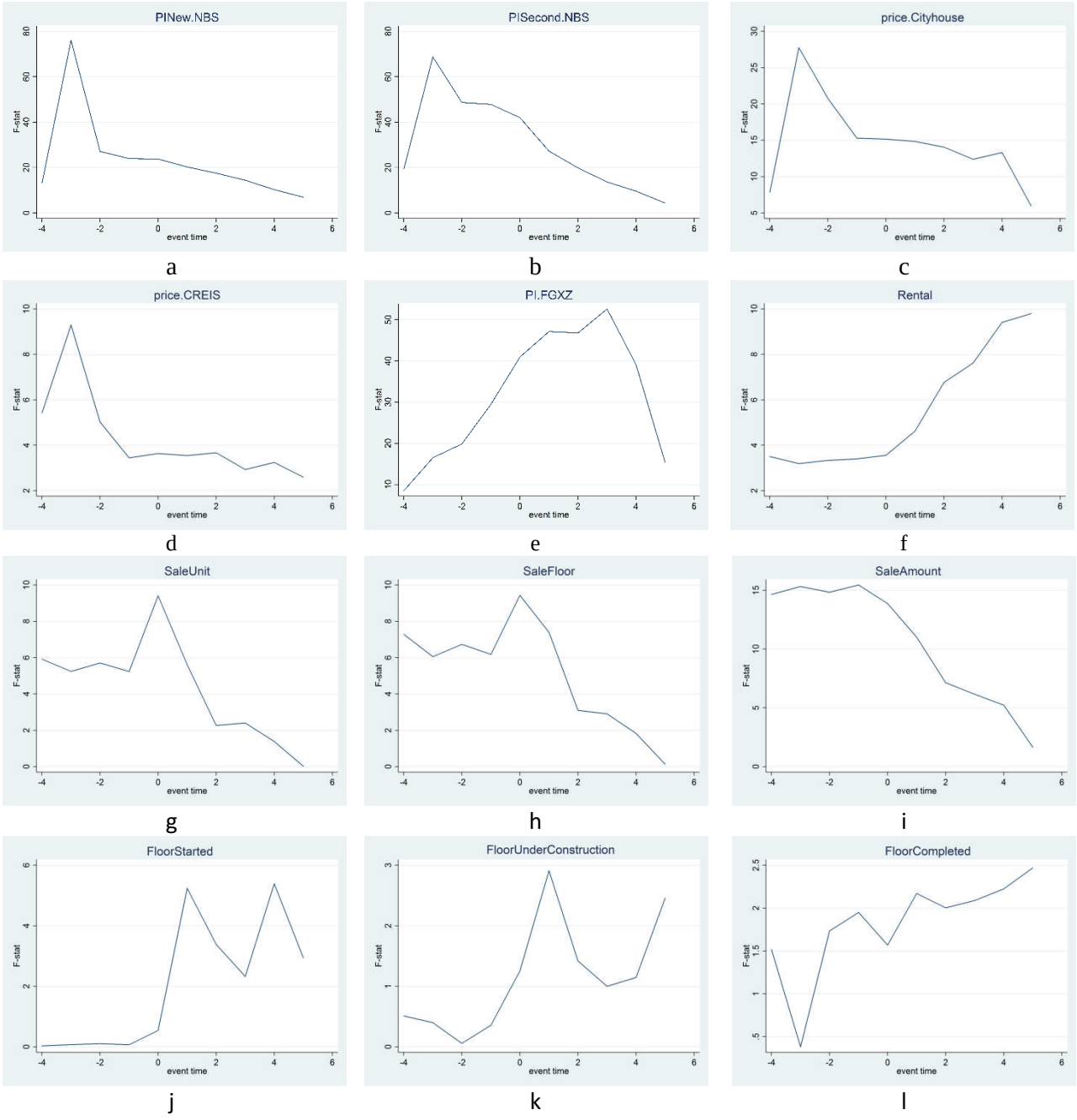
With respect to the transactions, Figure 2 evidently picks the occurrence of the biggest F-statistics around $\tau = 0$. Moreover, Table 5 reveals that the null hypothesis of no break at $\tau = -1$ can be significantly rejected for the sales amount. These findings further prove that the policy causes significant and sharp decline in the property transaction volume.

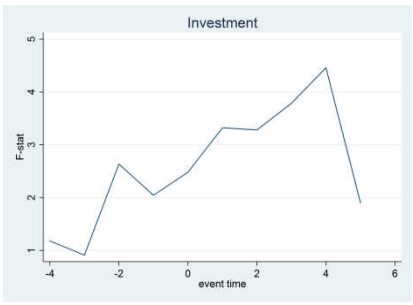
The structural break test results for the real estate investment, floor space started and construction are broadly supportive on the findings of the previous two subsections. The breaks representing by the largest *F*-statistics are found at $\tau = 3$, 4 and -4 respectively

where the null hypothesis of zero effect cannot be rejected, confirming that the policy do not change the construction boom, neither does it help address the potential oversupply of housing in the market.

Figure 2 F-statistics from QLR Test

The figure shows the structural break tests using Quandt likelihood ratio (QLR) statistic. The horizontal axis is the event time τ. The vertical axis is the F-statistics for the QLR tests.





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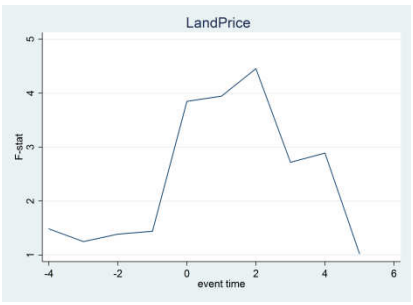

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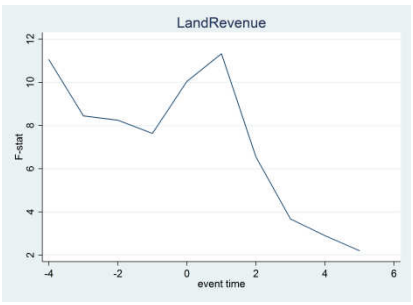

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The QRL test shown in Figure 2 for the land sales revenue evidently selects $\tau = 1$ as the event time with the most substantial break. Table 5 reinforces that the null hypothesis of no break at $\tau = 3$ can be rejected at high significance. This result further proves the decline of land sales revenue triggered by the HPR policy.

Table 5 Structural Break Analysis

Table 5 presents the results of structural break tests using the QLR test statistic and the corresponding quarter of the break in the data estimated from the specification of equation (2C). *** p<0.01, ** p<0.05, * p<0.1

	Quarter of maximum *F*-statistics	QLR test statistic
PINew.NBS	-3	76.007***
PISecond.NBS	-3	68.713***
Price.Cityhouse	-3	27.751***
Price.CREIS	-3	9.294
PI.FGXZ.	3	52.614***
Rental	5	9.794
SaleUnit	0	9.405
SaleFloor	0	9.4297
SaleAmount	-1	15.456***
Investment	4	4.462
FloorStarted	4	5.387
FloorUnderConstruction	1	2.908
FloorComplete	5	2.469
LandPrice	2	4.453
LandRevenue	1	11.324**

5.3.2 Robust Test with Different Samples

The sample from NBS data on property price index report relatively few observations. We use other data sources and increase the sample to 139 cities (45 of them with the home

purchase restriction policy). All the robust tests with the enlarged sample are reported in the Appendix. Appendix C maps the location of these cities. Appendix D reports the two step-DID estimation results that are consistent with those for the sample of 70 cities. Several points need to be noted: first, the decrease in the housing prices or price index following the policy implementation is much larger than that for the 70 city samples. Second, the transaction measured by the sale amount, sales unit and floor space sold plummeted significantly after the policy is in force, although smaller in magnitude than that for the 70 city samples. Third, the HPR policy has no measurable impacts on the housing construction and investment. Forth, the land price and land sales revenue plunged sharply after the policy was enacted.

6. Political Connections and HPR Policy Implementation: An Endogenous Treatment Effects Regression

We further address the endogeneity problem of HPR policy. Since the implementation of HPR policy is not random, some unobservable factors may affect the policy implementation and housing price growth simultaneously.

We employ an endogenous treatment effects model[15] to address the non-random adoption of HPR policy. Under this framework, we have an outcome equation and a treatment equation where the treatment is binary and the outcomes are continuous variables. The outcome equation describing the growth of housing price (y_j) can be expressed as:

$$y_j = X_j\theta + \delta T_j + \epsilon_j. \quad (3)$$

[15] See Imbens (2004); Cameron & Trivedi (2005), chapter 2.7; Imbens & Wooldridge (2009); and Wooldridge (2010), chapter 21 for more detailed discussions of the treatment effects model.

where X_j is a set of observable covariates affecting the housing price movements, including the disposable income, residential population, and developed area of city construction . ϵ_j is an idiosyncratic error term. T_i is the treatment variable representing a city's policy implementation as follows:

$$T_i = \begin{cases} 1, & if\ W_j\gamma + u_j > 0 \\ 0, & otherwise \end{cases}. \tag{4}$$

where W_j are the covariates used to model treatment assignment. The error terms ϵ_j and u_j are bivariate normal with mean zero and covariance matrix of

$$\begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix} \tag{5}$$

where ρ measures the correlation between the treatment errors and the outcome errors. The covariates X_j and W_j are unrelated to the error terms; in other words, they are exogenous.

We instrument the assignment of treatment or implementation of HPR policy with local governors' political connection with the central government. In China, central and local governments have conflict of interest in the property sector (Li, Chiang and Choy, 2011). In the wake of US subprime mortgage crisis, Chinese central government wishes to curb the housing bubble and avoid potential financial risks, while local governments rely heavily on the real estate sector for GDP growth and fiscal revenue. As pointed out by de Mesquita, Smith, Siverson and Morrow (2003), the key objective for any government is political survival and the key condition for survival is to have ample financial resources under government control. In China, local governors with a strong political connection not only have higher probability of promotion but also can easily get fiscal resources (like transfer from the central government) to promote economic growth, rather than rely heavily on the real estate sector (Huang and Chen, 2012). Hence, to what degree local governments

would comply with the central government's objective to cool housing market depends on local authorities' political connection with the central government

Under China's current political system, the Communist Party is responsible for the formulation of policies and the government is responsible for its day-to-day execution. A city's party secretary the leader of the Communist Party in an administrative region, hence is the *de facto* highest political office of its area of jurisdiction and more senior than the mayor. He plays a critical role in the local policy making by selecting key government officials and assigning crucial tasks. Therefore, whether a city would implement HPR policy is mainly decided by its party secretary's willingness and political connection with the central government.

A city's party secretary is connected with central government via three forms: 1) being the member of Communist Party's Central Committee or National Party Congress; 2) being the member of the National People's Congress (NPC); or 3) having been worked for the central government before. Although the NPC is the top legislative organization in China, the Communist Party is the ultimate controller of power. The Central Committee, the highest committee-level authority within the CCP, is elected by the National Party Congress every five years. The present 18th Central Committee elected in 2012 has approximately 200 members; among those, 25 occupy a seat in the Political Bureau (*Politburo*), where the ultimate authority of the CCP rests. Below the Central Committee, there are approximately 200 alternate members to replace the committee members who have either died or been dismissed.

To reflect the features of the Chinese political system and estimate its influence on the HPR policy adoption, we follow Huang and Chen (2012) to construct a political connection

index for each city in the year of 2011 when the HPR policy was enforced by most cities. In the calculation, we assigned a value of 7 to municipal party secretaries who are *Politburo* members; a value of 5 to those who are Central Committee members or previously worked for the central government; a value of 4 to those who are Central Committee alternate members; a value of 3 to those who are the members of National Party Congress; a value of 2 to those who are the members of NPC; and a value of 1 to those not belong to any of these categories. We obtain the name list of the party secretaries for each city from Zecheng website and biographies of city party secretaries mainly from Baidu Encyclopedia.

A comprehensive study of the advancement of Central Committee members in China indicates that the promotion of local governors to the Central Committee is closely related to the factional ties to top leaders, but not to economic growth (Shih, Adolph and Liu, 2012). Moreover, the timing of appointments of the members of Central Committee and National Party Congress closely follows the central political cycle. Most of new appointment is made in the year prior to or in the same year as the beginning of a new *Politburo* term.[16] This implies that the political connections of most cities' party secretaries in 2011 was decided in 2006 or 2007, long before the HPR policy was enforced. In addition, according to the Chinese cadre system, the assignment of central government officials to the positions at local jurisdictions is decided by the Organization Department that holds over personnel throughout every level of government and industry and uses the *nomenklatura* method to determine appointments.[17] Therefore, the political connection index we constructed should satisfy the exclusion restriction requirement.

[16] The three recent turnovers of Politburo took place in 2002, 2007 and 2012.
[17] *Nomenklatura* is "list of names" in Soviet terminology.

Table 6 reports the endogenous treatment effects regression results estimated by the maximum likelihood approach. For the outcome equation, the dependent variable (y_j) is the percentage change of housing price from 2012 to 2013, the independent variable of our main interest is HPR policy. The coefficient on HPR policy measures the average treatment effect of the policy. We employ the percentage change of disposable income, developed area of city construction and residential population from 2012 to 2013 to control the demand and supply side factors that might affect the housing price movement. In the treatment equation, besides the political connection index, the percentage change of housing price from 2008 to 2009 is included to account for the concern that the rampant housing price surge prior to the policy adoption results in the enforcement of HPR policy. The likelihood-ratio (LR) tests for regression (2) and (3) presented in the bottom of panel A are statistically significant, indicating that we reject the null hypothesis of no correlation between the treatment errors and the outcome errors. This suggests that the adoption of the HPR policy is endogenous. In the treatment equation, the coefficient on the political connection is statistically significant, implying that cities with higher political connection with the central government are more likely to adopt HPR policy to curb the housing bubble. In the outcome equation, the coefficients on HPR policy or the average treatment effects (ATE) of the policy, are significantly negative, hinting the effectiveness of the HPR policy in dampening housing price growth. Taking regression (1) as an example, the housing price growth rate in the adopting cities is on average 0.12% lower than the nonadopting cities.

Table 6 HPR policy and housing price with endogeneity treatment effects regression

Panel A. Outcome equation				
	(1)	(2)	(3)	(4)
	%Δ PI.FGXZ.	%Δ Price.CREIS	%Δ PINew.NBS	%Δ Price.Cityhouse
HPR policy	-0.12***	-0.20***	-0.03***	0.04
	(0.04)	(0.00)	(0.01)	(0.05)
%Δ disposable income	0.24	-0.29	0.01	-0.27
	(0.22)	(0.29)	(0.08)	(0.17)
%Δ developed area of city construction	0.11	-0.05***	0.00	0.01
	(0.08)	(0.01)	(0.03)	(0.06)
%Δ residential population	0.48	2.09**	0.19	0.68
	(0.87)	(1.02)	(0.31)	(0.67)
LR test of $\rho = 0$	1.265	12.73	7.079	=0.170
p-value	0.261	0.000	0.008	0.681
Observation	51	41	69	69
Panel B. Treatment equation: determinants of adopting HPR policy				
Political connection in 2011		0.174**		
		(0.102)		
%Δ housing price before policy adoption		11.428*		
		(6.964)		
Constant		-0.882**		
		(0.441)		
AIC		91.7796		
BIC		98.498		
Log likelihood		-42.898		

Note: standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

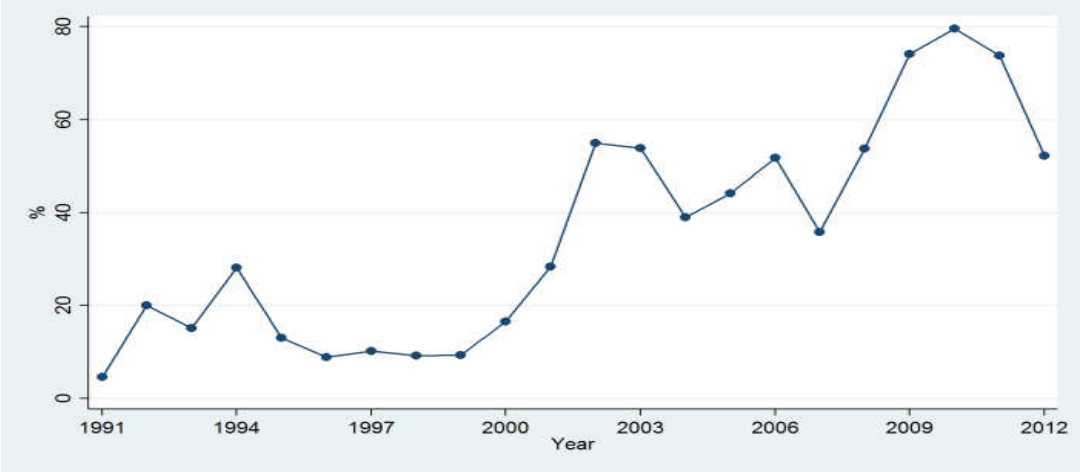
7. CROSS-SECTIONAL TESTS OF POLICY EFFECTS

Since real estate market carries quite a few of local characteristics, the effect of HPR policy on different cities can vary greatly. In this section, we follow Greenstone and Hanna (2014)'s practice to compare the policy effects across cities. The main idea is to divide the sample cities into those with above and below the median value of a given proxy, estimate separate σ_τs for these cities with equation (1), stacking the two sets of σ_τs obtained from the estimation of equation (2C), and then test whether $\pi_1 + 4\pi_3$ is the same for the two sets of policy adopting cities. We divide cities into two groups according to three different measures: their reliance on land sales for fiscal revenue, dependence on real estate investments for economic growth, and pace of urban expansion.

A. Land Finance

Land and housing are important fiscal sources in many countries, but China's land finance, or heavy and growing fiscal reliance on land sales revenue by the local authorities, carries several important characteristics that generate far-reaching impacts on the real estate market.

Figure 3 Ratio of Land Sales Revenue to Budgetary Revenue of Municipal Governments
The data for the years of 1989-2009 is from Barth et al. (2012) and the rest is calculated by the authors where the data of land sales revenue is obtained from China Land & Resources Yearbook (2011-2013) and the data of budgetary revenue is from CEIC.



Under the current intergovernmental fiscal relationship established in 1994, local governments currently receive half the nation's fiscal revenue but are responsible for 80% of spending (The Economist, 2014). Facing heavy expenditure responsibilities, local governments depend heavily on off-budgetary sources such as profits from expropriating farmers' land, revenue related to land sales and transactions, and so forth (Huang and Chen, 2012). As shown in Figure 3, the ratio of land sales to municipal government budgetary revenue[18] increased from less than 1% in the early 1990s to around 80% in 2010. Among our 70 sample cities, the average ratio of land sales revenue to budgetary revenue for the

[18] Budgetary revenue consists mainly of tax revenue and state-owned enterprise contributions.

years of 2001-2011 shows large variations across cities ranging from 11% to 117%. Cities having meager fiscal resources or tremendous needs for infrastructure investment exhibit higher degree of reliance on land finance.

Besides, land finance builds up a territory-based coalition between local governments and real estate developers both of whom cash in their political power and expand their wealth in a reciprocal way through the increasing intensification of land use (Fu, 2014). For example, by investing in the urban infrastructure with the land sales revenue, local authorities could prop up the sales of real estate and facilitate the flow of capital and goods, consistent with enlarged 'tax base' of the city (Logan and Molotch, 2007).

However, tremendous negative externalities and social costs have arisen due to land finance, including soaring housing prices, forcible land seizures in cities, rural land expropriation, unrests related to land and housing problems (Lin, 2009) and debt-laden local fiscal system (Tsui, 2011). In terms of the impacts on real estate market, although the immense land sales revenue spurs the local authorities to increase the supply of land for urban residential purposes (Chen et al., 2011), it also inflates housing prices by imposing substantial yet mandatory costs on real estate development (Fu, 2014).

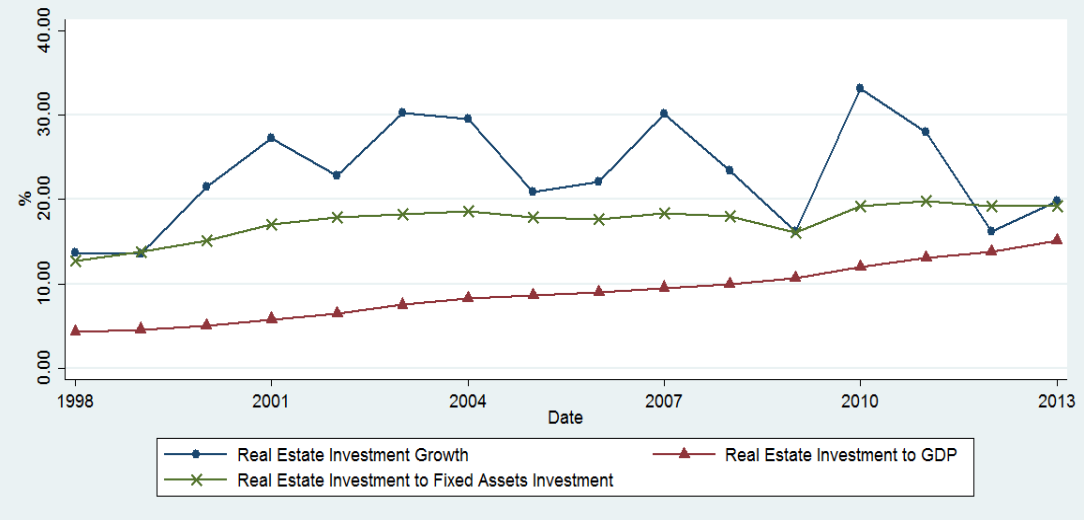
B. Real Estate Investment dependence

A considerable volume of literature has investigated the dynamic interaction between real estate investment and economic growth (for example, Braid, 2001; Brito and Perreira, 2002; Coulson and Kim, 2000; Liu et al. 2002). However, the role of real estate investment in Chinese economy is an issue merits special scrutiny.

China's more than a decade of spectacular economic growth, much of it in double digits, is mainly achieved by the gigantic investment whose share in the total economic

activity is as high as around 50% in 2012.[19] As shown in Figure 4, being the most significant contributor to the GDP growth, the real estate investment has grown at an average annual pace of 23% for the last 15 years. Given its extensive industrial linkage, real estate investment is of particular importance to create job opportunities and hence stave off social unrest for China whose workforce swelled by about 145 million from 1990 to 2008 (The Economist, 2012). Real estate-related industries, in particular, construction, steel, cement, copper and glass industries are key job providers for low skilled workers in China.

Figure 4 The Importance of Real Estate Investment in the Economy
The figure depicts the percentage of real estate investment to GDP, real estate growth rate and real estate investment to national fixed asset investment. The data is obtained from CEIC.



Moreover, under China's current political systems, achieving high economic growth is the main promotion criterion for local authorities. Driven by this target, local governments fostered reckless real estate investment across the nation, especially after

[19] According to China Statistical Yearbook 2013, the capital formation rate, which is computed as the share of gross capital formation in the GDP by expenditure approach, amounts to 47.8% in 2012.

2008 when housing is chosen as a key part of the economic rescue plan to fight against the global financial crisis. However, such spectacular building boom would be unsustainable as the housing market matures, population ages, urbanization slows down, and the rate of return of investment declines (Bai, Hsieh and Qian, 2006). Empty buildings and ghost towns have testified to the oversupply of housing and massive misallocation of resources in China.

Overinvestment in housing is more acute in smaller cities, where new drivers of growth are often lacking. To measure the importance of real estate investment to local economy, we calculate the average ratio of real estate investment to fixed asset investment as well as to GDP for the years of 2005-2013. The latter ratio varies substantially from 4% to 50% among our 70 sample cities, with Sanya topping in the dependence of property investment.

C. Urban sprawl

China's property boom is accompanied by the country's impressive and unprecedented urbanization process whose speed has been much faster than that in Western countries during their industrial transformations. It took China only 30 years to climb from 20% of urbanization to today's 54% while the equivalent journey took 100 years in Britain and 60 years in America (The Economist, 2014).

Some believe that the urbanization and internal migration is one of the most important forces to purport Chinese property boom (Economic Intelligence Unit, 2011). However, a very special feature of Chinese urbanization process is that the growth of urban area has outstripped the growth of urban residents. On average, the built-up areas across the country have recently been growing by 8% a year whereas their populations have been rising by

only 5% (The Economist, 2014)[20]. As a result, for the years of 2000-2011, the urban built-up areas grow by 76.4% while the urban population only increases by 50.5% (Southern Weekly, 2014)[21]. The gap is far wider in inland cities with urban areas growing three times faster than their populations. In those cities where the urban area is expanding too fast, the stock of new housing is also soaring and hence would have a serious problem of structural oversupply. The ratio of urban land area in 2010 to that in 1980 released by the Beijing City Lab (BCL)[22] indicates that the population density in around a quarter of cities is declining as the growth of urban population lags behind the growth of urban area.

7.2 Quantitative Evidence

Table 7 reports the test results of how the HPR policy effect four quarters after implementation varies in cities with above (relative to below) the median measures of land finance reliance, real estate investment dependence and urban expansion.

Table 7 Differences in Policy Effects across Cities

This table reports the results of how the HPR policy effect four quarters after implementation varies in cities with above (relative to below) the median measures of land finance reliance, real estate investment dependence and urban expansion.

	Land finance reliance	Real Estate Investment/ fixed asset investment	Real Estate Investment/GDP	Urban Expansion
	(1)	(2)	(3)	(4)
Panel 1. PINew.NBS				
Difference in four quarter effect	-2.58	-4.4***	-2.3	-6.5***
p-value	[0.11]	[0.00]	[0.21]	[0.00]
Observations	34	34	34	33
Panel 2. PISecond.NBS				
Difference in four quarter effect	-2.56**	-4.26***	-3.84***	-4.15***
p-value	[0.05]	[0.00]	[0.00]	[0.00]
Observations	34	34	34	33
Panel 3. price.Cityhouse				

[20] The rampant urban sprawl is actually the result of local governments' ability to seize rural land at will. Moreover, local bureaucrats have a predilection for vast areas of concrete because massive buildings help to boost local officials' egos and brand their cities.

[21] Available at http://www.infzm.com/content/106082

[22] The data is released at the website http://www.beijingcitylab.com/. Beijing City Lab infers urban land for all Chinese cities at the prefectural level and above in 1980 and 2010 from remotely sensed images. The ratio between urban land area in 2010 and that in 1980 is used to approximate the degree of urban expansion in individual cities.

Difference in four quarter effect	-1153.00**	157.62	139.72	-885.7*
p-value	[0.03]	[0.70]	[0.93]	[0.01]
Observations	33	34	33	34
Panel 4. price.CREIS				
Difference in four quarter effect	1421.8	-99.62	1553.4	-752.00
p-value	[.11]	[10]	[0.19]	[0.15]
Observations	33	33	34	34
Panel 5. PI.FGXZ				
Difference in four quarter effect	0.02	-0.04	0.07	-0.03
p-value	[0.61]	[0.33]	[0.16]	[0.22]
Observations	34	34	34	34
Panel 6. Rental				
Difference in four quarter effect	-1.96**	2.20**	-0.32	-0.28
p-value	[0.03]	[0.01]	[0.72]	[0.72]
Observations	34	34	34	33
Panel 7. SaleUnit				
Difference in four quarter effect	4519.10	68.14	-7000.00**	2415.30
p-value	[0.22]	[0.99]	[0.05]	[0.39]
Observations	34	33	34	33
Panel 8.SaleFloor				
Difference in four quarter effect	352.76	64.22	-703.70**	-35.44
p-value	[0.31]	[0.68]	[0.05]	[0.93]
Observations	34	33	34	33
Panel 8.SaleAmount				
Difference in four quarter effect	4905.10	315.25	-5166.00	-2215.00
p-value	[0.28]	[0.94]	[0.41]	[0.89]
Observations	33	34	33	33
Panel 8.Investment				
Difference in four quarter effect	1947.0*	-387.60	-259.70	-907.90
p-value	[0.09]	[0.10]	[0.82]	[0.13]
Observations	34	34	34	33
Panel 9.FloorStarted				
Difference in four quarter effect	-68.21	-469.10	-390.60	-201.30
p-value	[0.89]	[0.59]	[0.80]	[0.76]
Observations	33	33	34	33
Panel 10. FloorUnderConstruction				
Difference in four quarter effect	810.54	1921.80	-64.64	1465.80
p-value	[0.47]	[0.07]	[0.39]	[0.27]
Observations	34	34	34	33
Panel 9.FloorCompleted				
Difference in four quarter effect	-127.60	527.91	125.48	-258.1
p-value	[0.68]	[0.14]	[0.69]	[0.57]
Observations	34	33	34	33
Panel 11.LandPrice				
Difference in four quarter effect	1458.30	-1650.00	1085.20	-3082.00
p-value	[0.58]	[0.48]	[0.70]	[0.16]
Difference in eight quarter effect	1700.20	-2615.00	1226.70	-4177.00
p-value	[0.66]	[0.46]	[0.62]	[0.13]
Observations	34	34	34	34
Panel 12.LandRevenue				
Difference in four quarter effect	1741.80	-2675.00	-1530.00	205.91
p-value	[0.60]	[0.45]	[0.62]	[0.90]
Observations	33	34	34	34

The results for the three price indicators, i.e. *PINew.NBS, PISecond.NBS* and *Price.Cityhouse* are significantly negative, implying that the cities with land finance reliance, real estate investment dependence and urban expansion pace above the median value experience larger decline in the housing price. Moreover, panel 7 and 8 indicates that cities who have higher ratio of real estate investment to GDP observe more drops in housing sales. These findings indicate that housing market is more fragile in these cities. An external demand shock like the implementation of HPR policy would trigger larger corrections in them. No significant differences in investment and construction of real estate are found between two groups of cities, hinting the overheated property boom all over the nation.

8. CONCLUSION

Due to the skyscraping housing prices across the nation and the failure of traditional macroprudential policies to contain speculation in the property market, Chinese central government encourages local authorities to impose HPR policy to curb real estate speculation and stabilize housing prices. Among our sample of 70 cities, 39 local authorities adopted HPR policy starting from 2010. With a comprehensive real estate market data, this research systematically investigates the impacts of Chinese HPR policy on the property markets. To address endogeneity problems and refer casual relation, we employ two empirical strategies including the two-step DID approach and endogeneous treatment effects regression. We find that HPR policy leads to significant changes in the housing market.

HPR policy has negative impact on property price as well as remarkable effect in reducing transaction volume. The policy seems to be effective in dampening housing demand. However, the policy failed to restrain the nationwide property construction boom. Investment by property developers actually increased after the implementation of the policy. The cross sectional tests show that the HPR policy has more pronounced effect on housing prices for cities with heavy reliance on real estate, while these cities continue greater property investment and construction boom than those with less dependence on housing market.

Our findings cast serious doubts on the overall effectiveness of HPR in China. Such a policy seems to work temporarily well to stabilize housing prices and repress housing transaction volumes, but it does not correct a potential housing market excess supply. We first time provide empirical study that cities experience great investment or construction boom. This pattern is more pronounced in cities with high dependence on housing market for GDP growth and fiscal revenue. These evidences are consistent with government's misalignment of incentives and circumvention of the HPR policy.

From the policy perspective, our research suggests that the policies designed to contain the housing bubbles by choking demand may have limited effects. The housing problem in China needs to address some fundamental issues, e.g., lack of investment vehicles, the over-dependence of economic growth on real estate investment and the heavy fiscal reliance of local governments on land sales. The housing problem continues to present a fundamental risk to the Chinese and global economic stability. Governments should consider new ways of imposing transaction costs on speculators of both home purchasers and real estate developers.

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Appendix A Variable descriptions

Variable	Definition	Unit	Source
PINew.NBS	Property price index: newly constructed residential property	2005Q2=100	NBS, CEIC
PISecond.NBS	Property price index: secondary residential property	2005Q2=100	NBS, CEIC
Price.Cityhouse	Price of secondary residential property	RMB per square meter	City House
PI.FGXZ	Property price index estimated by FGXZ (2015)	2009Q1=1	FGXZ(2015)
Rental	Rental Price of residential property	RMB per square meter	City House
SaleUnit	Number of flats sold: newly constructed residential property	Unit	CREIS, CEIC
SaleFloor	Floor space sold: newly constructed residential property	thousand square meters	CREIS, CEIC
SaleAmount	Sales amount of newly constructed residential property	RMB million	CREIS, CEIC
Investment	Investment on new residential property seasonality adjusted	RMB million	NBS, CEIC
Floorstarted	Floor space started	thousand square meters	CREIS, CEIC
Floorconsturction	Floor space under construction	thousand square meters	CREIS, CEIC
LandPrice	Land Price	RMB per square meter	CREIS
LandRevenue	Land Sales Revenue	RMB million	CREIS
Population	Resident Population	thousand person	CREIS, city and provincial yearbook
DPI	Disposable Income per Capita Seasonality Adjusted	RMB	NBS, CEIC
GDPPC	GDP per capita	RMB	NBS, CEIC

Appendix B Implementation of home purchase restriction policies across 70 cities

No.	Name	Starting date	Ending date	Policy implementation	No.	Name	Starting date	Ending date	Policy implementation
1	Beijing	01-05-2010		YES	36	Tangshan			NO
2	Tianjin	01-03-2011	01-08-2014	YES	37	Qingdao			NO
3	Shijiazhuang	21-02-2011	26-09-2014	YES	38	Baotou			NO
4	Taiyuan	19-02-2011	04-08-2014	YES	39	Dandong			NO
5	Hohhot	31-03-2011	24-06-2014	YES	40	Jinzhou			NO
6	Shenyang	25-02-2011	10-06-2014	YES	41	Jilin			NO
7	Dalian	19-11-2010	03-09-2014	YES	42	Mudanjiang			NO
8	Changchun	28-01-2011	19-07-2014	YES	43	Wuxi	20-02-2011	30-08-2014	YES
9	Harbin	28-02-2011	16-08-2014	YES	44	Yangzhou			NO
10	Shanghai	01-02-2011		YES	45	Xuzhou	01-05-2011	01-08-2014	YES
11	Nanjing	19-02-2011	21-09-2014	YES	46	Wenzhou	14-03-2011	30-07-2014	YES
12	Hangzhou	01-03-2011	29-08-2014	YES	47	Jinhua	31-03-2011	01-08-2014	YES
13	Ningbo	22-02-2011	30-07-2014	YES	48	Bengbu			NO
14	Hefei	31-03-2011	02-08-2014	YES	49	Anqing			NO
15	Fuzhou	10-10-2010	01-08-2014	YES	50	Quanzhou			NO
16	Xiamen	01-10-2010	01-07-2014	YES	51	Jiujiang			NO
17	Nanchang	01-02-2011	12-08-2014	YES	52	Ganzhou			NO
18	Jinan	21-01-2011	10-07-2014	YES	53	Yantai			NO
19	Qingdao	31-01-2011	01-08-2014	YES	54	Jining			NO
20	Zhengzhou	31-12-2010	09-08-2014	YES	55	Luoyang			NO
21	Wuhan	14-01-2011	24-09-2014	YES	56	Pingdingshan			NO
22	Changsha	04-03-2011	06-08-2014	YES	57	Yichang			NO
23	Guangzhou	15-10-2010		YES	58	Xiangyang			NO
24	Shenzhen	30-09-2010		YES	59	Yueyang			NO
25	Nanning	01-03-2011	01-10-2014	YES	60	Changde			NO
26	Haikou	28-02-2011	22-07-2014	YES	61	Huizhou			NO
27	Chongqing			NO	62	Zhanjiang			NO
28	Chengdu	15-02-2011	22-07-2014	YES	63	Shaoguan			NO
29	Guiyang	20-02-2011	01-09-2014	YES	64	Guilin			NO
30	Kunming	18-01-2011	11-08-2014	YES	65	Beihai			NO
31	Xian	25-02-2011	01-09-2014	YES	66	Sanya	03-03-2011	07-10-2014	YES
32	Lanzhou	05-11-2010	03-09-2014	YES	67	Luzhou			NO
33	Xining	25-02-2011	10-09-2014	YES	68	Nanchong			NO
34	Yinchuan	22-02-2011	22-08-2014	YES	69	Zunyi			NO
35	Urumqi	28-02-2011	01-08-2014	YES	70	Dali			NO

Appendix C Location of 139 cities

Appendix D Trend Break Estimates of the Policy Effect in 139 cities

Table A1 Trend Break Estimates of the Policy Effect on Housing Price and Rental Price of 139 cities

This table presents the regression results for the NBS property prices index, as well as the transaction and rental price released by the City House. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. price.Cityhouse			
π_1: l(*Policy*)	512.77**	-54.75	-66.97
	(195.19)	(362.57)	(141.70)
π_2: Time Trend		66.88*	222.34***
		(36.96)	(22.71)
π_3: l(*Policy*) × time trend			-261.06***
			(29.43)
4-quarter effect = $\pi_1 + 4\pi_3$			-1111.00***
p-Value			[0.00]
Observations	17	17	17
Panel B. price.CREIS			
π_1: l(*Policy*)	547.15***	-7.32	-4.26
	(183.71)	(339.74)	(244.71)
π_2: Time Trend		65.27*	176.33***
		(34.64)	(38.79)
π_3: l(*Policy*) × time trend			-189.44***
			(50.66)
4-quarter effect = $\pi_1 + 4\pi_3$			-762.00**
p-Value			[0.03]
Observations	17	17	17
Panel C. price.FGXZ.			
π_1: l(*Policy*)	0.02	0.03	0.03
	(0.02)	(0.05)	(0.02)
π_2: Time Trend		-0.00	0.02***
		(0.01)	(0.00)
π_3: l(*Policy*) × time trend			-0.04***
			(0.00)
4-quarter effect = $\pi_1 + 4\pi_3$			-0.11***
p-Value			[0.00]
Observations	17	17	17
Panel D. Rental			
π_1: l(*Policy*)	1.05***	-0.36	-0.35
	(0.28)	(0.38)	(0.35)
π_2: Time Trend		0.17***	0.08
		(0.04)	(0.06)
π_3: l(*Policy*) × time trend			0.14*
			(0.07)
4-quarter effect = $\pi_1 + 4\pi_3$			0.20
p-Value			[0.68]

Observations	17	17	17

Table A2 Trend Break Estimates of the Policy Effect on Housing Sales of 139 cities

This table presents the regression results for sale unit, sale floor and sale amount for new homes as well as investment by the developers. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. SaleUnit			
π_1: l(*Policy*)	-229.09	-4,806.34***	-4,822.35***
	(1,005.16)	(1,519.64)	(1,526.90)
π_2: Time Trend		538.82***	714.82**
		(154.79)	(244.61)
π_3: l(*Policy*) × time trend			-295.41
			(316.91)
4-quarter effect = $\pi_1 + 4\pi_3$			-6003.00***
p-Value			[0.01]
Observations	17	17	17
Panel B. SaleFloor			
π_1: l(*Policy*)	-69.12	-489.68***	-491.34**
	(101.16)	(163.45)	(166.17)
π_2: Time Trend		49.51**	64.77**
		(16.65)	(26.68)
π_3: l(*Policy*) × time trend			-25.54
			(34.51)
4-quarter effect = $\pi_1 + 4\pi_3$			-593.40**
p-Value			[0.02]
Observations	17	17	17
Panel C. SaleAmount			
π_1: l(*Policy*)	-672.42	-4,948.22**	-4,943.47***
	(1,098.17)	(1,851.27)	(1,608.65)
π_2: Time Trend		503.24**	963.91***
		(188.69)	(255.30)
π_3: l(*Policy*) × time trend			-784.07**
			(333.07)
4-quarter effect = $\pi_1 + 4\pi_3$			-8079.00***
p-Value			[0.00]
Observations	17	17	17

Table A3 Trend Break Estimates of the Policy Effect on Construction and Investment by the Developers of 139 cities

This table presents the regression results for the floor space started, floor space under construction, land price and land sales revenue. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. FloorStarted			
π_1: l(*Policy*)	215.66**	46.15	47.58
	(96.20)	(192.48)	(176.81)
π_2: Time Trend		19.93	60.46**
		(19.61)	(27.96)
π_3: l(*Policy*) × time trend			-69.27*
			(36.55)
4-quarter effect = $\pi_1 + 4\pi_3$			-229.4
p-Value			[0.16]
Observations	17	17	17
Panel B. FloorUnderConstruction			
π_1: l(*Policy*)	4,046.98***	-272.80	-260.73
	(909.21)	(1,314.37)	(1,331.37)
π_2: Time Trend		509.52***	376.65
		(134.05)	(213.86)
π_3: l(*Policy*) × time trend			222.59
			(276.81)
4-quarter effect = $\pi_1 + 4\pi_3$			629.63
p-Value			[0.72]
Observations	17	17	17
Panel C. Investment			
π_1: l(*Policy*)	4,010.63***	-431.07	-418.99
	(703.82)	(475.60)	(350.14)
π_2: Time Trend		523.40***	368.31***
		(48.48)	(56.11)
π_3: l(*Policy*) × time trend			260.49***
			(72.72)
4-quarter effect = $\pi_1 + 4\pi_3$			622.96
p-Value			[0.03]
Observations	17	17	17

Table A4 Trend Break Estimates of the Policy Effect on Land Sales of 139 cities

This table presents the regression results for the floor space started, floor space under construction, land price and land sales revenue. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Panel A. LandPrice			
π_1: l(*Policy*)	375.19	-1,366.17*	-1,372.96*
	(438.66)	(728.01)	(734.39)
π_2: Time Trend		205.19**	284.42**
		(74.21)	(117.77)
π_3: l(*Policy*) × time trend			-132.93
			(152.56)
4-quarter effect = $\pi_1 + 4\pi_3$			-1904.00*
p-Value			[0.11]
Observations	17	17	17
Panel B. LandSalePieces			
π_1: l(*Policy*)	-9.62***	-7.34***	-7.34***
	(0.92)	(1.77)	(1.81)
π_2: Time Trend		-0.27	-0.14
		(0.18)	(0.29)
π_3: l(*Policy*) × time trend			-0.22
			(0.37)
4-quarter effect = $\pi_1 + 4\pi_3$			-8.23***
p-Value			[0.02]
Observations	17	17	17
Panel C. LandRevenue			
π_1: l(*Policy*)	-832.75	-3,136.94*	-3,175.55**
	(883.42)	(1,678.29)	(1,419.61)
π_2: Time Trend		271.51	721.98***
		(171.08)	(227.66)
π_3: l(*Policy*) × time trend			-755.82**
			(294.90)
4-quarter effect = $\pi_1 + 4\pi_3$			-6198.00***
p-Value			[0.01]
Observations	17	17	17