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ABSTRACT

The Chinese government imposed the housing purchase restriction policy to dampen the speculation in 2010. Using a two-stage difference-in-difference approach and a comprehensive dataset covering the real estate markets across 70 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 decline in housing prices following the policy implementation. However, the policy had no measurable effects on the nationwide construction boom, hinting the ineffectiveness of the policy to correct the housing bubble.

Keywords: housing purchase restriction policy, housing bubble, China, difference in difference

JEL code: G12, G18, H83

1. INTRODUCTION

Considerable evidences indicate that collapses in real estate prices are the main cause of many financial crises (Reinhart and Rogoff, 2009). Policymakers are now more in favors of early interventions to curtail the housing bubbles (IMF, 2011). It is therefore crucial to design effective macroprudential regulations. An emerging literature has begun to explore the effects of government interventions on the property market (Allen and Carletti, 2011; Almeida et al., 2006; Crowe et al., 2013; Igan and Kang, 2011; Kannan et al., 2012; Wong et al., 2011). However, we still know little about the effectiveness and difficulties in implementing various policy tools, especially from an empirical perspective.

China provides a compelling setting to study this issue for several reasons. First, within less than two decades, residential property prices in China have gone through a strong growing trend with occasional ups and downs. A study by the MacDonald et al. (2012) shows 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. The central concern now is whether the Chinese housing market is at the peak of the bubble such that a significant correction would trigger a systematic risk to the financial market.

Second, 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 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.

Third, as the world's second largest economy and the largest trading nation, a sharp slowdown in the property sector could have a domino effect on the world economy because China is the largest purchaser of commodities like copper, iron ore, coal, oil, etc. in the global market. 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.

Forth, the Chinese government has been actively intervening in the housing market to rein in the rampant housing price surge through various monetary and fiscal policy tools such as the increase of minimum down payment ratio, cap on the loan-to-value ratio, higher mortgage rate for second house, taxes on capital gains, and so on. When the effectiveness of these traditional policies diminished, the Chinese government recoursed to the heavy-handed regulation of housing purchase restriction (HPR) to curtail the speculation. This provides a rare opportunity to study such a less standard macroprudential tool and its impact on the whole real estate sector.

Starting from May 2010, 39 of the 70 Chinese cities whose housing prices are regularly surveyed by the National Bureau of Statistics (NBS) introduced the HPR policy. Different from the nationwide implementation of monetary and fiscal cooling measures, the HPR policy is decentralized and voluntary. 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[1], rather than mandated

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[1] In China, a widely-adopted city classification system categorizes all cities into three tiers in terms of their population, economic size, development of services, infrastructure and cosmopolitan nature. The first-tier

by all cities. Under this policy, only those with local *hukou* (household registration), or those who can prove they have worked in the city for certain consecutive years, are eligible to purchase one or two new homes.

This paper presents a systematic evaluation of China's HPR policy with a city-level quarterly panel data that comprises of various real estate market indicators, including housing prices, rental rates, transaction volume, investment and construction of property by developers, land price and sales revenue received by local governments for the years of 2008 to 2013. We follow Donald and Lang (2007) and Greenstone and Hanna (2014)[2] to form our empirical strategy. The autonomous and heterogeneous adoption of the policy in each city enables us to employ the two-stage difference-in-difference (DD) approach to address the endogeneity concerns associated with each city's selection into HPR policy. We treat those cities without adopting the HPR policy as a control group and draw the causality 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 DD design. We also investigate the variation of policy effects across cities, accounting for their heterogeneities in the fiscal reliance on land sales, economic dependence on real estate investment and pace of urban expansion.

We find that the HPR policy has a moderately negative impact on the official housing price index released by the NBS. Considering the potential possibility of data manipulation, we alternatively investigate the policy impact on the transaction prices of

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cities refer to the megacities of Shanghai, Beijing, Shenzhen and Guangzhou which are well recognized for being densely populated as well as culturally and economically influential. The capital city of each province and regional economic centers are classified as the second-tier cities while the rests are the third-tier cities.

[2] Greenstone and Hanna (2014) adopt a Quandt likelihood ratio test (Quandt, 1960) from the time-series econometrics and develop a new method of the structural break test for the DD setting.

secondary houses compiled by a nationwide private agent -- the City House, and discover large decrease in the housing price. Moreover, the HPR policy causes significant and sharp plunge in the transaction volume of new houses. This evidence is consistent with the policy motivation of curbing speculative demand in the property market. In terms of magnitude, the housing price on average dropped by 18.3% while the sales amount plummeted by 60% four quarters following the policy implementation. However, the policy does not address the problem of excessive supply of housing market. We find that the growing trend of property investment and construction do not alter after the policy enforcement. These findings suggest that property developers largely ignore the intention of the policy in curbing property boom but continue to pile up future supply of houses.

Cross-sectional tests show that local governments may overly rely on real estate sector to gain fiscal revenue and achieve the economic growth by pushing property prices into unsustainable levels. Those cities having higher reliance on land sales and real estate investment and radical urban sprawl experienced greater decline in housing prices and sales following the policy adoption but no significant fall in property investment or construction. The latter evidence suggests that HPR policy's effectiveness is limited due to local authorities' misaligned incentives and circumvention.

Our research contributes to the literature that studies the implications of regulations and how a specific policy may affect the market. Chinese housing cooling policy is different from that of other countries in the sense that government has the advantage of an autocratic approach to target the speculation by imposing purchase restriction. This novel policy warrants a systematic evaluation given the sheer size of Chinese housing market. Our empirical evidence reveals that the HPR policy is effective in tame the

speculation and contain the associated risk. However, it does not solve the mismatches between housing supply and demand and the distortion of resource allocation because the policy has no measurable effect in curtailing the nationwide property construction boom. This means that local governments would only dampen demand temporarily but not supply since they rely heavily on land sales or property sectors for their economic target. The overall alarming evidences imply the ineffectiveness of such policy to correct the property bubbles, rather only to defer it.

The rest of paper is organized as follows. The next section surveys the changes of government policies toward residential property market since 1998 and reviews the relevant literature. Section 3 presents the data source and summary statistics. Section 4 describes the empirical methods used in this study, and section 5 reports the empirical results. Section 6 assesses the differences of policy effect across cities and section 7 concludes the paper.

2. BACKGROUND

The Chinese government has interfered actively and significantly in the private housing market since the country terminated the welfare housing distribution system in 1998. Its policy stance is modified as the economic climate changes and has gone through several stages of amendments. Ahuja et al. (2010) found that over the past decade, any misalignment in house prices in China would be corrected relatively quickly due to government intervention.

Since the mid-1990s, to support the housing reform and fight against the adverse economic impacts arising from 1997 Asian Financial Crisis, the Chinese government has made great efforts to promote housing finance and hence stimulate the growth of real

estate sector. For example, between 1998 and 2002, it lowered the mortgage interest rate five times to encourage home purchases. By 2005, China has become the largest residential mortgage market in Asia, with an outstanding balance exceeding two trillion Yuan, almost 89 times the 1997 balance (Deng and Liu 2009; Zhu 2006). Meanwhile, it developed 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 & Wu, 2008).

In response to the significant housing price spikes, the Chinese government implemented a series of monetary and fiscal policies to curtail speculative activities after early 2004. For example, the minimum down payment ratio was raised to 40% in September 2007, mortgage rate to be 10% higher than the benchmark rate. And 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 implied by falling export earnings and employment triggered by the global financial crisis, the government abruptly reversed its policies in October 2008 to put in place a series of measures to support the housing market recovery. Among others, 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. Reinforcing this recovery was a post-global financial crisis stimulus package introduced by the central government, designating the real estate sector as one of the primary industries. Hence, after a short and moderate correction in 2008, the overall financial

conditions were relaxed. Fueled by a vast increase in the credit provided by the state-owned banks and companies, the housing market regained momentum in mid-2009 and started a new round housing price surge and massive construction boom across the nation[3].

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 second home purchase, and imposing business tax and personal income taxes on housing transactions came in place. However, none can be compared to the most stringent policy instrument -- housing 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 while families without local *hukou* are not allowed to buy any more unless they can provide documents to prove the payment of taxes and social security contributions for the previous five consecutive years (Sun et al., 2013). The goal of the HPR policy is to curtail the speculative housing demand, although it does not touch the fundamentals motivating the speculative demand, say the shortage of investment tools for Chinese residents.[4] Such restrictions on housing purchase substantially alters the demand in the housing market and are often criticized by the economists for its unfairness, discrimination against migrants, and inefficiency for its administrative nature.

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[3] 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.

[4] 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.

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 the HPR policy in the mid-2014. Currently, the housing purchase restriction 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. Some attempt to explain the underlying factors that caused the house price movement (Zhou, 2005; Glindro et al. 2005), some focus on the price misalignment and the sustainability of China's housing boom (Ahuja et al., 2010, Barth et al., 2012; Economic Intelligence Unit 2011; Ren et al., 2012; Wu et al. 2010;), some investigate the relationship between Chinese stock and housing market (Huang et al., 2014), and others look at the association of housing price with land policy (Cai et al., 2009; Du et al., 2010; Peng and Thibodeau, 2009). Fang et al (2014) measure the corruption of housing purchase in China. Although the Chinese government has actively intervened in the real estate sector, especially in light of US subprime mortgage crisis, very few studies have examine the impact of government cooling measures. Most research focuses only on the introduction and evolution of the policies, such as Wang and Murie (1999), Deng et al. (2011) and Zou (2014), Ahuja, et al (2010) and Barth et al. (2012).

Despite the vitriolic critics on the heavy-handed government restriction on housing purchase, there are few researches systematically assess its impact on Chinese real estate market. To our knowledge, there are only two papers examining the policy impact on an individual market. Sun et al. (2013) investigate the policy effect on Beijing's resale and

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rental market while Jia et al. (2014) focus on the response of Guangzhou's real estate sector to the policy implementation. In this paper, we aim to bridge the gap by assembling a set of empirical facts about 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 Source

We mainly use the NBS, CEIC and China Real Estate Index System (CREIS) as the data source while also collect transaction price and rental rates from a nationwide real estate agent--the City House. The CREIS database is built up by the China Index Academy which is currently the largest Chinese independent property research organization and provides a comprehensive data on property transaction, land auction and property developers. Our data covers 70 cities across 30 provincial units for the years of 2008-2013 at quarterly frequency. The sample selection is mainly due to the data availability at the NBS. Figure A1 in the appendix plots the location of these 70 cities and classify them into two groups -- restricted and unrestricted cities while Table A1 lists the definition, unit and sources of each variable.

A. 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[5]. It was afterward implemented in 39 of the 70 cities in our sample. Hand collecting the local version of "New National Ten Articles" and "New National Eight Articles", we assemble a dataset that systematically documents the policy changes. Table A2 lists the policy implementation status of all our sample cities. Beijing was the first city to enforce the HPR 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.

B. Real Estate Market Indicators

We use twelve indicators to capture the dynamics of Chinese residential property market, i.e., property price index, sales price, rental rates, sales amount, number of flats sold, floor space sold, real estate investment, floor space started and under construction, land price and land sales revenue.

We first construct a price index from the sales price indices of newly constructed (PINew) and secondary residential property (PISecond) published by the NBS . The main advantage of this data set is its wide coverage and long sample period. For our full sample of 70 cities, the starting date of NBS price indices could be traced back to July 2005. The 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

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5 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".

indices with the second quarter of 2005 equal to 100.[6] One drawback of NBS property price index is data manipulation that may underestimate the housing price appreciation (Ahuja et al., 2010; Barth et al. 2012; Wu et al., 2010). We hence collect the transaction price of the secondary houses (Price.Cityhouse) from a nationwide independent agent-- the City House whose data is free of manipulation problem. We also adopt its quarterly rental price to measure the dynamics of rental market.

The data for sales amount (SaleAmount), number of flats sold (SaleUnit), floor space sold (SaleFloor) are only available for new homes. We obtain the data for these transaction indicators as well as real estate investment by the real estate developers (Investment), floor space started (FloorStarted) and under construction (FloorUnderConstruction), land price (LandPrice) and land sales revenue (LandRevenue) received by the local governments from the CEIC and CREIS.

C. Control Variables

Housing price is usually pushed up disproportionately when the economic growth gathers momentum because the supply of nontradable goods such as housing is inelastic. It is believed that the demand factors for housing are likely to remain strong throughout the next decade (Economic Intelligence Unit, 2011; Chen et al. 2011). In this paper, disposable income per capita of urban residents and resident population of each city are adopted to measure the demand for property and control for the real estate market dynamics. The data of disposable income is obtained from the CEIC. There are two kinds of population data in China, i.e. *huji* population and *changzhu* population. The *huji* population refers to people who registered with the police under the household

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[6] 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.

registration system 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 where the manufacturing industry concentrates and hence becomes the residence of numerous migrants, the *huji* population might underestimate the total number of residents. For an inland city that is the home of migrants, the *huji* population might overestimate its total residents. To avoid this bias, we collect the data of *changzhu* population from the yearbooks of each city or province because *changzhu* population instead of *huji* population represents the real potential demand for urban residential housing.

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 and PISecond) 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). In terms of the absolute value, 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 only. 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.

Driven by the considerable amount of investment by the real estate developers which is as large as RMB 12,144 million for each city per quarter, the construction of residential

property is growing at an extraordinarily high pace in the last few years. Our summary statistics indicate that there is on average around 2 million square meter of floor space started and 22.3 million square meter of floor space under construction per city-quarter. The quarterly land sales revenue for each city amounts averagely to RMB 3.7 billion at a price of RMB 4,527 per square meter. The 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 housing market, we normalized standard deviation of each variable by its mean. Among all the nine property market indicators, the property 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 the HPR policy was launched to dampen the rampant housing price appreciation, the official price indicators -- PINew and PISecond declined 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 the sales volume hints that most of housing purchase before the policy adoption might be driven by the speculation purpose, instead of consumption needs. Cities adopting the policy on average

experienced a 60% drop in land sales revenue. It is therefore not surprising to see the local governments promptly abolished the HPR policy when the Central government decided to loosen control on the property market in the summer of 2014. 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 would unavoidably lead to the oversupply of residential housing.

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. Normalized Std. Dev. is calculated as the ratio of Std. Dev. to the mean.

Panel A: Summary statistics for all cities						
Variable	Obs	Mean	Std. Dev.	Normalized Std. Dev.	Min	Max
PINew	1680	138.05	20.21	0.15	90.99	226.49
PISecond	1680	135.68	22.65	0.17	84.10	234.75
priceCityhouse	1550	7730.66	5099.41	0.66	1943.00	37469.00
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
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	138.28	139.81	141.22	143.29	145.14	146.07	145.86	144.98	144.15
PISecond	138.19	139.55	140.78	142.32	143.23	143.39	142.27	141.19	140.09
priceCityhouse	9124.90	9555.41	10174.77	10724.21	10977.28	10963.41	10772.95	10770.77	10613.13
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
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 a two-stage DD approach developed by Donald and Lang (2007) and recently applied by Greenstone and Hanna (2014) to study the effects of environmental regulations on pollution abatement in India. We employ it to assess the impacts of HPR policy on the dynamics of Chinese real estate market. This approach

provides a convenient solution to the problem of intragroup correlation in the unobserved determinants of housing market dynamics. It is numerically equivalent to the GLS and FGLS approaches widely applied for single-stage DD approach, but avoids the difficulties of collapsing the data into group-level.[7] The first stage is a typical event study-style equation:

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

where Y_{it} is one of the twelve measurements of real estate market dynamics in city i at quarter t. $D_{\tau,it}$ is a vector composed of a separate indicator variable 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 before and after the policy implementation. All τs are set to zero for the nonadopting cities so as to facilitate the identification of time effects and the coefficients of βs on the control variables. The city fixed effects, γ_i, control for all unobserved factors across cities and prevent the estimates of the treatment effects, σ_τs, from 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 adjusts for national trends. The control variables of disposable income per capita and resident population (X_{it}) adjust for differential demand-side factors across cities. To account for differences in precision due to city economic development level, the estimating equation is weighted by the GDP per capita.

The parameters, σ_τs, which are of our main interests, gauge the average value of twelve measurements of real estate market dynamics in the quarters before and after the policy is enforced. The variation in the timing of the HPR policy adoption across cities enables us to identify the σ_τs and the time fixed effects separately. A plot of σ_τs estimated from equation (1) against the τs 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-stage model.

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

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

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

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

which 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 housing purchase obstacles set by the policy.[8] We therefore estimate the third specification:

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

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[8] There are quite a few anecdotal evidences reported by the media that real estate agencies prepare fraudulent documents for tax and social security payment to help their customers to buy the houses.

From this specification, we report the impact of the policy four quarters after its enforcement as $\pi_1 + 4\pi_3$.[9] 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 that 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 the estimated σ_τs 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 measurements are normalized to equal zero at $\tau = -1$ and noted with the horizontal dashed line for easy comparison.

The figure shows that the HPR policy was effective at reversing the upward trend in housing prices, transaction of new residential property and land sales revenue. The NBS price index of newly constructed residential property (PINew, panel a) and secondary residential property (PISecond, panel b) fell slightly up to the fourth quarter after the policy is in force with PINew declining by 0.7 point while PISecond decreasing by 1.38 point. The housing price released by the City House (priceCityhouse, panel c) fell considerably by RMB 772 two quarters after the policy adoption. Rental price (panel d)

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

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 f) slumped by about 535 thousand square meter, the number of flat sold (SaleUnit, panel e) plummeted by 4786 unites and the sales amount (SaleAmount, panel g) precipitously dropped by RMB 5.45 billion at the fourth quarter of policy adoption. Land sales revenue (LandRevenue, panel l) plunged by RMB 6.83 billion after the third quarter of policy enforcement.

No policy effect is witnessed for real estate investment and property construction. On the contrary, their growth momentum remains strong in our sample period. This is because HPR policy is designed to depress the speculation, and therefore its impacts on the supply side may not unfold immediately due to lead-lag in housing demand and supply. Moreover, local governments rely heavily on property investment to achieve the promotion target of high GDP growth, and thus do not have incentive to suppress the investment even though they were forced by the Central government to dampen the housing price surge. Excess supply over demand is hence unavoidable and quite a few of ghost cities are created or inevitably appeared in China.

Figure 1 Event Study of HPR Policy

The figures provide a graphic analysis of the effect of HPR policy on the twelve measurements of housing market indicators by depicting the estimated σ_τs 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.

a   b   c

d   e   f

g   h   i

j   k   l

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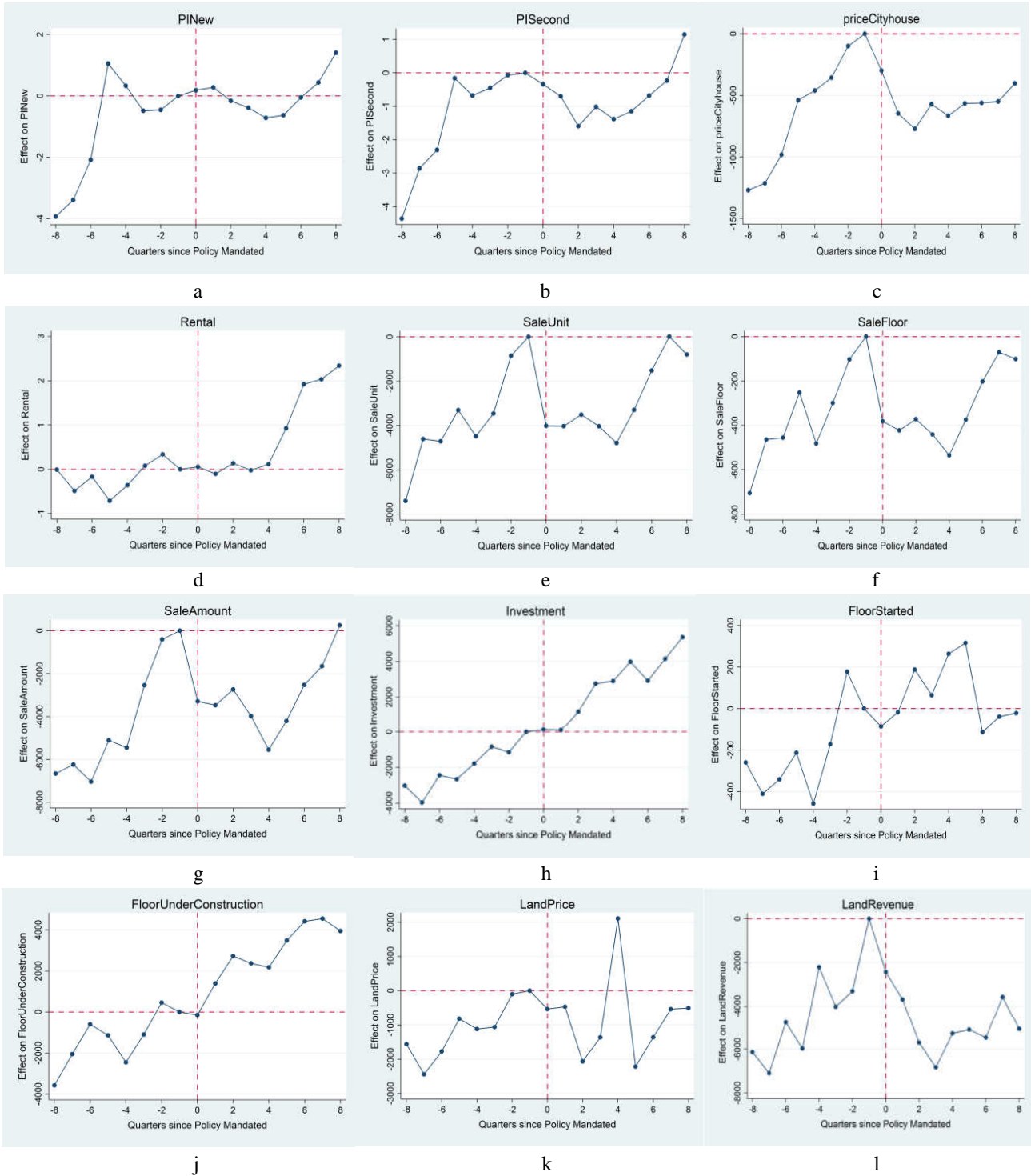
5.2 Quantitative Evidence

The oscillating trends for almost all real estate market indicators are observed in Figure 1, suggesting that the parallel trends assumption of the simple DD 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 systematically report the policy effects estimated by the two-stage DD 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 official property price index PINew and PIsecond declined by 3.08 and 3.88 points respectively, which were only 2.2 % and 2.9 % of sample mean. However, the fall in the price released by the Cityhouse is phenomenal, ebbing by RMB 1414 or 18.3% of the sample mean four quarters after the policy is enforced. No significant policy impact on the rental price is found a year after the policy is implemented.

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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 6,307 units, 643.1 thousand square meter and RMB 7.1 billion respectively, accounting for 46.3 %, 46.2 % and 60.3 % of the whole sample mean four quarter after the policy adoption. This phenomenal fall in the sales volume hints that most of housing purchase before the policy enforcement is for the speculation, instead of consumption needs. An exogenously negative demand shock induced by the HPR policy promptly results the plunge in both price and transaction volume. This evidence is consistent with Sun et al. (2013)'s finding for the response of Beijing's housing market to the HPR policy.

Similar to what we observe in Figure 1, the regression results shown in Panel D of Table 3 reveal that there is little evidence of a policy impact on the real estate investment. The regression results for the four quarters' policy effect are even positive although insignificant, indicating that the investment by property developers increased despite the policy designed to curb the housing purchase. These findings are reinforced by the estimation results for the floor space started and under construction presented in Panel A and B of Table 4 where the policy is found to be ineffective in taming the massive property construction boom.

The reduction in land price and sales revenue is strongly related with the policy. The results presented in Panel C and D of Table 4 suggest that the land sales revenue slumped by RMB 6.5 billion four quarters after the policy is mandated. This implies that the top-down effort in curbing the housing prices surge via the 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 2 Trend Break Estimates of the Policy Effect on the Sales Price and Rental Price

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. PINew			
π_1: l(*Policy*)	1.17*	-1.23	-1.22
	(0.65)	(1.12)	(0.98)
π_2: Time Trend		0.28**	0.55***
		(0.11)	(0.15)
π_3: l(*Policy*) × time trend			-0.47**
			(0.20)
4-quarter effect $= \pi_1 + 4\pi_3$			-3.08**
p-value			[0.02]
Observations	17	17	17
Panel B. PISecond			
π_1: l(*Policy*)	0.71	-2.13**	-2.12**
	(0.61)	(0.92)	(0.75)
π_2: Time Trend		0.33***	0.59***
		(0.09)	(0.12)
π_3: l(*Policy*) × time trend			-0.44**
			(0.16)
4-quarter effect $= \pi_1 + 4\pi_3$			-3.88***
p-value			[0.00]
Observations	17	17	17
Panel C. price.Cityhouse			
π_1: l(*Policy*)	49.73	-644.37**	-653.72***
	(168.01)	(272.27)	(124.49)
π_2: Time Trend		81.88**	195.35***
		(27.78)	(20.00)
π_3: l(*Policy*) × time trend			-190.22***
			(25.89)
4-quarter effect $= \pi_1 + 4\pi_3$			-1,414.00***
p-Value			[0.00]
Observations	17	17	17
Panel D. Rental			
π_1: l(*Policy*)	0.99**	-0.92*	-0.91**
	(0.38)	(0.51)	(0.39)
π_2: Time Trend		0.23***	0.06
		(0.05)	(0.06)
π_3: l(*Policy*) × time trend			0.27***
			(0.08)
4-quarter effect $= \pi_1 + 4\pi_3$			0.18
p-Value			[0.73]
Observations	17	17	17

Table 3 Trend Break Estimates of the Policy Effect on Transaction 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*)	718.38	-4,807.25***	-4,805.95***
	(977.99)	(1,092.21)	(1,015.79)
π_2: Time Trend		650.04***	870.61***
		(111.28)	(161.19)
π_3: l(*Policy*) × time trend			-375.26*
			(210.25)
4-quarter effect = $\pi_1 + 4\pi_3$			-6,307.00***
p-Value			[0.00]
Observations	17	17	17
Panel B. SaleFloor			
π_1: l(*Policy*)	22.74	-483.38***	-483.20***
	(94.51)	(117.85)	(109.93)
π_2: Time Trend		59.55***	83.06***
		(12.01)	(17.45)
π_3: l(*Policy*) × time trend			-40.00
			(22.76)
4-quarter effect = $\pi_1 + 4\pi_3$			-643.10***
p-Value			[0.00]
Observations	17	17	17
Panel C. SaleAmount			
π_1: l(*Policy*)	1,161.90	-4,192.73**	-4,191.55***
	(1,102.66)	(1,574.54)	(1,311.04)
π_2: Time Trend		630.05***	1,058.19***
		(160.44)	(208.16)
π_3: l(*Policy*) × time trend			-727.98**
			(271.43)
4-quarter effect = $\pi_1 + 4\pi_3$			-7,103.00***
p-Value			[0.00]
Observations	17	17	17
Panel D. Investment			
π_1: l(*Policy*)	4,589.70***	-263.23	-266.99
	(773.39)	(575.98)	(566.02)
π_2: Time Trend		570.32***	486.77***
		(58.65)	(89.34)
π_3: l(*Policy*) × time trend			143.11
			(116.93)
4-quarter effect = $\pi_1 + 4\pi_3$			305.43
p-Value			[0.44]
Observations	17	17	17

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 in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. FloorStarted			
π_1: l(*Policy*)	272.22***	72.73	74.97
	(89.94)	(176.17)	(162.77)
π_2: Time Trend		23.44	59.54**
		(17.94)	(25.65)
π_3: l(*Policy*) × time trend			-61.98*
			(33.61)
4-quarter effect = $\pi_1 + 4\pi_3$			-172.9
p-Value			[0.20]
Observations	17	17	17
Panel B. FloorUnderConstruction			
π_1: l(*Policy*)	4,078.21***	94.19	90.83
	(699.61)	(772.78)	(792.20)
π_2: Time Trend		468.20***	414.05***
		(78.71)	(124.84)
π_3: l(*Policy*) × time trend			92.98
			(163.60)
4-quarter effect = $\pi_1 + 4\pi_3$			462.76
p-Value			[0.66]
Observations	17	17	17
Panel C. LandPrice			
π_1: l(*Policy*)	338.44	-724.83	-719.30
	(527.08)	(1,041.97)	(1,012.22)
π_2: Time Trend		125.05	291.01*
		(106.17)	(160.14)
π_3: l(*Policy*) × time trend			-283.58
			(209.33)
4-quarter effect = $\pi_1 + 4\pi_3$			-1,853.00
p-Value			[0.18]
Observations	17	17	17
Panel D. LandRevenue			
π_1: l(*Policy*)	-599.38	-2,778.28	-2,759.87*
	(907.36)	(1,756.27)	(1,311.45)
π_2: Time Trend		256.26	808.56***
		(178.95)	(207.48)
π_3: l(*Policy*) × time trend			-943.73***
			(271.21)
4-quarter effect = $\pi_1 + 4\pi_3$			-6,534.00***
p-Value			[0.00]
Observations	17	17	17

5.3 Robustness Check: Structural Break Test

This subsection employs the structural break test developed by Greenstone and Hanna (2014) to check the robustness of applying the two-stage DD approach for this study. 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 DD results. In contrast, failure to find a break or finding of a break significantly before the time of policy adoption hints the ineffectiveness of the policy.

We use the Quandt likelihood ratio (QLR) statistic to select the maximum value of the F-statistics to assess the existence of a break at an unknown date. Figure 2 and Table 5 report the test results. For the official property price index of newly constructed (PINew) and secondary residential house (PISecond), the figure does not show any structural breaks after the policy implementation. Although the QLR statistic identifies significant breaks, they occur four quarters preceding the event, implying the ineffectiveness of the policy in curbing the growth of house price. This is in line with our findings in the previous two subsections that the effect of HPR policy on the official price index is relatively small. However, the test on the price released by the private agent of City House (priceCityhouse) is significant, implying the precipitous drop of housing price at

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the time of policy enforcement, i.e. $\tau = 0$. A significant break is found for the rental price at $\tau = 5$, corresponding to the upward trend observed also at $\tau = 5$ in Figure 2.

With respect to the three indicators gauging transactions, Figure 2 evidently picks the occurrence of the biggest F-statistics at $\tau = 0$. Moreover, Table 5 reveals that the null hypothesis of no break at $\tau = 0$ can be significantly rejected for the number of units and floor space sold. 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 finally leading to the oversupply of residential property.

The QRL test shown in Figure 2 for the land sales revenue evidently selects $\tau = 1$ as the event time with the most substantive 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.

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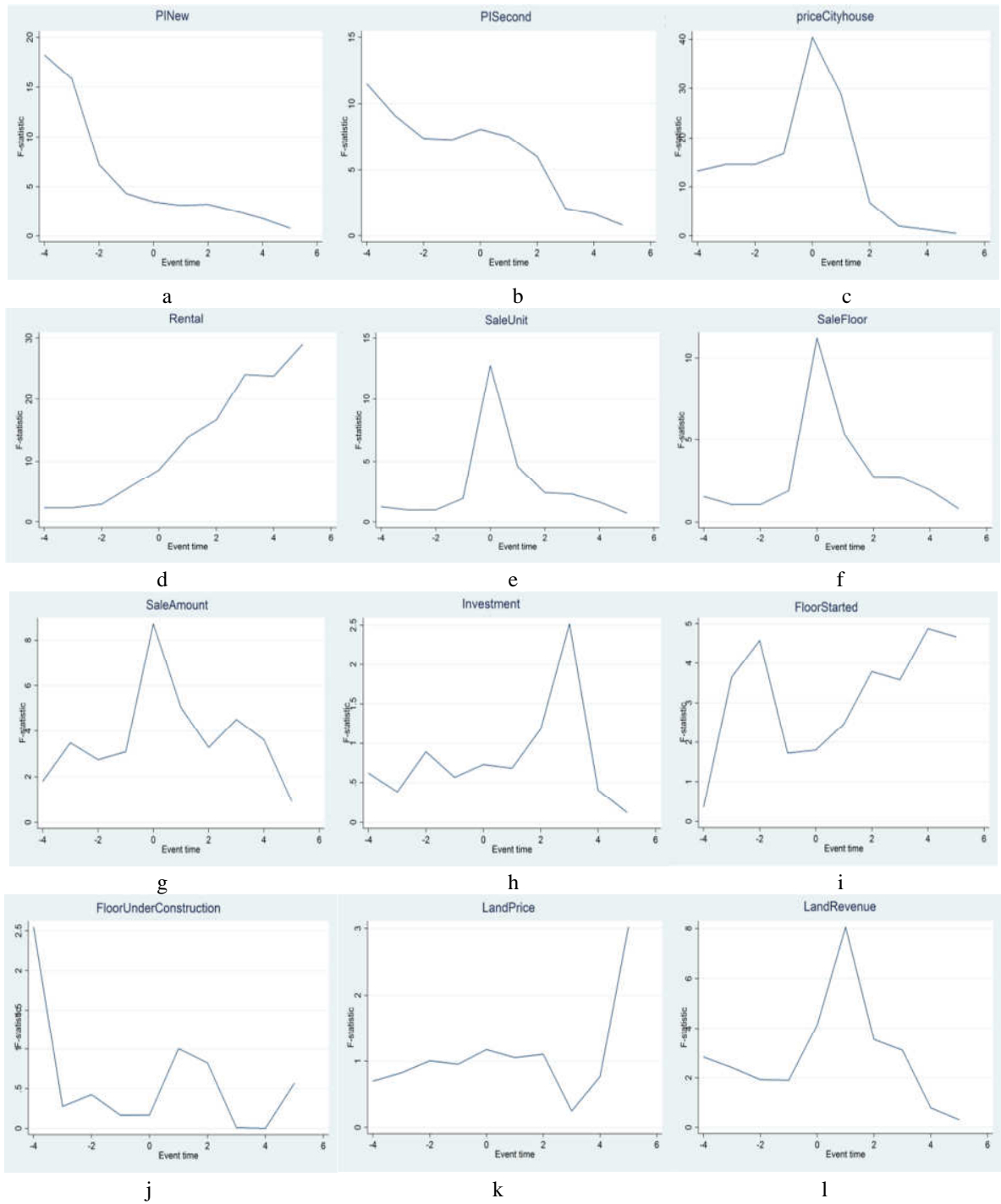
Table 5 Structural Break Analysis
Table 5 presents the results of structural break tests using the QLR test statistic and the corresponding quarter of the break in the data estimated from the specification of equation (2C). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

	Quarter of maximum F-statistics	QLR test statistic
PINew	-4	18.24***
PISecond	-4	11.48**
Price.Cityhouse	0	40.39***
Rental	5	28.96***
SaleUnit	0	12.79**
SaleFloor	0	11.21**
SaleAmount	0	8.71
Investment	3	2.53
FloorStarted	4	4.88
FloorUnderConstruction	-4	2.55
LandPrice	5	3.02
LandRevenue	1	10.55**

6. CROSS-SECTIONAL TESTS OF POLICY EFFECTS

Since real estate market carries quite a few of local characteristics, the effect of the HPR policy on different types of cities can be quite different. In this section, we compare the policy effects across cities according to their reliance on land sales for fiscal revenue, dependence on real estate investments for economic growth, and pace of urban expansion.

6.1 Qualitative Evidence

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.

The land finance is rooted in the Chinese 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 have to 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[10] 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 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.

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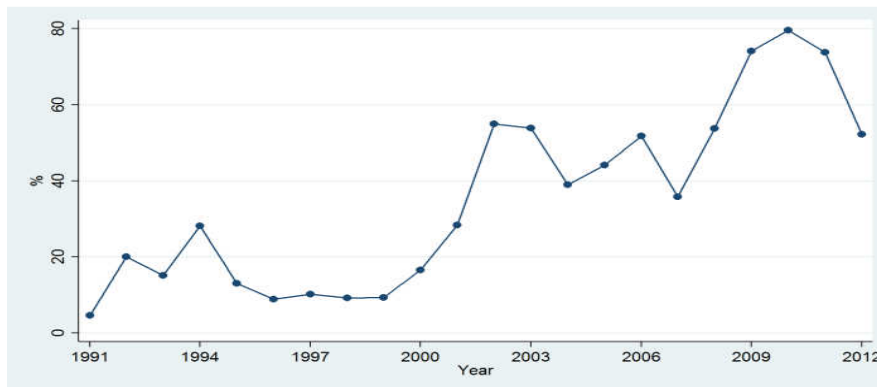
Besides, land finance builds up a territory-based coalition between local governments and real estate developers both of whom cash in their political power and expand their wealth in a reciprocal way through the increasing intensification of land use (Fu, 2014). For example, by investing in the urban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

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

of capital and goods, which in turn enlarge the 'tax base' of the city (Logan and Molotch, 2007).

Furthermore, 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[11]. 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,

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[11] 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.

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.
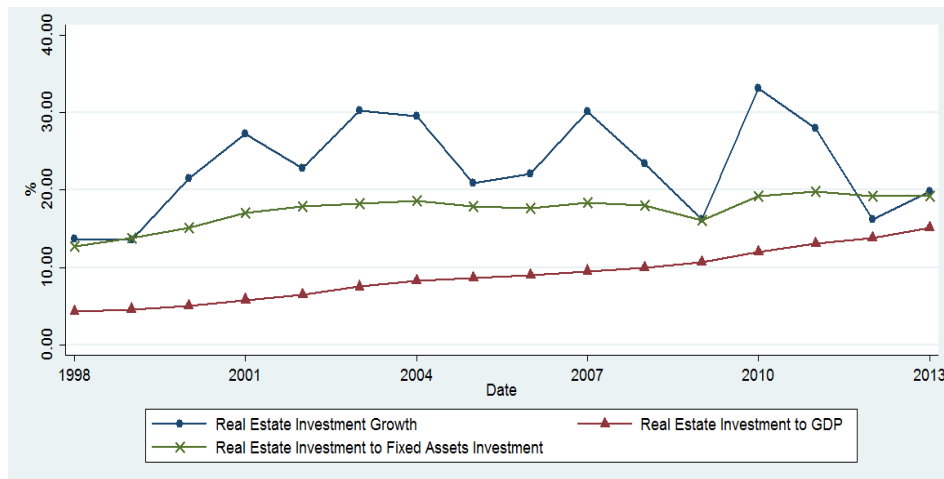
Moreover, under China's current political systems, achieving high economic growth is the main promotion criterion for local government officials (Cao et al., 2014). Driven by this target, local governments fostered reckless real estate investment across the nation, especially after 2008 when housing 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 et al., 2006). Empty buildings and ghost towns has 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; Wu et al., 2010). 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)[12]. 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)[13]. 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 might have a serious problem of structural oversupply. The ratio of urban land area in

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[12] 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.

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

2010 to that in 1980 released by the Beijing City Lab (BCL)[14] 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.

6.2 Quantitative Evidence

To assess the potential differences in policy effects arising from local variations in land finance reliance, real estate investment dependence or urban sprawl, we follow Greenstone and Hanna (2014)'s practice 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.

Table 6 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. Almost all results for the three price indicators, i.e. PINew, PISecond 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, column (5) 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.

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[14] 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.

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.

Table 6 Differences in Policy Effects across Cities

The 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				
Difference in four quarter effect	-2.58	-5.14***	-4.58**	-7.66***
p-value	[0.12]	[0.01]	[0.01]	[0.00]
Oberservations	33	33	33	33
Panel 2. PISecond				
Difference in four quarter effect	-5.11***	-6.48***	-5.96***	-4.62***
p-value	[0.00]	[0.00]	[0.00]	[0.01]
Oberservations	33	33	33	33
Panel 3. price.Cityhouse				
Difference in four quarter effect	-1619***	-525.8*	140.96	-1574***
p-value	[0.00]	[0.08]	[0.85]	[0.00]
Oberservations	33	33	33	33
Panel 4. Rental				
Difference in four quarter effect	-1.61*	2.15**	0.70	-0.10
p-value	[0.07]	[0.02]	[0.21]	[0.90]
Oberservations	33	33	33	33
Panel 5. SaleUnit				
Difference in four quarter effect	4585.6	-1931	-5986*	938.45
p-value	[0.14]	[0.55]	[0.07]	[0.76]
Oberservations	33	33	33	34
Panel 6.SaleFloor				
Difference in four quarter effect	418.74	-50.49	-656.40*	-116.8
p-value	[0.12]	[0.85]	[0.06]	[0.79]
Oberservations	34	34	33	33
Panel 7.SaleAmount				
Difference in four quarter effect	5071.50	881.64	-8213*	-1508
p-value	[0.18]	[0.77]	[0.06]	[0.64]
Oberservations	34	33	33	34
Panel 8.Investment				
Difference in four quarter effect	845.99	193.04	-1807.00	374.23
p-value	[0.53]	[0.88]	[0.13]	[0.77]
Oberservations	33	33	33	33
Panel 9.FloorStarted				
Difference in four quarter effect	-364.90	-398.50	-267.30	-140.5
p-value	[0.38]	[0.32]	[0.87]	[0.77]
Oberservations	34	34	34	33
Panel 10. FloorUnderConstruction				
Difference in four quarter effect	-612.50	-353.70	-2039	2672.10
p-value	[0.71]	[0.85]	[0.22]	[0.25]
Oberservations	34	34	34	33
Panel 11.LandPrice				
Difference in four quarter effect	1288.60	-7.25	-223.40	-1764
p-value	[0.61]	[0.10]	[0.94]	[0.53]
Oberservations	33	34	33	34
Panel 12.LandRevenue				
Difference in four quarter effect	1331.90	-1827	-1777	-1144
p-value	[0.67]	[0.59]	[0.54]	[0.65]
Oberservations	33	34	33	34

7. CONCLUSION

Due to the skyscraping housing prices across the nation and failure of traditional macroprudential policies to rein in speculation in the property market, the Chinese central government encourages local authorities, on a voluntary need base, to curb real estate speculation and stabilize housing prices by imposing the housing purchase restriction policy. Among our sample of 70 cities, 39 local authorities adopted the HPR policy starting from 2010. With a comprehensive unbalanced panel data and the two-stage DD approach developed by Donald and Lang (2007) and implemented by Greenstone and Hanna (2014), the research systematically investigates the effectiveness of Chinese HPR policy on the property markets. The two-stage DD approach enables us to draw the causality inferences without endogeneity biases.

We find that HPR policy has negative impact on property price as well as remarkable effect in reducing transaction volume, indicating the effectiveness of the policy 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 HPR policy has more pronounced effect on housing prices for cities with heavy reliance on real estate sector for fiscal revenue and economic growth.

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 possible housing market bubble since it fails to correct excessive supply problems due to circumvention and misalignment of government incentives.

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From the policy perspective, the findings of this paper suggest that the policies designed to choke the demand without touching the fundamental issues, in particular, lack of saving vehicles, the over-dependence of economic growth on real estate investment and the heavy fiscal reliance of local governments on real estate-related income, could hardly solve the problem of boiling bubbles in the property market, posing risks to the economic stability.

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Appendix I

Table A1 Variable descriptions

Variable	Definition	Unit	Source
PINew	Property price index: newly constructed residential property	2005Q2=100	NBS, CEIC
PISecond	Property price index: secondary residential property	2005Q2=100	NBS, CEIC
Price.Cityhouse	Price of secondary residential property	RMB per square meter	City House
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

Table A2 Implementation of housing 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

Figure A1 Location of 70 sample cities