China Economic Review 39 (2016) 91–114

Contents lists available at ScienceDirect

China Economic Review

Evaluating the risk of Chinese housing markets: What we know and what we need to know☆

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ARTICLE INFO

Article history:
Received 19 December 2015
Received in revised form 9 March 2016
Accepted 29 March 2016
Available online 10 April 2016

ABSTRACT

Real estate is an important driver of the Chinese economy, which itself is vital for global growth. However, data limitations make it challenging to evaluate competing claims about the state of Chinese housing markets. This paper brings new data and analysis to the study of supply and demand conditions in nearly three dozen major cities. We first document the most accurate measures of land values, construction costs, and overall house prices. We then create and investigate a number of supply and demand metrics to see if price growth reasonably can be interpreted as reflecting local market fundamentals. Key results include the following:

(1) Real house price growth has been high, averaging 10% per annum since 2006. However, there is substantial heterogeneity across markets, ranging from 2.8% (Jinan) to 19.8% (Beijing). House price growth is driven by rising land values, not by construction costs. Real land values have risen by 14.4% per annum on average. In Beijing, the increase has been by a remarkable 27.5% per year (or by 1036%) since 2004.
(2) There is variation about the strong positive trend in house price and land value growth. Land values fell by nearly one-third at the beginning of the global financial crisis, but more than fully recovered amidst the 2009–2010 Chinese stimulus. More recent growth has been much more modest, with some markets beginning to decline. Quantities of land sales by local governments to private residential developers have dropped sharply since 2013. The most recent data show transactions volumes down by half or more. This should lead to a reduced supply of new housing units in coming years.
(3) Market-level analysis of short- and longer-run changes in supply–demand balances finds important variation across markets. In the major East region markets of Beijing, Hangzhou, Shanghai and Shenzhen which have experienced very high rates of real price growth, we estimate that the growth in households demanding housing units has outpaced new construction since the turn of the century. However, there are thirteen large markets, primarily in the interior of the country, in which new housing production has outpaced household growth by at least 30% and another eleven in which it did so by at least 10%. Regression results show that a one standard deviation increase in local market housing inventory is associated with a 0.45 standard deviation lower rate of real house price growth the following year.

☆ We appreciate the comments of seminar participants at the Asian Bureau of Finance and Economic Research 3rd Annual Conference 2015, the 17th NBER-CCER Conference on China and the World Economy, the Federal Reserve Bank of New York and New York University. Gyourko thanks the Research Sponsor Program of the Zell/Lurie Real Estate Center at Wharton for the financial support. Wu thanks the National Natural Science Foundation of China for the financial support (No. 71003060, 71373006 & 91546113). We gratefully acknowledge Jingting Huang, Wei Guo, and Pu Wang for the outstanding research assistance.
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http://dx.doi.org/10.1016/j.chieco.2016.03.008
1043-951X/

(4) There are no official data on residential vacancy rates in China, but some researchers have reported very high figures (17%+). We develop a new series at the provincial level which yields a much lower vacancy rate on average, but it has been rising—from 5.2% in 2009 to 7.8% in 2014.
(5) The risk of housing even in markets such as Beijing which show no evidence of over-supply, is best evidenced by price-to-rent ratios. They are well above 50 in the capital city. Poterba's (1984) user cost model suggests these levels can be justified only if owners have sufficiently high expectations of future capital gains. Even a modest one percentage point drop in expected appreciation (or increase in interest rates) would result in a drop in prices of about one-third, absent an offsetting increase in rents.

1. Introduction

China's large share in global growth makes our understanding of the risks and opportunities in its housing markets of first order importance. Housing is not broken out separately in the Chinese national income accounts, but the real estate sector is quite large: it comprised 6.0% of Chinese output in 2014, while the construction sector contributed another 7.0%.[1] Unfortunately, it is extremely challenging to evaluate competing claims about conditions in Chinese housing markets, with data limitations being a key reason why. Private housing markets did not exist before the reforms of the late 1990s, so there is only a short time series over which variation in prices and quantities across markets can be examined (e.g., Wang (2011); Chen and Han (2014)).

This paper provides a new analysis of the risk of China's housing markets. We start with a review of the existing data sources reported by the public and academic sectors. This is followed by an estimation of underlying supply and demand fundamentals in 35 Chinese housing markets. Each is a relatively large city, particularly by western population standards, but this sample includes many Tier 2 and some Tier 3 cities, not just the major Tier 1 markets of Beijing, Shanghai, Guangzhou, and Shenzhen. Documenting variation in supply–demand (im)balances across markets is an important contribution of this study. We also estimate whether supply overhangs in a market predict weak future house price growth.

Key findings and conclusions include the following. On the data front, our comparison of official house and land price series with those developed by academic researchers concludes that the latter provide a more accurate picture of housing market conditions. These non-official series tend to report greater housing and land price appreciation over time and depict wide dispersion in performance across markets. Overall price growth is being driven by local land prices, not by construction costs. The latter are flat to very modestly increasing in most markets. Real land values have been appreciating at an average annual compound rate of 14.4% since 2004 across 35 large cities, but this average masks substantial variation across cities. For example, our land price index reports a stunning 1036% real, constant quality appreciation in the Beijing land market since 2004, for a real annual compound growth rate of 27.5% (Deng, Gyourko, and Wu (2014)). Real land values have grown in all 35 markets, but have done so by just over 7% per annum in Dalian and Wuhan. And, real land prices have been falling recently in markets such as Dalian.

We also find wide variation in measured supply–demand imbalances when we analyze local market supply and demand growth since the turn of the century. Even with Beijing's remarkable real price growth, we estimate that demand still outstripped supply by more than 10% since 2001. The other Tier 1 markets also appear to have excess demand for housing, even with their substantial increases in units supplied. In stark contrast, there are a series of primarily interior markets including Chengdu, Chongqing, Guiyang, Harbin, Hohhot, Lanzhou, Qingdao, Shenyang, Taiyuan, Yinchuan and Zhengzhou where net new housing supply has exceeded the growth in demand by at least 40% according to our estimates. Markets such as these with the weakest market fundamentals seem most likely to experience lower or even negative price growth going forward.

We are able to confirm that local supply–demand fundamentals predict future house price growth through a series of simple regression specifications. Those results show that a one standard deviation increase in a local housing market's inventory is associated with a 0.45 standard deviation lower rate of real house price growth the following year. This does not mean that housing is not risky in Tier 1 markets, where there is no evidence of excess supply or growing unoccupied inventory. Additional analysis of price-to-rent ratios illustrates that even modest declines in expected price growth in high price-to-rent multiple markets such as Beijing could lead to fairly large drops in prices, absent offsetting increases in rents.

In sum, data quality on Chinese housing and land markets varies widely by source. However, there is sufficient high quality data available to estimate the state of the balance between supply and demand in major markets. We do so for 35 large cities across the country, and show that fundamentals do matter in the sense they can predict future price movements. Excess supply has grown substantially in a number of interior markets, but there is no such evidence this has occurred in the Tier 1 markets in the East region. Nevertheless, those markets are priced aggressively in the sense that housing units trade at very high multiples of rents. The standard financial economics model of the rent–own decision by Poterba (1984) implies that price could decline materially if expectations of future price growth diminish. Whether recent declines in Chinese or global growth have begun to alter those expectations is an important issue for researchers to watch going forward.

[1] Source: National Bureau of Statistics of China. The construction sector includes non-housing real estate and non-real estate activities such as infrastructure.

The plan of the paper is as follows. The next section discusses and analyzes the two primary official series on house prices and contrasts them with a land price measure we have introduced and an unofficial constant quality house price series in development. Section 3 then investigates a number of other metrics that can be used to gauge housing market conditions. Section 4 examines whether these measures can explain the variation in price changes across markets. There is a brief conclusion.

2. Prices and quantities in Chinese housing markets

2.1. Official house price series

The National Bureau of Statistics of China (NBSC) reports two series on house prices. One called "Price Indices for Real Estate in 35/70 Large and Medium-sized Cities" tracks prices measured at the housing complex level within a city. An average transaction price is calculated for each sampled housing complex at a monthly frequency, and then compared with that for the same (or comparable) complex in the preceding month. The NBSC then calculates a monthly house price growth rate at the city level as the weighted average of the growth rates of all sampled complexes in the corresponding month.

This series originally covered 35 major markets and expanded to 70 in July of 2005. Unfortunately, it is not reported consistently over time because the NBSC adjusted its data and/or computational strategies at the beginning of 2011 in ways not fully detailed for the public. While results are not strictly comparable before and after that time, splicing together the June 2005–December 2010 and January 2011–December 2014 periods finds real aggregate house price growth is reported to be only 16.7% at the national level, for an implied compound annual growth rate of 1.6%. Many observers do not find this pattern consistent with the reality of Chinese housing markets on average, and we agree.[2]

A second government-provided series is the "Average Selling Price of Newly-Built Residential Buildings" ("Average Price Indices", hereafter). Since the mid-1990s, real estate developers in China are required to report a variety of business indicators to the government statistics agency, including the total volume (in floor area) of newly-built housing units sold within each sampling period and the aggregate sales price of these units. Dividing the total price paid by total floor area of the transacted units, weighted average house prices per square meter are calculated and reported at the city, province, and national level, respectively. To be more precise, if ten units with 100 m^2 each were sold in a market for an aggregate amount of one million yuan, the reported price would be 1000 yuan per square meter.

Reported house price growth is much higher in this series and there is substantial variation across markets. Table 1 lists aggregate and implied real compound appreciation rates between 2004 and 2014 from this series for 35 major markets that will be the focus of much of the analysis in this paper. The map in Fig. 1 shows that this set includes many non-Tier 1 cities that are spread throughout China's regions. The value of newly-built housing in these markets equals nearly one-half of the value of all new homes in China. The interquartile range of aggregate real price growth across these 35 cities runs from 95.8% to 162.2%. Thus, three-quarters of these major markets are estimated to have experienced close to or substantially more than a doubling of real prices since 2004. Implied per annum real appreciation rates over the past decade range from a low of 3.9% (Yinchuan) to a high of 14.3% (Xiamen) in these data.

2.2. Construction costs

The price of newly built housing reflects the sum of the price of land and improvements (i.e., the physical housing units), in addition to the developer's profit. To gauge whether construction costs have been escalating sharply in China, we constructed a basket of representative construction cost items including building material prices, construction worker wages, and expenses for construction machinery. Those costs are from the NBSC based on surveys conducted by local statistical agents. The average increase in real construction costs across our 35 markets from 2004–2014 is only 6.6% in aggregate, or 0.6% per annum on a compounded basis. The largest increase is 16.9% in Changsha and real costs actually fell by over 4% over the decade in Beijing. Thus, construction cost increases cannot account for the large increases in real house prices depicted in the Average Price Indices series.

2.3. Land price data

Modest increases in real construction costs imply that house price growth must have been driven primarily by land price growth in China. The only currently available official data on land prices in China come from the "China Urban Land Price Dynamic Monitor" system reported by the Ministry of Land and Resource of China. It tracks parcel values in over 100 major cities. Its land price indexes are appraisal-based, and are not derived from actual market transactions. In each city, representative land parcels are selected as "monitoring points" by technicians employed by local land authorities. For example, there are 257 such land parcels in Beijing. Of that total, 98 are for residential usage. Local land appraisals are conducted each quarter for every parcel. City, regional, and national-level average land prices and price indexes are then computed. This land price series tends to be quite smooth over time, and does not show markedly high appreciation in land values on average. For example, real growth of

[2] For example, reports from the *Financial Times* ("Fears of China Property Bubble Grow", Mar 10, 2010), *China Daily* ("Doubts over Increase in Property Price", Feb 27, 2010) and *Wall Street Journal* ("China Underestimated House Price Growth in Beijing, Shanghai", Jan 28, 2013) show their concerns on the low growth rates suggested by this index.

Table 1
Real house price appreciation based on "Average Selling Price of Newly-built Homes", 35 major cities, 2004–2014.

	Aggregate real price growth (%)	Implied per annum compound growth rate (%)
Beijing	226.4	11.6
Changchun	84.3	5.8
Changsha	92.5	6.3
Chengdu	143.8	8.6
Chongqing	156.9	9.2
Dalian	115.8	7.4
Fuzhou	218.6	11.4
Guangzhou	164.2	9.5
Guiyang	121.7	7.7
Haikou	79.0	5.6
Hangzhou	196.6	10.6
Harbin	91.0	6.2
Hefei	215.9	11.3
Hohhot	206.5	11.0
Jinan	95.8	6.4
Kunming	147.4	8.8
Lanzhou	109.6	7.1
Nanjing	149.2	8.9
Nanchang	147.6	8.8
Nanning	87.4	6.0
Ningbo	162.2	9.4
Qingdao	185.3	10.2
Shanghai	158.8	9.2
Shenyang	64.4	4.7
Shenzhen	207.1	11.0
Shijiazhuang	146.2	8.7
Taiyuan	86.6	6.0
Tianjin	141.4	8.5
Urumqi	153.7	9.0
Wuhan	157.6	9.2
Xiamen	322.3	14.3
Xian	106.0	7.0
Xining	55.4	4.2
Yinchuan	51.6	3.9
Zhengzhou	131.1	8.1
35 City Aggregate	96.4	6.5

the aggregate residential-usage land price index at the national level between 2004 and 2014 was 54.2%, for a 4.4% per annum implied compound growth rate.

This stands in sharp contrast to another land price index that we developed in previous research Deng, Gyourko and Wu (2012). This "Chinese Residential Land Price Index" (CRLPI) is a constant-quality, residential land price index based on sales of long-term leasehold estates to private developers in the same set of 35 large cities listed in Table 1. China is one of the only countries in the world for which it is possible to frequently observe transactions involving vacant residential land. This is because the Chinese government retains ownership of all urban land. Since 1988, private developers have been able to purchase use rights from the government for up to 70 years on residential properties. Developers make a single, upfront payment to the relevant local public entity. Our series treats that payment as the transactions price of the land parcel, but it clearly is for a lengthy (but finite-lived) leasehold estate.

This series begins in the first quarter of 2004 and presently runs through the third quarter of 2015. Table 2 reports the number of cities covered each year, along with the number of land parcels sold. This land price index adjusts average transactions prices for various differences in site quality via a hedonic model that is estimated at the city level for a dozen large markets at an annual frequency, at the regional level on a semi-annual basis, and the 35 city aggregate level on a quarterly basis. Each land parcel is equally weighted.[3]

We report annual indexes for a dozen large cities, but aggregate data are available quarterly, with regional series published semiannually. Fig. 2 plots the 35-city aggregate. Real prices have appreciated by 371% since 2004(1), for an implied real average annual compounded appreciation rate of 14.4% (3.4% on a quarterly basis; see Table 3). There is variation about this very strong decade-long trend, with real land values dropping by about one-third between 2007(3) and 2009(1) as the global financial crisis spread. That this was followed by a more than doubling of real prices during the massive Chinese stimulus period in 2009 provides an indication of how important government policy likely is for this sector. Real land price growth then was flat during most of 2011 and 2012 before escalating again in 2013. Real price appreciation flattened out again over the past couple of years.

This aggregate series masks sometimes substantial heterogeneity at more local levels. This is not so evident in the regional data plotted in Fig. 3. There is a strong common trend across land markets in all three regions, although the most recent data

3 Deng, Gyourko and Wu (2014) describe the underlying data sources and index construction in detail.

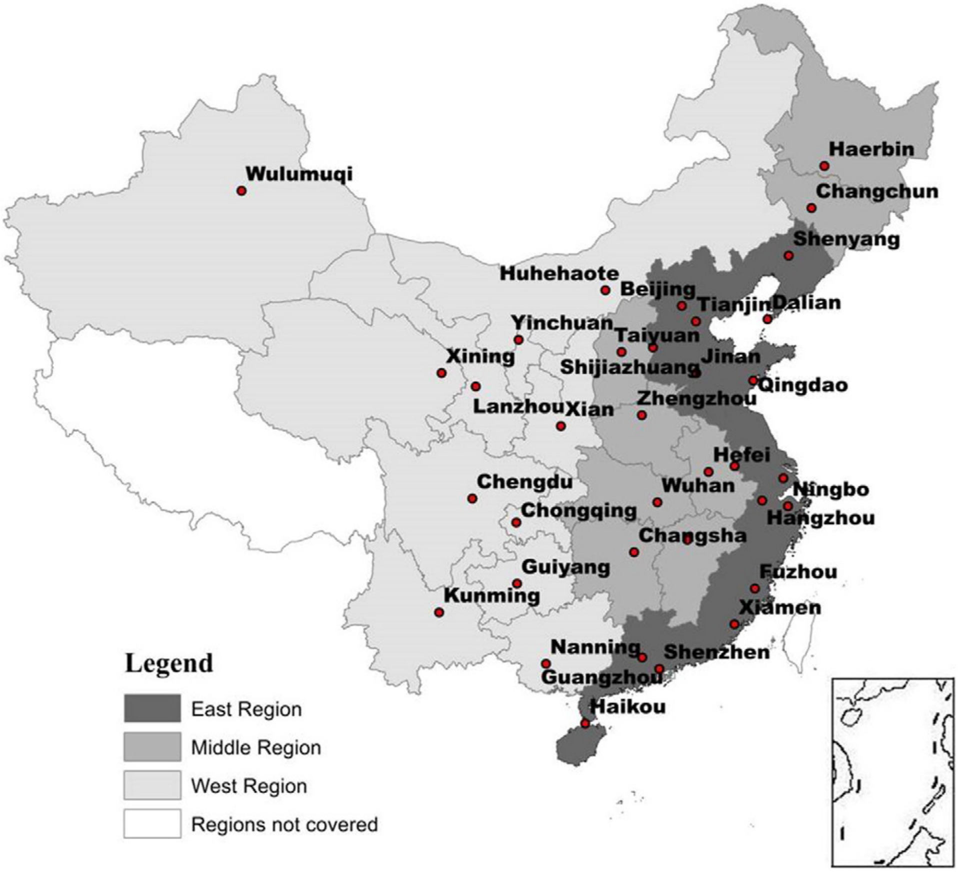

Fig. 1. The 35 major cities covered.

show some divergence since the second half of 2013. Real, constant quality land price growth ranges from 236% in the West region to 399% in the Middle region (see Table 4).

More variation is visible across the 12 large cities for which annual indexes are reported in Fig. 4. The first two columns of Table 5 show that real land price growth has been strong in each of these cities between 2004 and 2014, with only three being below 10% on an average annual compound basis (7.2% in Dalian; 7.3% in Wuhan; 8.6% in Xian). Real price growth in Beijing has averaged an astounding 27.5% per year since 2004, for an aggregate increase of over 1000%. No other city approaches this magnitude, but four other markets have real average annual compound appreciation rates over 15% (Shanghai, Chongqing, Tianjin, and Guangzhou). The remaining four experienced still strong price growth of between 10%–15% per year (Hangzhou, Changsha, Nanjing and Chengdu).[4]

2.4. Discussion

The middle set of columns in Table 5 incorporate the government's Average Price Indices data. Land price appreciation is greater than reported house price growth in most, but not all, of these major markets. In Beijing, Changsha, Chongqing, Nanjing, Tianjin and Shanghai, aggregate land price growth is more than 100 percentage points higher than the government's Average Price Indices.

Reconciling our high land price appreciation rates with the government's house price appreciation estimates requires that land constitute a relatively small share of overall house value. We doubt that is reasonable, especially in markets such as Beijing. A simple comparison would start with the following identity, which states that overall house price is the weighted sum of the value of the land and the building improvements, with developers earning a standard profit on that sum. More specifically,

$$(P_l + P_b) * Dev_p = HP \tag{1}$$

[4] The CRLPI for Beijing reports real land price appreciation that is 900 percentage points higher than the government's appraisal-based series. No other gap is as wide, but the differences in aggregate appreciation typically are wide—300+ percentage points in other cities such as Chengdu, Hangzhou and Shanghai.

Table 2
Sample volume of the land transaction dataset.

	Number of cities covered	Number of land parcels sold
2004	22	675
2005	24	770
2006	33	1123
2007	34	1409
2008	35	964
2009	35	1567
2010	35	1752
2011	35	1675
2012	35	1860
2013	35	1871
2014	35	1186
Aggregated	–	14,852

where P_l and P_b are the prices of land and building improvements, respectively; Dev_p is the developer's profit margin, and HP is the overall house price. If we presume that only the price of land and building improvements changes, the growth rate of house price (gHP) can be calculated as Eq. (2):

$$(s_l * gP_l) + (s_b * gP_b) = gHP \tag{2}$$

where gP_l and gP_b are the price growth rates of land and building improvements, respectively; s_l and s_b are the share of land and building improvements in overall house value, respectively.

Eq. (2) allows us to experiment with different land and building shares to see whether our land price series is consistent with the government's house price series. If land has a 50% share in overall house value in Beijing, Eq. (2) implies either that our land

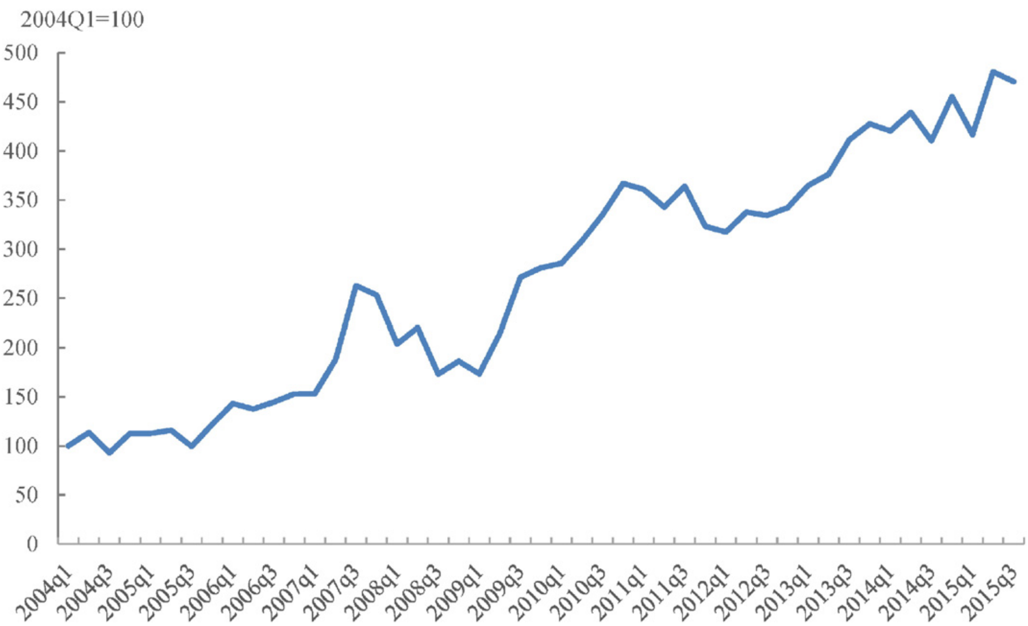

Fig. 2. Chinese national real residential land price index, 35 markets, constant quality series (quarterly: 2004q1–2015q3).

Table 3
Chinese residential land price index growth 35 city aggregate, 2004(1)–2015(3) 47 quarters.

Total appreciation	371%
Compound quarterly growth rate	3.4%
Annualized compound quarterly rate	14.4%

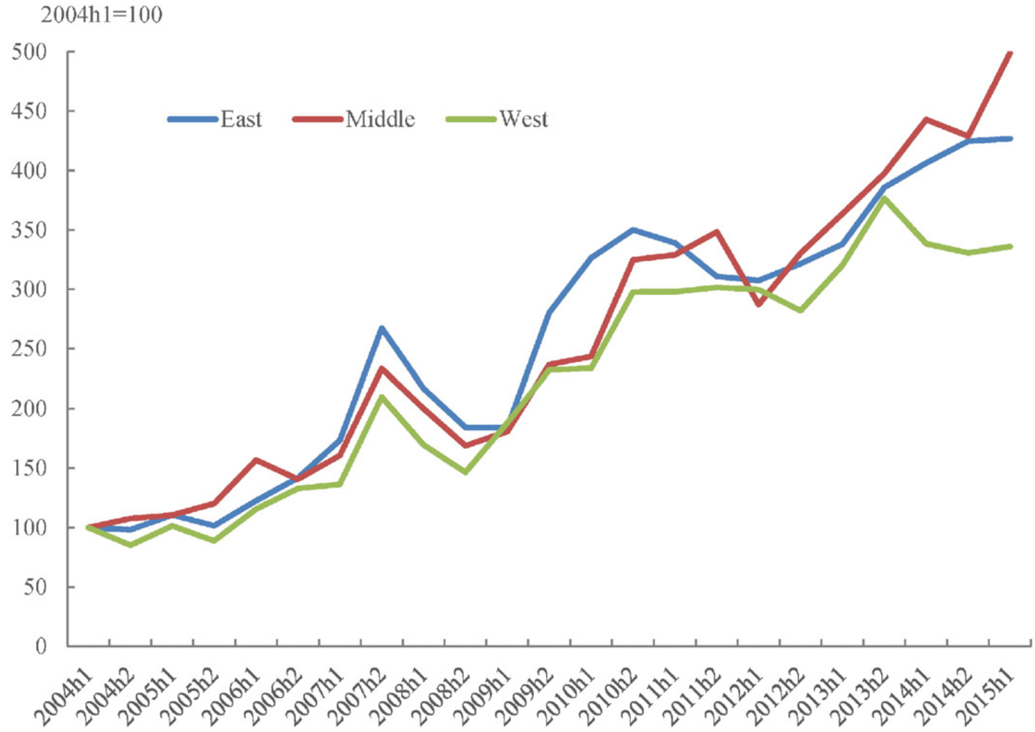

Fig. 3. Chinese regional real residential land price indexes—east, middle and west regions, constant quality series, 2004h1–2015h1.

Table 4
Chinese residential land price index growth regional level, 2004h1–2015h1 23 half years.

	East region	Middle region	West region
Total appreciation	327%	399%	236%
Compound semi-annual growth rate	6.8%	7.6%	5.7%
Annualized compound semi-annual rate	14.1%	15.7%	11.6%

price growth measure is biased upward or the government's house price growth is biased downward. Using the 1036% real land price growth from Table 5 and a 4% decrease in construction costs yields the following:

$$(0.5 * 1036\%) + (0.5 * -4\%) = 516\% \gg 226\%. \tag{3}$$

The implied house price growth is 516%, which is far greater than the 226% reported by the government's Average Price of Newly-built Housing series. In contrast, if one thought land share in Beijing was only 20%, the equation becomes 204%, which would be close to the government's house price series.

One noteworthy effort to improve the quality of house price measurement is Wu, Deng and Liu (2014). They estimate a hedonic model to create a constant-quality house price index based directly on micro transactions data of all newly-built housing units in the 35 major city sample we are using. While Wu, Deng and Liu (2014) data stopped in 2010, Table 6 lists the aggregate and implied real compound annual appreciation rates based on constant-quality prices between 2006 and 2014. In general, it suggests a higher appreciation rate than the Average Price Index reports for most, but not all, 35 markets. For example, the series for Beijing finds total real house price growth of about 385% between 2006(1) and 2014(4), which implies a real average compound appreciation rate of 19.8% (4.6% on a quarterly basis). This is about 8 percentage points above the rate measured in the Average Price Indices. While not available to the public, we work below with updated constant quality house price data from Wu, Deng and Liu (2014). We view its index construction as superior because it is directly based on micro-level transaction data, with an additional effort made to adjust for changing trait quality over time. Those data show very high real house price appreciation rates, with an average of about 10% per annum for 35 major markets over the past decade (Table 6). There is wide variation in growth across markets, ranging from 2.8% (Jinan, column 2, Table 6) to 19.8% (Beijing, column 2, Table 6).[5]

[5] Very recent work by Fang et al. (2015) based on mortgage data from a large lender uses a hybrid approach that builds price indexes from 2003 to 2013 based on sequential sales of new homes within the same housing development. They also find high average real price appreciation and substantial variation across markets.

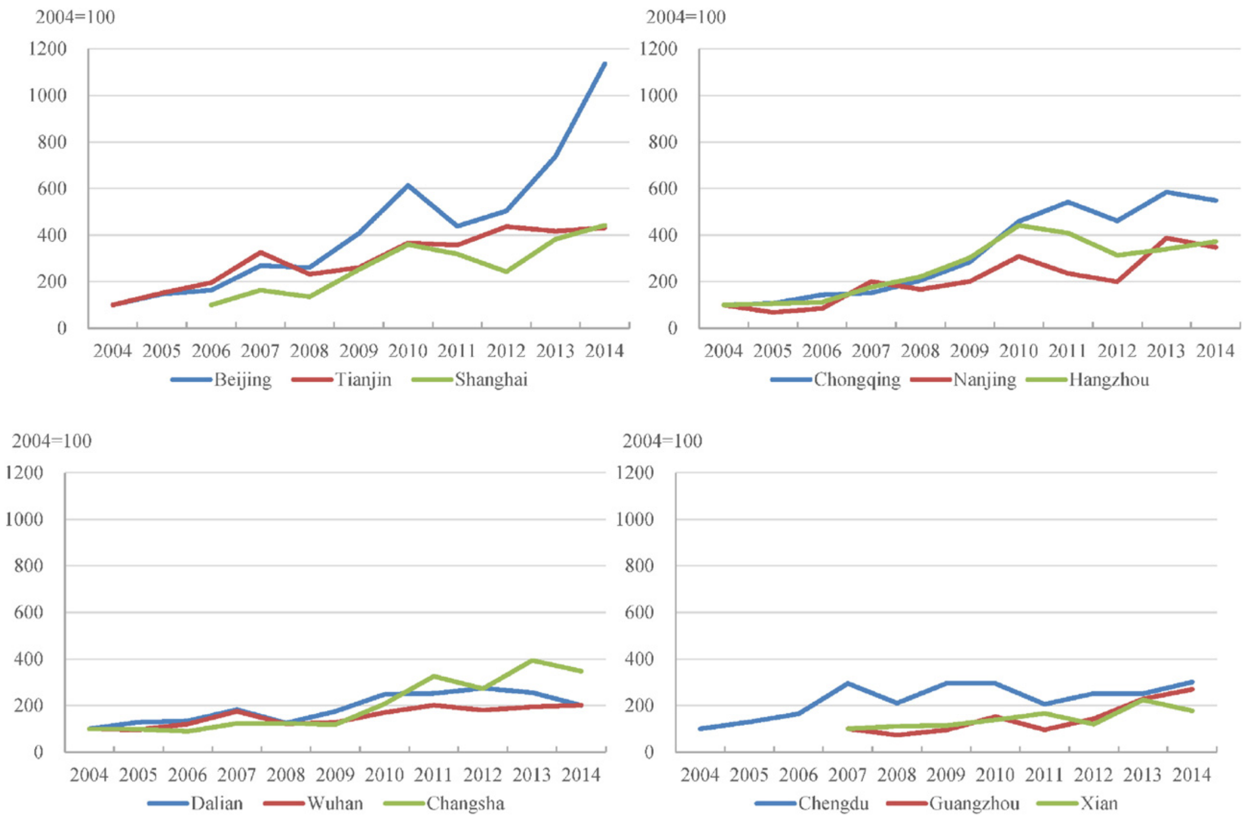

Fig. 4. Real residential land price indexes in 12 markets, constant quality series, 2004–2014.

2.5. Quantities: transactions volumes

Short time series on land parcel sales and the square meters of newly-built housing sold are available. The land parcel sales data are from the 35 markets tracked in the CRLPI and are plotted in Fig. 5. There is considerable volatility in these data. It shows a doubling in the quantity of land parcel purchases from around 200 to 400 per quarter in the cities covered by the CRLPI from the beginning of 2005 through the end of 2006. Transactions volume fluctuated around that higher level until the global financial crisis hit China in 2008. By the beginning of 2009, the number of parcels sold had fallen back just below 200. The stimulus period in 2009–2010 then saw a dramatic rebound, with sales escalating well above 500 in the fourth quarter of 2009. There are strong seasonal effects in these sales data, and the series fluctuates fairly widely between 350 and 550 per quarter until the third quarter of 2012, after which we see a sharp spike to 700, before volumes fall back down to the 500 level. There have been fewer than 300 purchases in each quarter since early 2014. In the third quarter of 2015, there were only 294

Table 5
Land vs. house price growth 12 major markets, 2004–2014.

	Chinese residential land price index series		Average price of newly-built homes series		Ratio of aggregate land to house price growth
City	Aggregate growth	Per annum rate	Aggregate growth	Per annum rate	Aggregate
Beijing	1036%	27.5%	226%	11.6%	4.6
Changsha	248%	13.3%	93%	6.3%	2.7
Chengdu	201%	11.6%	144%	8.6%	1.4
Chongqing	449%	18.6%	157%	9.2%	2.9
Dalian	101%	7.2%	116%	7.4%	0.9
Guangzhou[a]	169%	15.2%	75%	7.5%	2.3
Hangzhou	273%	14.1%	197%	10.6%	1.4
Nanjing	348%	13.3%	149%	8.9%	2.3
Shanghai[b]	342%	20.4%	101%	8.3%	3.4
Tianjin	332%	15.7%	141%	8.5%	2.4
Wuhan	102%	7.3%	158%	9.2%	0.6
Xian[a]	78%	8.6%	50%	5.4%	1.6

[a] Annual land price data for Guangzhou and Xian are available only from 2007 to 2014, or for eight years. Comparable house price data are used for the same period.
[b] Annual land price data for Shanghai are available only from 2006 to 2014, or for night years. Comparable house price data are used for the same period.

Table 6
Real house price appreciation, constant-quality index, 2006–2014.

	Aggregate real price growth	Implied per annum compound growth rate
Beijing	384.5%	19.8%
Changchun	108.3%	8.7%
Changsha	105.7%	8.6%
Chengdu	56.0%	5.2%
Chongqing	104.8%	8.5%
Dalian	47.7%	4.6%
Fuzhou	201.9%	13.5%
Guangzhou	172.3%	12.1%
Guiyang	71.7%	6.4%
Haikou	125.4%	9.7%
Hangzhou	72.1%	6.4%
Harbin	66.4%	6.0%
Hefei	59.7%	5.5%
Hohhot	125.5%	9.7%
Jinan	27.4%	2.8%
Kunming	131.4%	10.1%
Lanzhou	114.6%	9.1%
Nanchang	56.7%	5.3%
Nanjing	145.3%	10.8%
Nanning	45.5%	4.4%
Ningbo	55.1%	5.1%
Qingdao	105.6%	8.6%
Shanghai	165.2%	11.8%
Shenyang	74.0%	6.5%
Shenzhen	110.4%	8.9%
Shijiazhuang	149.3%	11.0%
Taiyuan	30.1%	3.1%
Tianjin	80.2%	7.0%
Urumqi	157.1%	11.4%
Wuhan	55.7%	5.2%
Xian	61.2%	5.6%
Xiamen	320.6%	17.8%
Xining	92.6%	7.8%
Yinchuan	54.5%	5.1%
Zhengzhou	126.3%	9.8%
35 City Aggregate	138.5%	10.4%

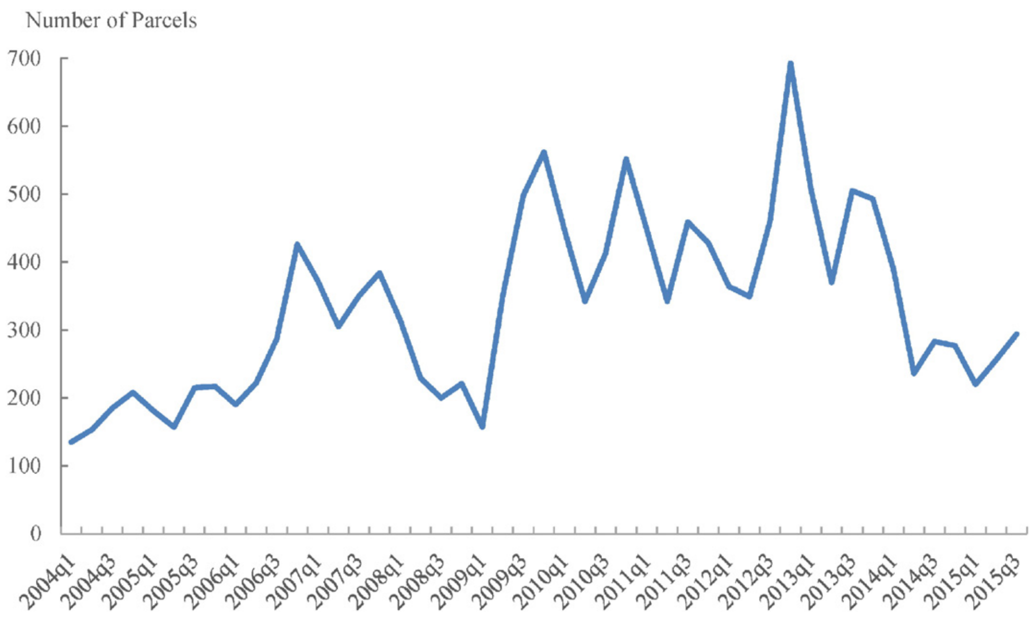

Fig. 5. Quarterly land parcel sales in China (35 market aggregate) 2004(1)–2015(3).

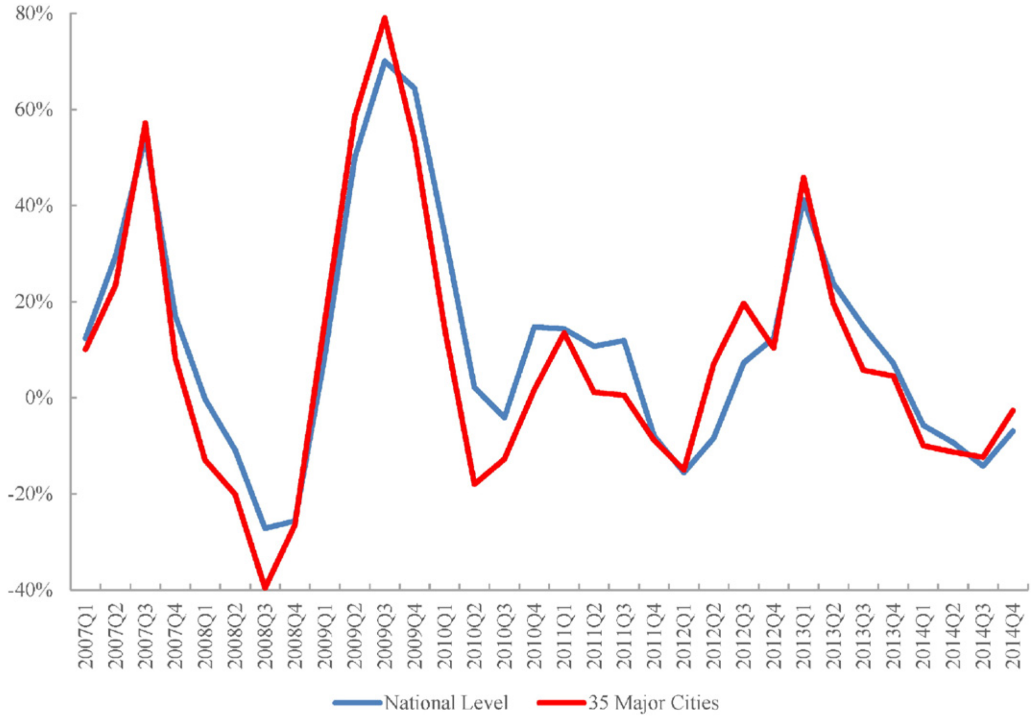

Fig. 6. Year-over-year growth in floor space sold, newly-built housing units, 2007(1)–2014(4).

sales, which is barely above the analogous number from one year ago, but is 42% below the number sold two years earlier in 2013(3). And, this is 60% below historical peak years.

Fig. 6 plots the year-over-year growth in total square meters of newly-built housing units that are sold, as provided by National Bureau of Statistics of China. This series starts in 2007(1), with the latest data available from the last quarter of 2014. It also exhibits a sharp spike in sales volume leading up to the financial crisis, followed by a dramatic decline. The impact of the beginning of the stimulus period in 2009 is clearly visible, as is the mean reversion after that. The sharp rise in transactions in 2012 is evident. Growth in transactions volumes of newly-built units has been declining since the beginning of 2013, and all four quarters in 2014 show absolute declines in year-over-year growth.

The short-term volatility in Chinese housing market transactions quantities is markedly different from the U.S. data, which is depicted in Fig. 7. Transactions volumes do fluctuate widely over the housing cycle in America, but they do so more smoothly over quarterly or even annual periods. Some of the difference may be due to the Chinese government intervening in the housing and mortgage markets much more frequently and forcefully than does the U.S. government. That is an area urgently in need of more research.[6] This figure also shows that change in trading volumes led price changes by about 12–18 months, both at the peak and trough of the cycle. Only time will tell if this pattern holds in the Chinese data, too, but if it does, the recent declines in trading volumes in land parcels and square footage of new unit sales are foreboding.

3. Thinking about risk: can Chinese price growth possibly be explained by fundamentals?

Prices reflect the intersection of supply and demand, so one cannot tell all that much simply by looking at their levels or rates of growth. Moreover, the very high growth rates of Chinese house prices need to be kept in perspective. For example, the 1995–2005 U.S. housing boom saw real prices increase by about 50% at the national level, with so-called 'bubble markets' such as Las Vegas, Phoenix and Miami escalating by from 100% in Las Vegas to 130% in Miami over the same time span. Those certainly are far lower than what we believe to be credible data shows for many major Chinese housing markets. However, it is critical to recognize that prices started from different levels at the beginning of each country's boom, with the appreciation in China coming off a very low base. Differences in economic growth across the two countries also are large. From 2004–2014, Chinese GDP grew in real terms at an average compound real rate of 10.0% or by about 158% in aggregate. That is nearly four times the 42% real aggregate growth during the U.S. housing boom years from 1995 to 2005. And, as we show just below, real income growth also has been much higher in China, particularly in its urban markets.

[6] See Du and Zhang (2015) and Cao, Huang, and Lai (2015) for examples on some recent research on this topic.

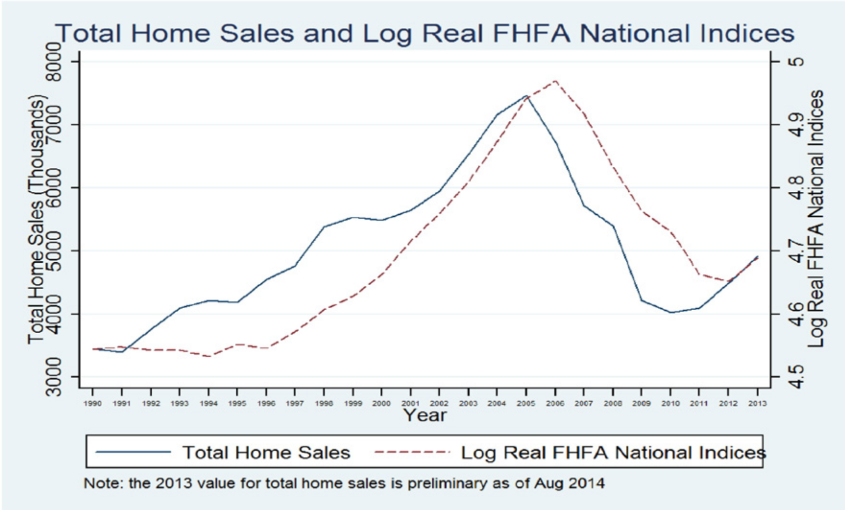

Fig. 7. Transactions volume and prices in the U.S. housing market.

While it is challenging to execute a convincing econometric analysis on such a short time series, there are a number of other metrics by which one can judge the risk that Chinese housing markets are substantially overpriced. Developing those measures and interpreting them is the purpose of this section. We start with what we consider the most intuitive: measuring whether growth in the quantity of housing supplied has outpaced demand as reflected in the number of households needing a place.

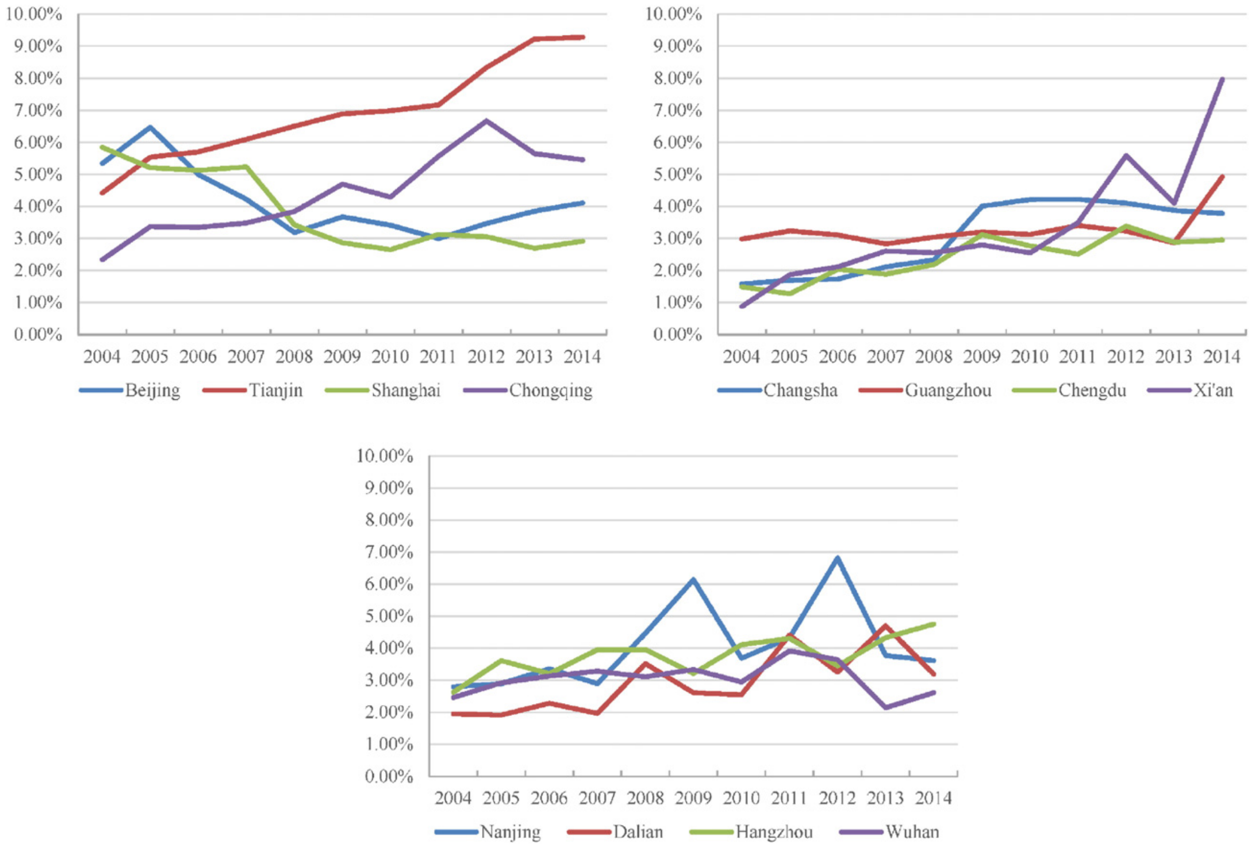

Fig. 8. Annual new housing supply as a share of the 2010 stock in 12 major markets.

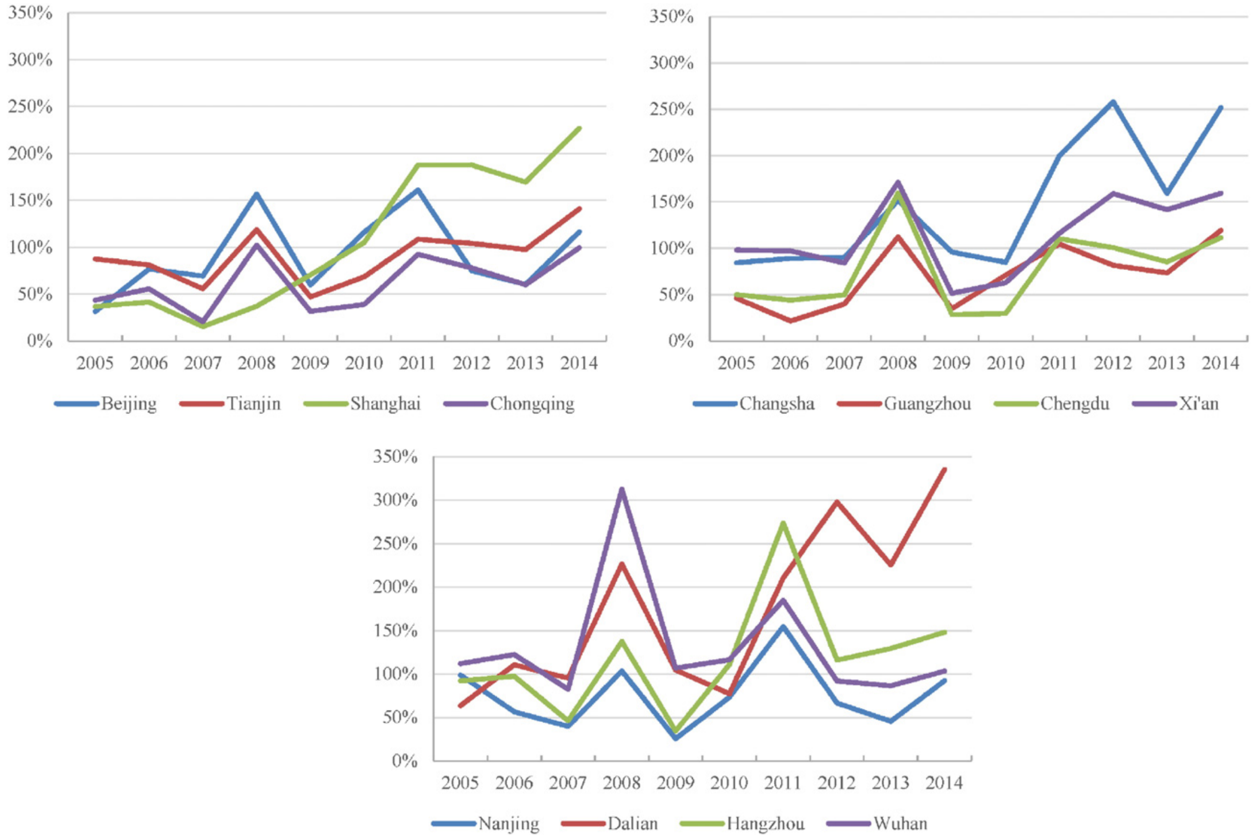

Fig. 9. Unsold inventory held by developers as a share of sales volume in 12 major markets.

3.1. Supply and demand: units and households

It is well known that demand-side fundamentals tend to be quite strong in most Chinese housing markets. Even without rapid national population growth, an on-going, massive rural-to-urban migration underpins strong demand for housing units in Chinese cities. According to the two latest *National Population Censuses* by NBSC, the urban population in China increased from 458.8 million (36.9% of total population) in 2000 to 670.0 million (50.3% of total population) in 2010, for an average compound growth rate of about 3.9%. Urban household income also has grown substantially as the Chinese economy has prospered over the past couple of decades. The average annual compound real growth rate of per capita disposable income for urban households reached 8.9% between 2004 and 2014 according to NBSC. The importance of these demand factors is also highlighted in recent research (Chen, Guo, and Wu (2011); Fang, Gu, Xiong, and Zhou (2015); Garriga, Wang, and Tang (2014); Huang, Leung, and Qu (2015); Wang and Zhang (2014)).

Less is known about the supply side of the housing market, but some research suggests that high and rising prices are due at least in part to some type of natural constraint or restrictive behavior by local governments (e.g., Wang, Chan, and Xu (2012); Wu, Feng and Li (2015)). Fig. 8 begins our documentation of supply side conditions with its plot of the ratio of new housing supply as a share of the 2010 stock in the 12 major markets for which land price growth was reported above.[7] The first panel shows that residential space is not rising as a share of overall market size in Beijing and Shanghai, but is in Tianjin and Chongqing. In 2014 alone, developers in Tianjin delivered new space equal to over 9% of the 2010 stock; in Chongqing, the analogous figure is nearly 6%.[8] The other panels of Fig. 8 document rising trends in other markets such as Xian, Chengdu, and Guangzhou.

Fig. 9 gauges supply in another way for these same markets, this time with unsold inventory held by developers as a share of yearly sales volume in the same market.[9] A value of 0.5 implies that unsold inventories equal six months of average sales volumes in the same market. Consider the series for Beijing in the first panel. There are sharp spikes in unsold inventories relative to sales

7 In this measure, the numerator is the annual volume (in floor area) of newly-built housing completion as reported by local statistics agency. The denominator, the housing stock in 2010, is calculated based on the per capita living space of urban households and urban population in 2010, both reported in the *National Population Census*. Ratios for all 35 major markets discussed above are available upon request. These dozen cities capture most of the local variation across the 35 cities.

8 To help put these numbers in perspective, it may be useful to know that housing permits in Phoenix, one of the U.S. 'bubble markets', did not quite reach 6% at the height of its boom.

9 The numerator is the inventory (in floor area) of newly-built housing units held by developers at the end of the year. The denominator is the transaction volume (in floor area) of newly-built housing units sold during this year. Both are reported by local housing authorities.

Table 7
Inventory level of 119 listed housing developers in China, 2006–2014.Source: authors' calculations based on firms' annual financial reports.

	Average turnover ratio	Aggregated inventory (in billion yuan)	Average normalized inventory
2004	44.30%	76.00	23.70%
2005	40.54%	87.63	24.69%
2006	42.71%	136.45	28.32%
2007	45.20%	226.93	30.54%
2008	33.08%	356.92	44.65%
2009	30.01%	377.54	37.83%
2010	28.97%	517.44	41.92%
2011	24.90%	707.81	45.74%
2012	24.22%	815.20	44.41%
2013	25.26%	1039.71	44.80%
2014	24.08%	1618.68	48.61%

volume in 2008 during the global financial crisis and in 2010 and 2011 amidst the national stimulus program. Inventory relative to transactions volume was low in 2012 and 2013, but increased in 2014. This ratio has been trending up in Shanghai since 2007. Inventories in Shanghai equal about 24 months of sales volumes at the end of the sample period. Other markets such as Dalian, Changsha, and Xian recently have seen multiple years of similarly high levels of unsold inventory relative to overall market sales volume.

Table 7 provides another perspective that confirms inventory levels have been rising not just absolutely, but relative to the scale of activity in the market. It reports data on a balanced panel of 119 property development firms listed on the Shanghai and Shenzhen stock exchanges. The first column reports average turnover rate as reflected by the mean sales-to-asset ratio for these firms. Under Chinese accounting rules, a housing developer's inventory includes all land parcels purchased and housing units under construction, including those already presold to households. We adjust that number to exclude all advance payments from presold units and report it in the second column. Normalized inventory, which standardizes by the level of assets, is reported in the final column. Absolute and relative inventory levels clearly have risen over time, with a higher plateau roughly double that experienced in 2004 being reached following the stimulus period, followed by a remarkable increase again in 2014. Those high inventory levels have been maintained over time.

Fig. 10 helps us understand the rapid increase of housing inventory held by developers during recent years. Floor space in aggregate housing starts in the 35 major cities fluctuated between 200 and 300 million square meters before 2009, but then jumped by about 50% to over 450 million square meters in 2010 following the stimulus. Even with the downturn in 2014, the level of space delivered remains well above that seen prior to the stimulus period. One needs more than modest growth in demand to keep pace with a surge in supply that large. For many cities, that growth did materialize, but not in others. In

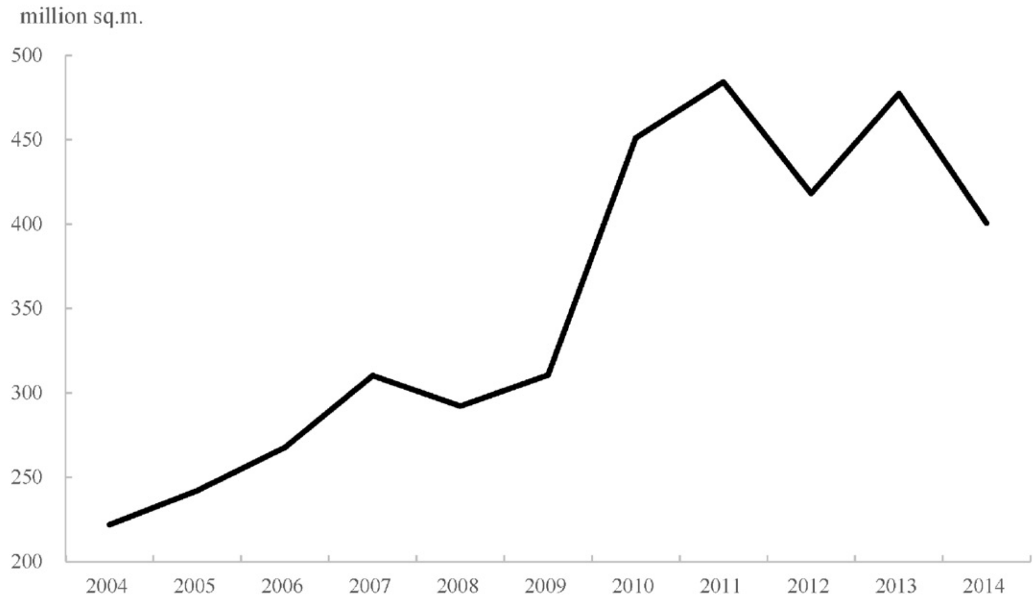

Fig. 10. Aggregate space delivered in housing starts, 35 major markets.

those places, inventory started to increase when the huge volume of housing starts were converted to effective supply in the market.

We also investigated longer-run changes in quantities in our 35 major markets. More specifically, the increase in the number of households is compared to the number of units supplied during the same interval. It is surprisingly difficult to estimate these quantities for Chinese cities for a number of reasons (e.g., urban boundaries change, the housing units of some local households are torn down so they need a unit even though they did not migrate into the city). They require a number of assumptions to be made. Appendix A describes them and the entire estimation process in detail. While we obviously made what we consider the best choices, readers are encouraged to review that section carefully.

Table 8 reports our results. The top row of the table is for the entire nation. During the decade between 2001 and 2010, growth in the number of households needing a housing unit exceeded the increase in the supply of units by nearly 14% in aggregate. However, there was an oversupply of units relative to households of about 26% in 2011–2014, which resulted in supply roughly equaling demand over the full 2001–2014 period. Once again, that aggregate average masks important heterogeneity across markets. This is highlighted by contrasting the cases of Beijing and Chongqing, the two cities with the 1st and 2nd highest land price appreciation rates and the 1st and 3rd highest house price growth rates. Our calculations suggest that the number of new units supplied in the capital city has been sufficient to satisfy only 87% of our estimate of the growth in households living in Beijing since 2000. This stands in stark contrast to the situation in Chongqing. Additions to net new supply there appear to have been over 90% above the increase in households. We estimate that net new supply has exceeded the net increase in households by at least 30% in another twelve markets: Chengdu, Guiyang, Harbin, Hohhot, Lanzhou, Qingdao, Shenyang, Taiyuan, Tianjin, Xining, Yinchuan, and Zhengzhou. Another eleven saw net new supply exceed net new demand by from 10%–30% (Changchun, Changsha, Dalian, Fuzhou, Hefei, Kunming, Nanning, Shijiazhuang, Wuhan, Xiamen, and Xian). That means another eleven markets of the major did not see supply outpace demand this century (by more than 10%, a magnitude that we consider well within the range of estimation error). This group includes many of the largest markets in the East region of China such as Beijing, Guangzhou, Shanghai, and Shenzhen, as well as other coastal markets such as Hangzhou and Nanjing.

Table 8
Supply vs. demand over time, national level and 35 major cities.

	Annual average supply (thousand units)			Annual average demand (thousand units)			Supply–demand ratio		
	2001–2010	2011–2014	2001–2014	2001–2010	2011–2014	2001–2014	2001–2010	2011–2014	2001–2014
Nation	6739.32	10305.54	7758.24	7768.63	8170.90	7883.56	86.75%	126.12%	98.41%
Beijing	243.28	194.81	229.43	281.44	216.48	262.88	86.44%	89.99%	87.27%
Changchun	46.35	90.89	59.07	58.43	39.84	53.12	79.33%	228.11%	111.21%
Changsha	50.93	92.46	62.79	50.34	59.39	52.93	101.16%	155.68%	118.64%
Chengdu	100.11	210.19	133.32	51.7	73.26	57.86	193.63%	286.90%	230.41%
Chongqing	223.99	398.85	273.95	128.81	175.32	142.1	173.88%	227.50%	192.78%
Dalian	56.46	95.13	67.51	60.04	54.66	58.51	94.04%	174.04%	115.39%
Fuzhou	51.62	56.22	52.93	43.3	48	44.64	119.22%	117.13%	118.58%
Guangzhou	138.91	135.43	137.92	148.19	150.01	148.71	93.74%	90.28%	92.74%
Guiyang	37.54	70.92	47.08	26.35	35.77	29.04	142.45%	198.26%	162.09%
Haikou	11.25	23.53	14.76	14.54	14.91	14.64	77.37%	157.77%	100.76%
Hangzhou	72.83	116.89	85.42	96.57	136.59	108.01	75.42%	85.58%	79.09%
Harbin	105.93	143.96	116.8	83.52	46.81	73.03	126.84%	307.54%	159.93%
Hefei	46.24	83.61	56.92	45.14	47.15	45.71	102.45%	177.30%	124.51%
Hohhot	41.04	46.01	39.57	22.64	21.05	22.18	181.30%	218.63%	178.38%
Jinan	35.43	42.65	37.5	40.67	51.34	43.71	87.14%	83.09%	85.78%
Kunming	51.42	44.96	49.57	40.22	43.46	41.15	127.83%	103.44%	120.47%
Lanzhou	36	31.49	34.71	21.63	30.64	24.21	166.43%	102.75%	143.40%
Nanchang	30.5	36.22	31.64	26.63	41.78	30.96	114.52%	86.70%	102.20%
Nanjing	58.59	83.2	65.62	49.5	96.36	62.89	118.37%	86.34%	104.35%
Nanning	37.5	46.9	40.19	36.13	31.55	34.82	103.81%	148.64%	115.42%
Ningbo	63.78	86.51	70.27	72.22	107.83	82.39	88.32%	80.23%	85.29%
Qingdao	66.88	87.01	72.63	45.95	61.71	50.46	145.54%	140.99%	143.95%
Shanghai	258.93	178.53	235.96	304.68	417.46	336.9	84.98%	42.76%	70.04%
Shenyang	99.42	160.28	116.81	79.84	66.1	75.92	124.52%	242.50%	153.87%
Shenzhen	181.08	63.87	147.59	235.25	105.6	202.82	76.97%	60.48%	72.77%
Shijiazhuang	41.03	68.4	48.85	39.39	53.04	43.29	104.16%	128.97%	112.85%
Taiyuan	37.79	59.02	43.86	28.07	33.48	29.61	134.64%	176.31%	148.10%
Tianjin	114.45	196.78	137.98	92.72	135.43	104.92	123.44%	145.30%	131.51%
Urumqi	46.25	64.22	51.38	57.69	46.19	54.41	80.16%	139.04%	94.44%
Wuhan	68.82	66.03	68.02	46.32	68.72	52.72	148.57%	89.77%	129.02%
Xiamen	54.6	53.37	54.25	53.28	31.73	47.12	102.48%	168.20%	115.12%
Xian	59.23	116.55	75.61	58.1	58.75	58.29	101.95%	198.37%	129.72%
Xining	16.06	59.73	28.54	19.89	26.18	21.69	80.74%	228.12%	131.57%
Yinchuan	36.5	57.97	42.64	21.06	24.79	22.13	173.29%	233.82%	192.66%
Zhengzhou	52.66	146.17	79.38	37.62	51.6	41.61	140.00%	283.29%	190.76%

Note: See Appendix A for the details of how supply and demand were estimated.

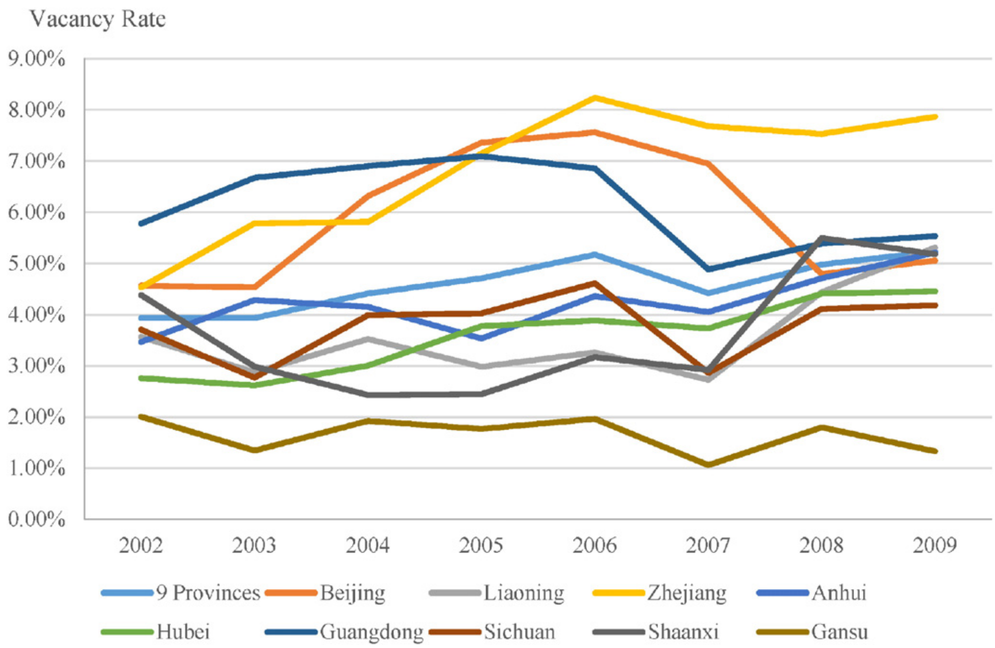

Fig. 11. Housing vacancy rate based on urban household survey between 2002 and 2009.

3.2. Residential vacancy

If quantity supplied really has outpaced the growth in the quantity of units demanded in a market, then the vacancy rate should have increased. Measurement of residential vacancy is of great interest in China, but data limitations once again make it very hard to document convincingly. There has been no official housing survey that could provide a reliable estimate since the first *National Urban Housing Census* in 1985.[10] This has led some researchers to conduct independent surveys on urban households. Perhaps the most well-known is the *China Household Finance Survey* (*CHFS*) at Southwestern University of Finance and Economics (Gan, 2012). For their latest report in 2013, they surveyed 28,000 households around the country, with each household sampled providing the total number of dwelling units it owned, as well as the number of units leased out. Presuming that a household occupies only one unit at a time, the number of vacant units owned by the household can be calculated. Aggregating across households, they reported a very high nationwide vacancy rate of 22.4% in 2013.[11]

Other researchers have imputed a vacancy rate indirectly from macro-level statistics. For example, researchers from China International Capital Corporation (CICC), a leading investment bank, started with the data from the *National Population Census* in 2010.[12] This source reports the breakdown of urban households by the number of bedrooms they were: 1) occupying; or 2) owning and leaving vacant. After making some assumptions on the average number of bedrooms per unit, the CICC imputed a housing unit-level vacancy rate of 18.3% for the nation in 2010.[13] A recent update at the end of 2013 indicates a slightly lower level of 17.7%.

We would expect vacancy rates that high to have exerted a material dampening effect on house price appreciation that one does not see in the data in most markets. Hence, we make an independent measurement using existing data (not a new survey) that allows us to compute vacancy rates at the provincial level. More specifically, we use micro-data from the *Urban Household Survey* (*UHS*), an official survey designed by the NBSC that is conducted annually by local statistics bureaus. Annual sample sizes of about 50,000 households are available. Households are surveyed in each city according to population size (e.g., there are 2100 households surveyed in Beijing). Within each city, households are randomly sampled using stratified three-stage (neighborhood, housing complex, and household) random sampling with probability proportionate to size. More specifically, each household reports the total number of dwelling units it owns, and identifies its main residence as well as the occupancy

[10] Sporadic region-level surveys exist such as the housing census conducted in 2007 by the Beijing local government, but in most cases official statistics were not published and no micro-data were released.

[11] The results are reported in "The Vacancy Rate of Urban Housing and Trend in the Housing Market" (in Chinese) released in June 2014 on the official website of CHFS (www.chfs.swufe.edu.cn).

[12] The results are reported in "Are Vacancy Rates too High in China" (in Chinese) released on June 19th, 2014 by CICC (www.cicc.com).

[13] For example, they assumed that for households with three bedrooms, 99% had 1 unit and 1% had 2 units; for households with four bedrooms, 20% had 1 unit, 75% had 2 units, and 5% had 3 units; for households with five bedrooms, 20% had 1 unit, 72% had 2 units, and 8% had 3 units; and so on. These assumptions were based on information on the breakdown of dwelling units by the number of bedrooms from the same census. They also assumed that a single household could occupy one unit at a time.

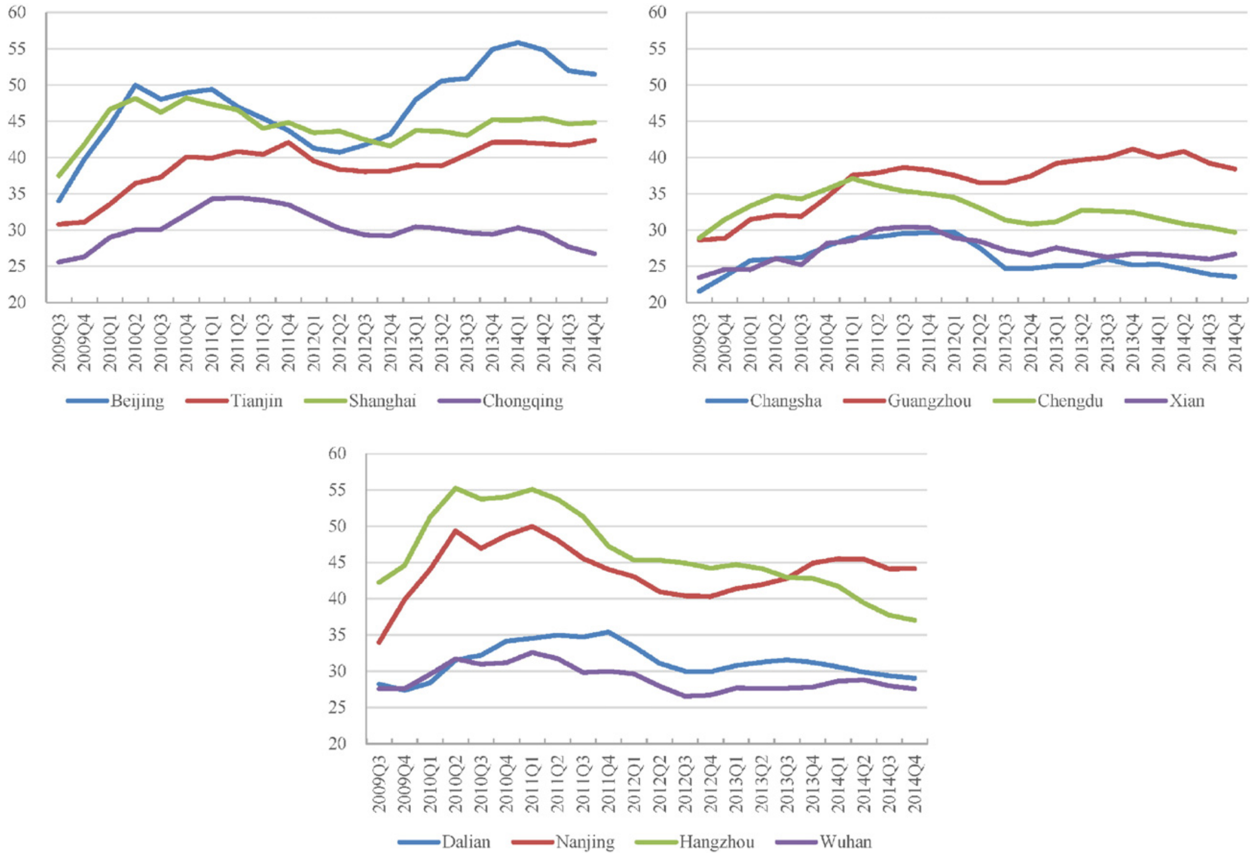

Fig. 12. Quarterly price-to-rent ratios in 12 major markets.

status of all other units it owns as either "occasionally occupied", "leased out", or "other". To be conservative, we consider "occasionally occupied" and "other" units as vacant.

By law, it is the obligation of any household sampled to participate in the survey and to provide accurate information. Thus, survey data quality is perceived to be high.[14] With support from the China Data Center at Tsinghua University, we were able to obtain the micro-level data in nine provinces between 2002 and 2009, including that for Beijing which is a provincial-level city. Fig. 11′s plot shows much lower vacancy rates, with the level across all nine provinces increasing gradually from 3.9% in 2002 to 5.2% in 2009. There is noteworthy heterogeneity in vacancy conditions across provinces, too. In 2009 for example, the vacancy rate was highest in the eastern province of Zhejiang (7.9%), followed by Guangdong (5.5%) and Liaoning (5.3%). Beijing's vacancy rate was 5.1%, with the western province of Gansu having the lowest rate at 1.3%.

More recent vacancy rates can be imputed using our supply–demand change results if we are willing to use the 9-province aggregate to proxy for the nation. Based on the *National Population Census*, we can impute that the total number of urban households nationally was 197.95 million in 2009. Using the 5.2% vacancy rate reported just above implies there were 10.86 million vacant units in urban areas that year ($197.95 / (1 - 5.2\%) * 5.2\% \approx 10.86$), presuming one household occupies one unit. Based on the calculation in the previous sub-section, there was a net increase of 32.68 million households needing housing units during the four years between 2011 and 2014; on the supply side, the number of housing units increased by 41.22 million over the same time period. If all the 8.54 million units of excess supply were left vacant, then the vacancy rate increased to 7.8% by the end of 2014 ($(10.86 + 8.54) / (208.81 + 41.22) \approx 0.078$).

Both the level and the change need to be interpreted with care because Chinese economic conditions are fundamentally different from those in the U.S. and most other developed countries. As an emerging market experiencing rapid growth, the annual flow supply comprises a substantial share of the housing stock in China. For example, there were about 15.13 million housing units completed in 2013, which amounts to 5.7% of the total stock of about 265.74 million units at the end of that year in urban markets. In most cases, it would take the purchaser of a newly-built unit several months to furnish the unit before moving in. In addition, the share of uneconomic or dilapidated housing units is likely to be relatively high in China. The *National Population Census* in 2010 reports that 8.7% of the urban housing units were completed before 1979. That is before the reform era, which

[14] For example, certain official statistics such as household disposal income and household expenditures on consumption reported are calculated using *UHS* data.

Table 9
Expected capital gain based on the user cost model.

	Expected capital gain equalizing user cost and rent	Per annum compound growth rate between 2006 and 2014
Beijing	7.30%	19.80%
Changchun	5.10%	8.70%
Changsha	5.00%	8.60%
Chengdu	5.90%	5.20%
Chongqing	5.50%	8.50%
Dalian	5.80%	4.60%
Fuzhou	6.30%	13.50%
Guangzhou	6.60%	12.10%
Guiyang	4.70%	6.40%
Haikou	5.30%	4.40%
Hangzhou	6.50%	6.40%
Harbin	4.60%	6.00%
Hefei	6.00%	5.50%
Hohhot	5.20%	9.70%
Jinan	6.20%	2.80%
Kunming	5.70%	10.10%
Lanzhou	5.40%	9.10%
Nanchang	6.60%	5.30%
Nanjing	7.00%	10.80%
Nanning	4.80%	9.70%
Ningbo	6.30%	5.10%
Qingdao	6.90%	8.60%
Shanghai	7.00%	11.80%
Shenyang	5.70%	6.50%
Shenzhen	6.90%	8.90%
Shijiazhuang	6.50%	11.00%
Taiyuan	5.80%	3.10%
Tianjin	6.90%	7.00%
Urumqi	5.60%	11.40%
Wuhan	5.60%	5.20%
Xiamen	7.20%	17.80%
Xian	5.50%	5.60%
Xining	4.50%	7.80%
Yinchuan	5.50%	5.10%
Zhengzhou	5.70%	9.80%

suggests that many of these units do not meet the current quality standards demanded by urban households. Thus, many of them are likely to be left vacant. Factors such as these suggest that the natural vacancy rate probably is higher in China than in developed markets such as the United States. That said, it is difficult to believe that the natural vacancy rate doubled over the past four years, so the recent jump in vacancies is mostly likely due to oversupply.

3.3. Other metrics: price-to-rent and price-to-income ratios

Other metrics such as the price-to-rent and price-to-income ratio can be computed for Chinese markets. Price-to-rent ratios for the same 12 major markets are plotted in Fig. 12 dating back to the third quarter of 2009.[15] The underlying data are averages of district-level prices (in the numerator) and rents (in the denominator), both of which are reported by a data vendor (www.cityre.cn) based on their collection of micro-level listing prices or rental prices information in the corresponding cities.

There is a very wide range of ratios, running from the low 20s to just over 50 in the latest data from the last quarter of 2014. These are high values compared to the U.S. Recent decennial census data for July 2011 reports ratios from the mid-teens to the mid-40s for the thirty largest cities in the United States. Sixteen of those 30 areas have price-to-rent ratios below 20; another eight are between 20 and 30, with five cities in the thirties (New York City, Los Angeles, San Jose, Seattle, and Washington, DC), and only one above 40 (San Francisco at 44.1).[16]

Fig. 12 shows little evidence of rising trends for this ratio, with Guangzhou being the exception. Its price-to-rent ratio has increased from just below 30 to just over 40 since 2009. Other markets such as Shanghai, Tianjin, Chongqing, Wuhan and Dalian show flat trends, while there are significant declines in Hangzhou, Chengdu, and Xian. The latter cities are evidence that price-to-rent ratios can compress at least somewhat without prices themselves dropping at all. Beijing has the highest ratio (along with Shanghai) on average. It has been above 50 since 2013(1).

[15] Data for all 35 major markets are available upon request.

[16] See the story at http://seattlebubble.com/blog/2013/03/29/top-30-cities-price-to-rent-price-to-income-ratios-2011/ for more detail. The underlying U.S. Census data are downloadable at http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

Table 10
Can year and city fixed effects explain local housing price growth? (dependent variable: log change in real annual housing price index).

Independent variables	(1)	(2)	(3)
Year fixed effect	Yes	No	Yes
City fixed effect	No	Yes	Yes
R^2	0.39	0.12	0.50
Adjusted R^2	0.37	−0.03	0.41
F Stat. for the joint test of all year fixed effects equaling 0	25.08***	–	26.38***
F Stat. for the joint test of all city fixed effects equaling 0	–	0.82	1.34*
Number of observations	244	244	244

Note: $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$

Poterba's (1984) user cost model of the rent-versus-own decision can be used in conjunction with price-to-rent data and information on the costs of occupying a housing unit to impute the breakeven price appreciation necessary for a new buyer to be indifferent between owning and renting each year. In the Chinese context, the user cost equation is given by

$$UC = r + m + \beta - \pi^{e}, \tag{3}$$

where *UC* represents the all-in costs of owning your housing unit for a given period of time, one year typically. Those costs are captured on the right-hand side of Eq. (3) by the capital cost (r), maintenance and depreciation cost (m), risk premium associated with housing investment (β), and the expected housing appreciation (π^{e}), with no property taxes in almost all localities. This formula is further simplified from the standard Poterba equation because there is no deductibility of mortgage interest in China.

Following Wu, Gyourko, and Deng (2012), we use the 5-year deposit rate as the capital cost, presume maintenance and depreciation amount to 2.5% of house value annually, and impose a 2% risk premium. The first column in Table 9 lists the expected price appreciation needed for a buyer to be indifferent between owning and renting the unit given the other assumptions noted just above. The implied expected appreciation rates range from 4.5% (Xining) to 7.3% (Beijing) as of 2014(4).

Comparing the figures in columns 1 and 2 of Table 10 shows that in eleven cities the breakeven appreciation rate exceeds the average per annum compound rate realized over the previous nine years (Chengdu, Dalian, Haikou, Hangzhou, Hefei, Jinan, Nanchang, Ningbo, Taiyuan, Wuhan, and Yinchuan). Implied expectations seem to be more reasonable in other cities in the sense that they are within the range of recent experience in most markets. Of course, these results paint too optimistic a picture if we are underestimating on-going user costs of ownership. For example, if we use a 5-year loan rate in lieu of the deposit rate, then costs are about 150–200 basis points higher. In that case, the other nine markets would have required price growth expectations above recent average appreciation. They include some of the largest markets in China: Harbin, Guiyan, Qingdao, Shenyang, Tianjin, and Xian.

There are no reasonable assumptions that do not leave the implied breakeven rate for Beijing well below its extremely high recent rates of price appreciation. However, that does not suggest that housing market price risk in the nation's capital is low. The contrary is the case, in fact, and the reason is because the market's price-to-rent ratio itself is so high. To better understand this, consider the potential outcome if expected appreciation in Beijing were for any reason to fall by only one percentage point from 7.3% to 6.3%. In that case, the equilibrium user cost would increase from 1.9% to 2.9%, implying a drop of price-to-rent ratio from 52.6 ($1/0.019 \approx 52.6$) to 34.5 ($1/0.029 \approx 34.5$), all else constant. Absent an offsetting increase in rents, this implies about a one-third drop in prices. Only modest drops in expected price growth (or rises in interest rates) are needed to generate potentially large price declines because they involve large percentage changes in (abnormally low) user costs. Large price declines need not occur, of course, if there are countervailing changes such as rising rents, and we see such cases in markets such as Hangzhou in Fig. 12, where a falling price-to-rent ratio is associated with relatively flat prices and rapidly rising rents.

Fig. 13 presents analogous information on the price-to-income ratio.[17] Caution is in order when interpreting these data, as there is substantial 'gray' income in China which biases up measured ratios (Deng, Wei and Wu, 2015; Wang and Woo, 2011). Changes in these ratios probably are more informative over time, as we have no reason to suspect large, high-frequency changes in reporting of income. With that caveat in mind, these figures show that price-to-income ratios are extraordinarily high in China. Five is a low number, with Beijing's being well over 10. Mortgage underwriting in the U.S. and many other developed countries considers anything above 3 to be potentially problematic. That said, conditions in China are quite different. Commercial banks typically consider 50% as the upper bound for the ratio of monthly debt service to monthly disposable income. Given a typical current mortgage with a 30 year term, a 30% down payment and a 6.55% interest rate, the maximum implied price-to-income ratio is about 9.4. Thus, price-to-income ratios in all markets but Beijing and Shanghai are consistent with current underwriting practices. That does not mean debt service is not high relative to income in China. It is. However, it is likely that other factors such as expected growth in urban incomes are perceived to make affordability less burdensome.[18] Of course, this highlights how important future income growth is to the health of China's housing markets.

[17] In the calculation, we use the average newly-built housing price and the average per capita disposable income, both reported by local statistics agency (either median house price or median income is available in China now). We then calculate the ratio between the price of a housing unit of 90 square meters in size and a household with three members (i.e., assuming that the per capita living space is 30 square meters).

[18] Fang et al. (2015) report results consistent with this conclusion. In their study of 120 cities, they find that households from the lower end of the income distribution still are able to access financing and purchase homes, even in cities with high house price appreciation.

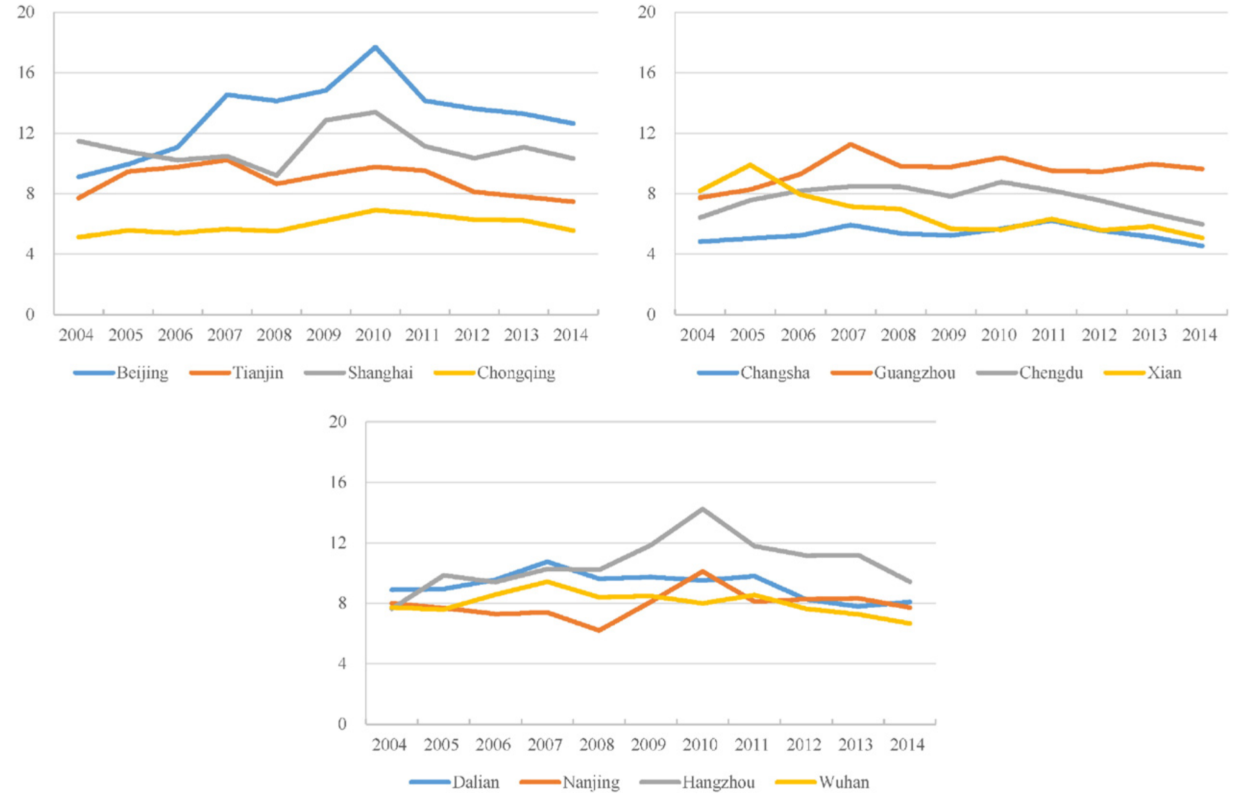

Fig. 13. Annual price-to-income ratios in 12 major markets.

4. House price changes and market fundamentals: 35 major markets

In this section, we estimate simple regression models to determine whether supply and demand fundamentals like those discussed above can help explain house price variation over time across Chinese cities.[19] In doing so, we construct a panel data model using annual data between 2006 and 2013 for the 35 major cities listed above. Our price series is an update of the log change in real constant-quality prices from Wu, Deng and Liu (2014).

We begin with Table 10′s summary results describing how much of real city-level house price growth can be explained by common versus city-specific factors. Column 1 reports the findings of a specification that regresses log real price change on year fixed effects. There is a strong common component in price growth, as year dummies can explain almost 40% of the variation in annual housing price growth. This is consistent with shifts in the macroeconomic environment, market sentiment, and/or the central government's housing market intervention policies playing an important role in all local housing markets. In contrast, column 2′s results show that the explanatory power of city dummies is a much lower 12%. The adjusted-R^2 is so low that we cannot reject the null that city fixed effects are jointly equal to zero. The final column in Table 10 shows that these two factors are largely orthogonal to one another. When both sets of fixed effects are included on the right-hand side, the R^2 is 50%.

We next investigate the role of relative supply–demand conditions. The first column of Table 11 adds controls for the ratio of unsold inventory held by developers to total sales in the relevant market during the previous year and for the ratio of presale permits to total sales in the previous year.[20] Both are negative and statistically significantly different from zero. However, only the inventory variable remains statistically significant when we add controls for the previous year's price level and rate of price growth. One possible reason is that developers could be adjusting the volume of new housing supply based on current housing prices or price changes. For example, during a downturn in the market, developers could choose to postpone some new projects and reduce new housing supply, which would at least partially reduce the magnitude of price drops. The impact of the inventory-to-sales variable declines modestly, but remains highly statistically significant. Interestingly, price growth this year is significantly lower if the price level was higher last year (column 2 of Table 11). Thus, more expensive markets tend to mean revert in the sense their rate of appreciation will be lower.

Column 3 of Table 11 then adds a number of other “fundamental” factors to the specification. On the demand side, three reflect exogenous demand shocks. The exogenous shocks of non-farm employment growth in the city is created using the method

[19] See Ahuja, Cheung, Han, et al. (2010), Ren, Xiong and Yuan (2012), Zhang, Hua, and Zhao (2012); Dreger and Zhang (2013); Chow and Niu (2014) for some other recent attempts on modeling housing price dynamics in major Chinese cities.

[20] Both variables are calculated based on data provided by local housing authorities.

Table 11
Can fundamental factors explain local housing price growth? (dependent variable: log change in real annual housing price index).

Independent variables	(1)	(2)	(3)	(4)
Housing inventory at the beginning of this year/housing sales in the previous year	−0.0529	−0.0443	−0.0424	−0.0429
	(0.0101)***	(0.0096)***	(0.0100)***	(0.0100)***
Housing receiving presale permits in this year/housing sales in this year	−0.0356	−0.0008	−0.0040	−0.0027
	(0.0140)**	(0.0150)	(0.0149)	(0.0155)
Lagged housing price level	–	−0.3981	−0.4043	−0.4089
	–	(0.0588)***	(0.0587)***	(0.0593)***
Lagged housing price change	–	0.0428	0.0161	0.0390
	–	(0.0650)	(0.0655)	(0.0681)
Expected employment growth	–	–	−0.0046	−0.0047
	–	–	(0.0034)	(0.0035)
Expected export growth	–	–	0.0021	0.0020
	–	–	(0.0008)**	(0.0008)**
Expected outstanding loan balance growth	–	–	0.0016	0.0016
	–	–	(0.0012)	(0.0013)
Lagged construction cost change	–	–	0.0223	0.0480
	–	–	(0.3037)	(0.3092)
Residential land supply volume	–	–	−0.0025	–
	–	–	(0.0093)	–
Lagged residential land price change	–	–	–	−0.0047
	–	–	–	(0.0154)
Year fixed effect	Yes	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes	Yes
R^2	0.56	0.70	0.72	0.72
Number of observations	244	209	209	204

Note: $^*p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$

developed by Bartik (1991). This variable, $epgrowth_{i,t}$, is calculated as the weighted average of national industrial sector employment growth rates, where the weights reflect each city's share of that industry's aggregate employment. More specifically,

$$epgrowth_{i,t} = \sum_{j=1}^{18} \frac{e_{i,j,t-1}}{e_{i,t-1}} \cdot \left(\frac{\tilde{e}_{i,j,t} - \tilde{e}_{i,j,t-1}}{\tilde{e}_{i,j,t-1}} - \frac{e_t - e_{t-1}}{e_{t-1}} \right) \tag{4}$$

where e_t is the national employment level in all non-farm industries, $e_{i,j,t}$ is city i's employment in industry j in year t, $\tilde{e}_{i,j,t}$ is the national employment level in industry j outside of city i, and the j subscript indexes the 18 non-farm employment sectors in China.[21]

A similar approach is taken to create another variable intended to reflect exogenous shocks in exports. That variable, $exportgrowth_{i,t}$, is calculated as:

$$exportgrowth_{i,t} = \frac{export_{i,t-1}}{gdp_{i,t-1}} \cdot \left(\frac{\widetilde{export}_{i,t} - \widetilde{export}_{i,t-1}}{\widetilde{export}_{i,t-1}} \right), \tag{5}$$

where $export_{i,t}$ is city i's export in year t, $gdp_{i,t}$ is city i's GDP in year t, and $\widetilde{export}_{i,t}$ is the national-level export outside of city i in year t.

A credit conditions control is created in an analogous way. The exogenous growth in loans, $loangrowth_{i,t}$, is defined as

$$loangrowth_{i,t} = \frac{loan_{i,t-1}}{gdp_{i,t-1}} \cdot \left(\frac{\widetilde{loan}_{i,t} - \widetilde{loan}_{i,t-1}}{\widetilde{loan}_{i,t-1}} \right) \tag{6}$$

where $loan_{i,t}$ is city i's total outstanding loan balance at the end of year t, and $\widetilde{loan}_{i,t}$ is the national-level loan balance outside of city i in year t.

We also experiment with a couple of supply side variables. One is the change in construction costs. We use the lagged term in order to exclude the potential endogeneity. The second factor is about the land market conditions, and we try two different variables: the annual residential-usage land supply volume from the CRLPI, or the lagged term of CRLPI change in the corresponding city.[22]

The findings from this expanded specification show that only the export variable consistently is statistically significant. A one standard deviation increase in expected export growth is associated with a 0.15 standard deviation higher rate of local house price

[21] Unless otherwise stated, the data used in the rest of this section are provided by National Bureau of Statistics of China and local housing authorities.
[22] We do not include the concurrent term of land price change from the CRLPI because of the obvious endogeneity problems.

appreciation. That is not nothing and signifies that a positive demand shock does lead to higher house price appreciation. However, the R^2 does not increase much from that reported in the first two columns.

More importantly economically is the fact that the inventory overhang variable remains statistically and economically significant. Its coefficient implies that a one standard deviation increase in normalized housing inventory would lead to a 0.45 standard deviation lower rate of real house price growth. Thus, supply overhangs as proxied for by rising unsold inventories relative to overall sales activity are associated with economically-meaningful lower rates of price growth the following year. This correlation remains strong even controlling for time and location fixed effects, as well as various other controls.

5. Conclusion

It is routine for people to ask whether Chinese housing is a 'bubble'. This paper does not attempt to answer that question given the limited time series available, but does take on the challenge of assessing the riskiness of Chinese housing markets. That turns out to be substantially more difficult than the typical economist might believe. The first reason is that the data needed for any such analysis is limited. Hence, more accurate measurement of house prices themselves is the first answer to the question of 'what we need to know' in order to sensibly assess Chinese housing market risk. The official government price series are of lower quality than those created by private researchers, but data quality is improving and should continue to do so. Unfortunately, a very short time series for analysis cannot be improved upon by additional public or private research support. Only the passage of time will do in that respect.

In the meantime, insight into market risk still can be gleaned from a careful analysis of supply and demand conditions. We looked at a number of metrics and came to the following conclusions: (1) there is substantial heterogeneity in the volume of supply–demand imbalances across markets, both over time and in the shorter run; (2) high price level and price appreciation rate markets such as Beijing and others on the east coast do not look to be oversupplied by our metrics; there are a number (much more than a handful) of markets, primarily off the coast, where oversupply looks to be substantial by one or more measures; even absent a negative economic shock, these markets look very risky, as we would expect weak housing market fundamentals to lead to weak or negative price growth no matter what; empirically, we report a correlation showing that a one standard deviation higher inventory overhang in a local market is associated with nearly a one-half standard deviation lower future growth rate of real prices; (3) even markets such as Beijing with strong measured fundamentals should be considered risky because housing units there trade at very high multiples of rent; it only takes a modest downward shift in expectations (or a commensurate increase in interest rates) to generate sharp asset value declines when a market is 'priced to perfection'; naturally, a true negative shock in terms of a policy intervention or a further downshift in economic growth would compound the problem.

There are other factors that affect risk which are beyond the scope of this already lengthy paper. Debt is one example. Negative equity appears to have played a critical factor in the U.S. housing bust, but there appears to be substantial equity in the Chinese residential housing system. If there is hidden leverage in the system, that would be problematic, but we leave that possibility to other research.

Appendix A. Calculation of the ratio between changes in housing demand and supply

A.1. Demand side indicator

The demand side indicator measures the number of family households needing new housing units in the city during the decade between 2001 and 2010. It is important to note that the definition of "family household" in China is not consistent with that in other countries like the U.S. In China, all the three following cases would be counted as one family household in the *National Population Census* (*NPC*): (1) if one family occupies one dwelling unit, it would be counted as one family household; (2) if two or more families share one dwelling unit, but each of them occupies at least one bedroom, each of them would be treated as one family household; and (3) if one person occupies one dwelling unit (or one room in the unit) alone, he/she would also be counted as one family household.

The demand side indicator is calculated as the sum of two components: (1) net increase in family households living in the urban area and (2) urban family households previously living in units that were demolished.

(1) Net increase of family households living in the urban area
The first component measures the net increase of family households living in the urban area of the city between 2000 and 2010, which may come from either the formation of new families, or immigration of households from other cities or from rural areas (of the same or other cities).
The number of urban family households is directly available in the *NPC*s in both 2000 and 2010: from the 2000 *NPC*, we obtain the total number of family households living in the urban area of the city on Nov 1st, 2000, both with and without local "*hukou*" (residence registration); similarly, the corresponding figure for Nov 1st, 2010 is available in the 2010 *NPC*. Based on these two numbers we calculate the net increase in the number of family households during the decade. In the city of Beijing for example, there were 3,231,319 households living in its urban area as reported in the 2000 *NPC*, and 5,803,085 in 2010, implying a net increase of 2,571,766 (5,803,085–3,231,319 = 2.571,766) households.
One potential problem here is that the boundary of the "urban area" in a city is not necessarily consistent between 2000

and 2010. Due to the continuous urbanization, some villages at the city edge might be defined as a “rural area” in the 2000 *NPC*, but then urbanized during the decade and so redefined as an “urban area” in the 2010 *NPC*. Such a redefinition would lead to an increase in urban households, but some households in these “villages” might actually live in exactly the same units in 2000 and 2010. Therefore, it might result in an upward bias in the demand side indicator.

We try to correct for this bias based on data of households reported as living in a rural area. Using Beijing as an example, in the 2000 *NPC* there were 2,533,459 persons with local *hukou* living in its rural area. Without any population migration or redefinition of urban area, these 2,533,459 persons ought to increase to 2,573,766 in 2010, given the natural growth rate of 1.591% in Beijing during the decade; however, the actual population living in the rural area of Beijing reported in the 2010 *NPC* was 1,908,652, which implies that there were 665,114 (2,573,766–1,908,652 = 665.114) persons which were either re-defined as living in the urban area, or moved to the urban area of Beijing, or moved out of the city. According to the *NPC* data, during the decade there were 209,910 persons who previously lived in the rural area of Beijing but moved to other cities or the urban area of Beijing, which implies that 455,204 (665,114–209,910 = 455.204) persons were re-defined as living in the urban area. Presuming three people per household, this works out to 150,481 households. Therefore, the actual number of increase in urban households is 2,421,285 (2,571,766–150,481 = 2.421,285).

(2) Urban family households with previous dwelling units demolished

The second component measures the number of family households living in the urban area (as of the 2000 NPC) whose dwelling units were demolished in the urban regeneration process over the decade. These households need to purchase or rent a new unit and thus also contribute to the demand for new housing supply. Unfortunately, for almost all cities this number is not directly available, but can only be imputed indirectly. The procedures are as follows, and again we take Beijing as the example (Table A-1).

1) In both the 2000 and 2010 *NPC*s, about 10% of the family households were sampled to provide additional information, including the building age of their current dwelling units. We use this information to calculate the demolition rate for each building age category. For example, there were 4,096,844 family households in Beijing (both urban and rural area) in 2000, of which 402,717 households were sampled to provide additional information. Of these 402,717 households, 18,425 reported that their current dwelling units were built before 1949, which implies that there were about 187,438 ($18,425 / 402,717 * 4,096,844 \approx 187,438$) family households in Beijing with dwelling units built before 1949. Using the same methodology, we compute that there were only 7913 such households in 2010. This suggests that there were 106,752 dwelling units of pre-1949 vintage demolished during the decade, or a demolition rate of 56.95% ($106,752/187,438 \approx 0.5695$).
2) Analogous demolition rates are calculated for other vintages. For the vintages of “1990–1999” and “after 2000”, we assume that the demolition rates are 1% and 0%, respectively, according to a report by Institute of Real Estate Studies, Tsinghua University.
3) In the 2010 *NPC* the building age category information is also available for family households living in the urban area. With the assumption that the demolition rate did not significantly differ between urban and rural areas, we can use that figure to impute the number of households with units demolished in each category. For example, in 2010 there were 76,584 urban family households with dwelling units built before 1949, and according to the above calculation the demolition rate was 56.95%. This implies that there were 101,327 ($76,584 / (1 - 56.95\%) * 56.95\% \approx 101,327$) households in this category with units demolished during the decade.

In total, we estimate that housing units of 393,159 urban households in Beijing were demolished during the decade.

(3) Aggregated number

Based on these calculations, the aggregated demand for new housing units in Beijing is 2.81 million units.

A.2. Supply side indicator

The supply side indicator measures the number of housing units completed and available for family households in the city during the decade. There are two components included here: (1) units developed by firms or institutions; and (2) units built by households themselves.

(1) Units developed by firms or institutions

We start with the total floor area of housing completed. In Beijing, there were 209.69 million m^2 of housing completed between Nov 1st, 2000 and Oct 30th, 2010, including private housing developed by housing developers, public housing developed by governments, institutional housing developed by universities or other institutions, etc., but excluding any informal housing or units built by households themselves.

However, not all the 209.69 million m^2 are available for the family households. Besides the family households, there is also another group of “non-family” households reported in the *NPCs*. These so-called “non-family households” refer to those living in one room but are legally unrelated. Mainly, they include three groups: (1) those who rent and live in dormitories provided by universities, high schools, factories, construction sites, or other institutions; (2) those who rent and share one room; and (3) unmarried couples.

We deduct their demand from the 209.69 million m^2. In Beijing, there were totally 1,443,186 persons defined as non-family households in the 2000 *NPC*. Based on the building code for institutional housing in 2000, we assume that the per capita living space for them is 6.5 m^2 in 2000, and thus they need about 9.38 million m^2 of housing in aggregate. By 2010, the population of this group increased to 2,892,968 persons and the standard for per capita living space also increased to 7.0 m^2, and so they need about 20.25 million m^2 of housing. Therefore, their housing demand increased by

10.87 (20.25–9.38 = 10.87) million m^2 during the decade. Presuming that demand was fully satisfied implies 198.60 (209.47–10.87 = 198.60) million m^2 of new housing supply available for family households.
Finally, we need to covert the floor area to units. According to the 2010 *NPC* (10% sample survey), in Beijing there were 240,996 urban household respondents whose current units were built after 2000, and the total floor area was 19.69 million m^2, implying an average unit size of 81.73 m^2. This helps us to get the final result of about 2.43 (198.60/ 81.73 ≈ 2.43) million units completed and available for family households during the decade.

(2) Units built by households
According to the sample survey mentioned above, in 2000 there were 512,298 urban households in Beijing who built their own units. In addition, there were 150,481 rural households re-defined as urban households, and we assume each household occupied one housing unit. Given the average demolition rate of 11.08% mentioned above, the number would decrease to 589,374 ((512,298 + 150,481) ∗ (1–11.08%) ≈ 589,374) in 2010. The corresponding number reported in the 2010 *NPC* was 429,589 in 2010. Thus, in Beijing we believe that the sector of self-built housing units did not contribute to the flow supply during the decade, but it does not necessarily apply to other cities. In particular, this sector is usually more important in less developed cities.

(3) Aggregate number
Based on the above calculation, we can get the aggregated supply for new housing units. For Beijing, the result is 2.43 million units.

A.3. Supply–demand ratio

Based on the above results we can compare the supply–demand ratio. In Beijing, we get the result of 86.44% (2.43/ 2.81 ≈ 0.8644).

A.4. Updating the calculation to post-2010 years

We also update the supply–demand ratio calculation to 2011–2014. Without the detailed data provided by a *NPC*, we have to make several assumptions as described below.

(1) For the component of "net increase of family households living in the urban area", we adopt the estimate of urban population at the end of each year provided by the relevant local statistic agency, and assume that the average urban household size remained at the level of 2010.
(2) For the component of "urban family households with previous dwelling units demolished", we apply the demolition rate for each building age category calculated based on the period 2001–2010 to the housing stock in 2010, and assume that the volume of demolition would be evenly distributed between 2011 and 2020.
(3) For the component of "units developed by firms or institutions", we adopt the volume of annual housing completion reported by the relevant local statistic agency, and assume that both the percentage for non-family households and the average housing unit size were consistent with the corresponding numbers in 2001–2010.

For the component of "units built by households", we assume that its ratio against units developed by firms or institutions kept stable, as between 2001 and 2010.

Table A-1
Imputing of urban households with previous dwelling units demolished.

A. Households in both urban and rural areas									
		All	Before 1949	1950–1959	1960–1969	1970–1979	1980–1989	1990–1999	After 2000
2000 census	Sample	402,717	18,425	21,406	16,858	43,577	148,539	153,912	–
	Total	4,096,844	187,438	217,763	171,497	443,309	1,511,089	1,565,748	–
2010 census	Sample	655,178	7913	13,829	12,683	35,520	135,322	182,140	267,771
	Total	6,680,552	80,685	141,008	129,323	362,181	1,379,817	1,857,199	2,730,339
Change		–	106,752	76,755	42,174	81,128	131,272	–	–
Demolishing rate		–	56.95%	35.25%	24.59%	18.30%	8.69%	1.00%	0.00%
B. households in urban area									
		All	Before 1949	1950–1959	1960–1969	1970–1979	1980–1989	1990–1999	After 2000
2010 Census	Sample	567,545	7490	13,061	10,611	27,106	108,066	160,245	240,966
	Total	5,803,085	76,584	133,547	108,496	277,156	1,104,963	1,638,487	2,463,851
Demolishing rate		–	56.95%	35.25%	24.59%	18.30%	8.69%	1.00%	0.00%
Demolished		393,159	101,327	72,694	35,382	62,082	105,123	16,550	0

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