

Demystifying the Chinese Housing Boom*

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Abstract

We construct housing price indices for 120 major cities in China in 2003-2013 based on new home sales within same housing developments over time. By using these indices and detailed information on mortgage borrowers across these cities, we find that despite the enormous housing price appreciation during the decade, the price appreciation was accompanied by equally impressive growth in household purchasing power, except in the few first tier cities, and housing market participation by households from the low-income fraction of the city population remained steady. Nevertheless, the severe financial burdens endured by bottom-income mortgage borrowers throughout China, who commonly used price-to-income ratios over eight to buy homes, reflected expectations of persistent high income growth and housing price appreciation into the future, which contrasted what were reflected by the distressed Chinese stock markets. The high price-to-income ratios might be a key source of the fragility of the housing market in the event of a sudden economic slowdown.

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There have been growing concerns across the global economic and policy communities regarding the decade-long housing market boom in China, the second largest economy in the world and the major engine of the global economic growth during the past decade. The housing boom in China is still ongoing, even though news in the recent months seems to suggest that it might be slowing down. A main concern is that a potential housing market meltdown might severely damage the Chinese economy, which in turn might generate contagious effects across the world and slow down the fragile global economy that has just stepped out of a series of crises that originated from the U.S. and Europe. In particular, critics are particularly worried by the soaring housing prices and enormous construction booms throughout the country causing China to follow the footsteps of Japan, which had a lost decade after its housing bubble burst in early 1990s.

How much have housing prices in China appreciated during the last decade? How did the price appreciation vary across the country? Did the soaring prices exclude low-income households from participating in the housing markets? How much financial burden did households face in buying homes? Addressing these questions is crucial for systematically assessing the risk presented by the Chinese housing markets to the Chinese economy. By taking advantage of a comprehensive data set of mortgage loans issued by a major Chinese commercial bank in 2003-2013, this paper is able to address these questions. Specifically, we construct a set of housing price indices for 120 major cities in China, which allows us to evaluate housing price fluctuations across these cities, in conjunction with the growth of households' purchasing power and stock price fluctuations. The detailed mortgage data also allows us to analyze the participation of low-income households in housing markets and the financial burdens faced by low-income home buyers.

Due to the nascent nature of the Chinese housing markets, there are relatively few repeated home sales for building Case-Shiller type repeated sales housing indices. Instead, we take advantage of the large number of new housing developments in each city and build a housing price index for the city based on sales of new homes over time within the same developments, which share similar characteristics and amenities. Consistent with casual

observations made by many commentators, our price indices confirm enormous housing price appreciation across China in 2003-2013: In first tier cities, which include Beijing, Shanghai, Guangzhou and Shenzhen, the four most populated and most economically important metropolitan areas in China, housing prices had on average appreciated by 5.2 folds during this decade. Our sample also covers 31 second-tier cities, which are autonomous municipalities, provincial capitals, or vital industrial/commercial centers, and 85 other third tier cities, which are important cities in their respective regions. Housing prices had appreciated on average by 3.9 folds in second tier cities and by 3.1 folds in third tier cities. These magnitudes easily surpass the housing price appreciation during the U.S. housing bubble in the 2000s and are comparable to that during the Japanese housing bubble in the 1980s.

Despite the enormous price appreciation, the Chinese housing boom is different in nature from the housing bubbles in the U.S. and Japan. As banks in China strictly imposed down payments of at least 30% on all mortgage loans, mortgage borrowers' default risk in the event of a housing market meltdown is minimal, which makes a U.S. style subprime credit crisis unlikely in China. The housing boom was also accompanied by equally spectacular growth in households' disposable income, which had on average grown by roughly 3 folds throughout the country during the decade. This joint presence of enormous housing price appreciation and income growth contrasts the Japanese housing bubble, which occurred in late 1980s when the Japanese economy was growing at a more modest rate than the 8 percent plus growth rate of the Chinese economy during the last decade. The enormous income growth roughly matched the housing price appreciation in the second and third tier cities, although not as much as that in the first tier cities, and thus provided assurance over a widely held concern inside China that housing markets in the third tier cities are particularly vulnerable due to their large supply of new homes relative to first tier cities.

We also analyze the financial status of mortgage borrowers with income in the bottom 10% of all mortgage borrowers in each city and each year. By mapping the income of these marginal home buyers into the income distribution of the urban population in the city, we find that they came from the low-income fraction of the population, roughly around 25 percentile of the

distribution in first tier cities and around 30 percentile in the second tier cities. Interestingly, despite the enormous housing price appreciation over the decade, the participation of these low-income households in the housing markets remained stable.

While these low-income home buyers were not excluded from the housing markets, they did face enormous financial burdens in buying homes at price-to-income ratios of around eight in second and third tier cities and, in some years, even over ten in first tier cities. To be concrete, consider a household which paid eight times its annual disposable income to buy a home. In order to obtain a mortgage loan, it has to make a down payment of at least 30%, or typically 40%, of the home price, which is equivalent to 2.4 times or 3.2 times of the household's annual income. Suppose that the household made a down payment of 40% and took a mortgage loan for the other 60% of the home price, which is 4.8 times its annual income. A modest mortgage rate of 6%, which is low relative to the actual rate observed during the decade, would require the household to use nearly 30% of its annual income to pay for the interest of the mortgage loan. Furthermore, paying down the mortgage would consume another 16% of its annual income even if the mortgage has a maximum maturity of 30 years and uses a linear amortization. Together, buying the home entails a saving of 3.2 times of its annual income to pay for the down payment and another 45% of its annual income to service the mortgage loan.

To explain the willingness of the households to endure such severe financial burdens for a home, it is important to take into account the households' expectations. To the extent that urban household income in China has been rising steadily during this decade, as well as in the previous two decades, at a nominal rate over 10 percent per year, many households may expect their income to continue growing at this rate. At a 10% income growth rate, a household's income in five years would grow to 1.6 times of its initial income and the ratio of current housing price to its future income in five years would drop to five. Thus, a high expected income growth rate renders the aforementioned financial burdens temporary. Furthermore, this expectation may also lead the household to an expectation that the housing price may rise as well (which was actually supported by the realized housing prices throughout

China during the decade.) Thus, expectations of its own high income growth and future housing price appreciation may have worked together to motivate the household to endure the temporary financial burdens.

In summary, the rapid household income growth provides a solid explanation for the enormous housing price appreciation during the last decade, especially the price appreciation in second and third tier cities. It is also possible to use households' expectations of high future income growth to explain the high price-to-income ratios endured by low-income households throughout China to buy homes. However, it remains a challenge to determine whether such expectations are too optimistic going forward. In particular, the spectacular economic growth of China during the past does not necessarily justify an expectation that the Chinese economy would continue to grow at the same rate in the future.

This aspect is particularly curious in 2008-2009 when the world economy ran into the worst economic crisis in decades and the Chinese economy also faced tremendous pressure. Nevertheless, the housing markets in China remained strong during this period. While the housing prices in first-tier cities had a drop of about 10%, second- and third-tier cities continued to rise. This experience was in sharp contrast to the dramatic boom and bust experienced by the Chinese stock markets around this period. The Shanghai stock market index rose from a level of 1200 at the beginning of 2006 to a peak of 6092 in October 2007, but only to plunge to just below 2000 in October 2008, and never recovered again. The drastically different expectations reflected by the housing markets and the stock markets about the Chinese economy are puzzling. In this regard, we argue that the frequent policy interventions by the central government and the heavy reliance of local governments on land sales revenue for their fiscal budget might have emboldened many households to believe that the housing markets are too important to fail as the central government would institute policies to support the housing markets when it has to.

To the extent that the spectacular economic growth of China over the past three decades will eventually slow down, the high expectations reflected by the housing markets may not be sustainable. In particular, any sudden slowdown in the Chinese economy may suppress

households' expectations about their own income growth and housing price appreciation and consequently crash down the multiples of the housing prices relative to household income. This is in our opinion the ultimate source of housing market fragility in China.

This paper is organized as follows. Section 1 briefly describes the institutional background of the housing markets in China. We introduce the housing price indices in Section 2 and then discuss the housing price boom across three tiers of Chinese cities in Section 3. Section 4 summarizes characteristics of mortgage borrowers, and Section 5 analyzes housing price dynamics. We summarize the role of government in the Chinese housing markets in Section 6 and discuss several sources of risk in the housing markets in Section 7.

1. Institutional Background

The development of housing markets in Mainland China is a relatively new phenomenon. From the founding of the People's Republic of China in 1949 to 1978, all land was publicly owned and the Chinese Constitution prohibited any organization or individual from buying, selling, leasing or transfer of land. Housing was allocated through a working unit-employee linkage as a form of in-kind compensation, with the size and location of homes depending on the length of employment and the size of the household, among other factors. In 1978, per capital residential area in urban areas was 3.6 square meters, which was even lower than that in 1949.

To reform (and to a large extent privatize) the state-owned enterprises in the mid-1980s, it was considered necessary to introduce an alternative housing system that delinked home allocation from employment. An important milestone occurred in 1988 when the Chinese constitution was amended to allow for land transactions, which set the legal stage for the privatization of housing in China.¹

Comprehensive housing reform was initiated in 1994 when employees in the state sector

¹ Under the current law, land used to build residential properties is leased for a term of 70 years; after the expiration of the lease period, the right to use the land and the property will no longer belong to the current owner. It is commonly presumed that the law will eventually be amended so that the property owner will be allowed to renew the lease.

were allowed to purchase full or partial property rights to their current apartment units at subsidized prices. Nascent markets for homes, known as “commodity houses”, emerged in some large cities in early 1990s; but they grew rapidly only after 1998 when the central government completely abolished the traditional model of housing allocation as in-kind benefit and privatized housing properties of all urban residents.

Also in 1998, partly as a response to the adverse effects of the 1997 Asian Financial Crisis, Chinese government established the real estate sector as a new engine of economic growth. As an important impetus to the development of private housing markets, China’s central bank, the People’s Bank of China (PBC), outlined the procedures for home buyers to obtain residential mortgages at subsidized interest rates in 1998; moreover, between 1998 and 2002, PBC lowered the mortgage interest rate five times to encourage home purchases. See Appendix A for detailed information about mortgage loans in China. By 2005, China has become the largest residential mortgage market in Asia. According to a PBC report published in 2013, financial institutions made a total of 8.1 trillion RMB in mortgage loans in 2012, accounting for 16 percent of all bank loans in that year. At the same time, PBC also developed policies to encourage housing development, including broadening the scope of development loans and allowing pre-sales by developers.

[Figure 1 about Here]

These policies were effective in stimulating both the demand and supply of residential housing. During this period, home sales maintained about 15 percent of annual growth on average, and area of residential housing under construction grew even faster, reaching about 18 percent of annual growth. Figure 1 provides a rough estimate of the supply of newly completed residential housing from 2002-2013 by tier of cities, measured by completed area in each city and each year divided by the city’s urban population in 2012.

It is common in China to separate cities into three tiers: The first tier includes Beijing, Shanghai, Guangzhou and Shenzhen, four cities with the largest population and economic importance in China. Our data covers all of these first tier cities. The second tier includes 35

cities listed in the Appendix A. This list is composed of Tianjing and Chongqing (the two autonomous municipalities other than Beijing and Shanghai) and the capital cities of the 24 provinces² and 9 other cities, which are typically vital industrial or commercial centers. Our data covers 31 of these 35 second tier cities. There is not a commonly used list for third tier cities. Instead, we list 85 other cities in our sample as the third tier. Appendix B lists the cities in each of the three tiers.

In Figure 1, new construction of residential housing showed a similar growth rate across the three tiers of cities until 2005. From 2005, the new construction in first-tier cities has slowed down substantially, while the supply in second- and third-tier cities continued to grow at similar rate as before. Some estimate suggests that investment to residential housing accounted for 25 percent of total fixed asset investment, and contributed to roughly one-sixth of China's GDP growth (Barth et al., 2012).

[Figure 2 about Here]

The development of the housing markets was also accompanied by an urbanization process throughout China with rural migrants moving into cities, especially into first and second tier cities. As shown by Figure 2, the total population of the four first tier cities, the vast majority of which lives inside the city proper, grew from 48 million in 2004 to almost 70 million in 2012. The total population of second tier cities, which is distributed roughly half inside the city proper and half outside, grew from 220 million to about 260 million in 2012. The total population of third tier cities remained stable in this period at around 370 million, among which only 100 million lived inside the city proper.

2. Constructing Chinese Housing Price Index

To systematically examine the housing market boom, it is important to construct an accurate housing price index for major cities in China. The difficulty in constructing housing price index arises because a good price index requires that we compare the price of the same

² Lasha, the capital of Tibet, is typically excluded from the list due to its special economic status.

(or at least comparable) houses over time. To the extent that the set of homes involved in the transactions in different periods of time is likely to be different, the price index constructed by simply comparing the mean or median sale prices per square meter likely measures not only the changes in the prices of similar homes, but also the changes in the composition of transacted homes. This problem is likely to be more severe in emerging housing markets than in mature ones because in the former, the homes in more central locations are likely to be transacted earlier than homes built in outer-rings of the city.

A. Standard Methodologies

There are two standard methodologies that are widely used to construct housing price indices. These methods, which we review briefly below, are aimed to find a suitable way to compare the prices of similar homes.

One prominent approach to construct housing price is to use hedonic price regressions, which goes back to Kain and Quigley (1970). In a hedonic approach, the sales price is regressed on a set of variables that characterize the housing unit -- number of rooms, square feet of interior space, lot size, quality of construction, condition and so forth. The regression coefficients can be interpreted as prices for implicit attributes. This hedonic approach can then be used to construct a price index in two ways (Case and Shiller, 1987). The first way to construct a price index is to run separate regressions on data from each time period. The estimated equations are then used to predict the values of a standard unit in each period, which is in turn used to construct the housing price index for the standard unit. A second way is to run a single regression on the pooled data from sales in all time periods. Inclusion of a time dummy for the period of the sale allow the constant term to shift over time reflecting movement in prices, again controlling for characteristics.

Whether or not hedonic price regression can capture the movements in prices accurately crucially depends on how well the data capture the actual characteristics and quality of the unit. Unobserved characteristics that are valued by the market but not captured in the data can lead to biased estimates of the housing price index. This is particularly an issue in China. In the urban

housing sector in China, housing units have typically been condominium units.³ Due to the rapid expansion of Chinese cities, new housing units have been constructed mostly on land near the urban fringes. According to the *China Urban Statistical Yearbook* (published by Ministry of Housing and Urban-Rural Development), the total size of developed urban area at the national level increased from 19,844 square kilometers in 2003 (Form 3-9 on page 107) to 34,867 square kilometers in 2013 (Form 2-12 on page 90). Such dramatic expansions of urban residential land parcels imply that ignoring location and simply comparing the average transaction prices over time is likely to lead to misleading housing price indices.

Case and Shiller (1987) popularized another method using repeated sales. This approach goes back to Baily, Muth and Nourse (1963), who initially proposed a method involving a regression where the i -th observation of the dependent variable is the log of the price of the i -th house at its second sale date minus the log of its price on its first sale date. The independent variables consist of only dummy variables, one for each time period in the sample except for the first (the base period for the index).⁴ The estimated coefficients are then taken as the log price index. This initial method builds on a strong assumption that the variance of the error term is constant across houses. As this variance is likely to depend on the time interval between sales, Case and Shiller (1987) proposed a weighted-repeated-sales method with a two-step procedure to relax this assumption.⁵

Case and Shiller (1987) noted that the repeat sales approach does not require the measurement of quality; it only requires that the quality of individual units in the sample remains constant over time. However, it is well recognized that this repeated sales method wastes a large fraction of transactions data because repeated sales may contribute to only a

³*Statistical Yearbook of China*, published by the Chinese National Bureau of Statistics, estimates that the percentage of condominium units in the newly-built housing markets was around 94-96% during the past decade at the national level.

⁴ Specifically, for each house, the dummy variables are zero except for the dummy corresponding to the second sale (where it is +1) and for the dummy corresponding to the first sale (where it is -1). If the first sale was in the first period, there is no dummy variable corresponding to the first sale.

⁵ In the first stage, they implement the Baily, Muth and Nourse (1963) procedure and calculate the vector of regression residuals, which is then used to construct the weights to be used in the stage two regression. In the second step, a generalized least squares regression (with weights constructed from the regression residuals in the first stage) is run.

small fraction of all housing transactions. More importantly, the set of homes that are sold repeatedly may not be representative of the general population of homes (see Mark and Goldberg, 1984).

B. A Hybrid Approach for Chinese Housing Markets

We propose a hybrid approach of constructing housing price indices for a large number of Chinese cities. Our approach takes into account the following features of the Chinese housing markets: As a result of the nascent nature of the Chinese housing markets, there are relatively few repeat sales. Many of the observed repeated sales are old style housing units, which are not representative of the newly developed housing markets. This feature prevents us from directly using the Case-Shiller repeated sales method. On the other hand, there are a large number of new home sales in each city. These new homes are in the form of apartments, and typically apartments in development projects. As a developer sells apartments in a project over a period of time, and sometimes even complete the development over several phases, we observe sequential sales of apartments in the same development. Within the same development project, the unobserved apartment amenities are similar. This feature allows us to build a hybrid index based on repeated new home sales within housing developments after accounting for hedonic characteristics of individual homes.

We implement the housing price indices from January 2003 to March 2013 by running the following regression *for each city*:

$$\ln P_{i,c,t} = \beta_{c,0} + \sum_{s=1}^T \beta_{c,s} \cdot 1\{s = t\} + \theta_c \mathbf{X}_i + DP_i + \varepsilon_{it},$$

where $P_{i,c,t}$ is the price of a new home sold in month t in city c , $\beta_{c,t}$ is the time dummy for month t , the vector of characteristics \mathbf{X}_i includes area, area squared, floor dummies, and dummies for the room numbers, and DP_i is a set of *development project* fixed effects. The base month ($t = 0$) is January 2003 and the last month is March 2013. The price index $PI_{c,t}$ for month t in city c is simply given by:⁶

⁶For a couple of cities in our sample, mortgages first appeared later than January 2003. For such cities, $\hat{\beta}_{c,t}$ only

$$PI_{c,t} = \begin{cases} 1 & \text{if } t = 0 \\ \exp(\beta_{c,t}) & \text{for } t = 1, 2, \dots \end{cases}$$

[Figure 3 about Here]

Figure 3 graphically illustrates our method of constructing the price index. In every month, say month 1, there are many development projects with new apartments on sale in a given city. In Figure 3, three units in development project A are sold in month 1 and 2 units are sold in month 2. We take the sales in our data in development projects that have sales in both month 1 and month 2. In our proposed regression above, we control for the development project, and other observable differences in the characteristics of the apartment units (such as area, floor number, etc.), thus the time dummy β_1 precisely captures the price difference among otherwise identical units sold between month 1 and month 2. Of course, the *key assumption*, which we believe to be empirically realistic, is that within a development project, differences in the units are fully described by the additional controls we include in the regression. Similarly, as illustrated in Figure 3, the price change from month 2 to month 3 would be estimated by the price differences of similar units in development project B sold in month 2 vs. those sold in month 3; and the price change from month 3 to month 4 are estimated by the price differences of similar units in development projects B and C that are sold in month 3 vs. month 4.⁷

The regression specification we use to construct price indices in a city via time dummies also makes two additional assumptions: First, we assume that that the price changes between any two months are *uniform* across development projects that may be located in different parts

reflects the changes in price beyond the first month in record (which is not January 2003). However, as long as a city has some records in the first quarter of 2003, we still use the above method to construct the price index, assuming that the change in prices from January to March 2003 is likely to be small. If a city has no record in any month in the first quarter of 2003, we do not construct a price index.

⁷ Our method of constructing housing price indices is related to the pseudo-repeated sales price index recently proposed by Guo, Zheng, Geltner and Liu (2014). They also recognize that the multiple apartments sold by a development project over a period of time can be used to construct matching pairs which are simply pairs of units within a matching space (say, building or a development project) sold at different point in time. They implement their price index using data of new residential unit transactions from Chengdu. The main difference between their method and ours lies in the regression specifications. In their specification, each unit may appear multiple times in the regression depending on the number of times it is included in matching pairs. This may create a complicated variance-covariance structure for regression noise. In contrast, in our specification, each unit appears exactly once.

of the city.⁸ To see this, note from Figure 3 when we estimate the price change from month 3 to month 4, we pool the units sold in development projects C and D in the two months in the regression; since we restrict the time dummy not to be interacted with the development projects, we implicitly assume that the price changes in development projects C and D from month 3 to month 4 are the same. Second, we also implicitly assume that the only source of price changes between any two months in a development project is the overall change in the housing market in the city. In particular, we assume that the developers do not change their pricing strategies as new units go on the market.⁹ One may also be concerned that over time, the amenities and infrastructure around the development projects may improve, thus part of the price differences for units in the same development project sold at different months may reflect such differences, not the housing market conditions. We believe that this is less likely an issue in China, as buyers of the earlier units are almost surely aware of the upcoming improvements in the infrastructure (e.g. subway stations, shopping malls, etc.) close to the development projects, as such projects are public information and developers are surely to advertise them to earlier buyers.

3. Chinese Housing Market Boom

We use the method outlined in the previous section and a detailed mortgage data set to construct a housing price indices for 120 major cities in China. The list of these cities is given in Appendix B. Our mortgage data is compiled from mortgage contracts provided by a large commercial bank, which accounts for about 15 percent of the mortgage loan market in China. We restrict the sample to mortgages for new, residential properties and as a result have over one million mortgage loan contracts dating from the first quarter of 2003 to the first quarter of 2013. A typical mortgage contract contains detailed information on the personal characteristics of home buyers (e.g., age, gender, marital status, income, work unit, education, occupation,

⁸ This assumption in principle can be relaxed. If each month we have a sufficiently large number of sales located in each district of a city, we can implement our regression at the district level and construct district-specific price indices.

⁹ Wu, Deng and Liu (2013) provide some evidence that developers may adopt different pricing policies for units that go on the market at different months.

and region and address of residence), housing price and size, apartment-level characteristics (e.g., complex location, floor level, and room number), as well as loan-level characteristics (e.g., maturity, loan to value ratio, and down-payment).

Our housing price indices allow us to precisely characterize the housing market boom in the last decade throughout China. We describe the housing market boom below by tiers of cities.

A. First-Tier Cities

[Figure 4 about Here]

Figure 4 depicts the monthly housing price indices for the four first-tier cities in four separate panels, together with measures of households' purchasing power. In Panel A, the housing price index of Beijing experienced an enormous rise from an index level of 1 in January 2003 to 7.6 in March 2013. That is, the housing price level has increased 660% in a short period of ten years!

During this period, Beijing's housing prices have actually experienced at least two episodes of downward movement. The first episode started in May 2008, when the price index was at 3.50 (relative to January 2003), and continued until March 2009, when the price index slid to 3.05. This represented a 13% price drop and coincided with the global financial crisis. The second episode is more recent. It began at May 2011 and ended at June 2012 when the housing price index fluctuated in the interval of 5.99 and 6.67.

As benchmarks for the housing price appreciation, Panel A also plots two measures of the households' purchasing power in Beijing: per capita GRP and disposal income (urban) during the same period. The per capita GRP measures the per capita value of output in the whole city and the per capita disposal income (urban) measures the per capita income received by urban residents of the city. Both of these measures have experienced similar growth from 1 in 2003 to a level around 3 in 2013. While this growth is remarkable by any standard, it is nevertheless substantially smaller than the housing price appreciation in the city.

Panel B plots the monthly housing price index for Shanghai. The index went up from 1 in

January 2003 to about 4.43 in March 2013. The overall housing price appreciation in Shanghai is more modest than that in Beijing, even though Shanghai's housing price appreciation actually started faster than Beijing. Shanghai's housing prices doubled by the month of April 2005 relative to that in January 2003, while Beijing's housing prices did not double until August 2006. However, Shanghai experienced three episodes of price adjustment in the last decade. The first adjustment started in May 2005 when the index was at 2.05, and ended in March 2007 when the index went down to as low as 1.79. This represented a 13% price correction. However, the housing prices picked up again from March 2007 to reach an index level of 2.72 in August 2008. The second episode was a swift and small adjustment with the index dropping from 2.72 in August 2008 to 2.41 in December 2008. The third episode started in June 2011 with the price index dropping from 4.27 to as low as 3.20 in March 2012. This represented a 25% price correction. However, housing prices picked up again from March 2012. By March 2013, the price index reached its peak at 4.43.

The growth of households' disposal income in Shanghai during this period was about the same as that in Beijing, with disposal income of urban residents roughly tripled from January 2003 to March 2013. Thus, the housing price appreciation in Shanghai, while quite substantial, is nonetheless much more closely aligned with the growth of disposal income. The other measure of purchasing power, GRP per capita, exhibits more modest growth in Shanghai, but it is still more than doubled in this period.

Panels C and D respectively plot the housing price indices for Guangzhou and Shenzhen. The overall pictures of these two cities in Guangdong Province, near Hong Kong, are similar to each other. Guangzhou's price index increased from 1 in January 2003 to 5.1 in March 2013, while it rose from 1 to 3.65 in Shenzhen during the same period. Both cities experienced multiple episodes of price adjustment. The most severe price adjustment occurred in Shenzhen, starting from October 2007 when its price index was at 2.97 and reaching a trough in January 2009 when the index reached 1.82. This represented a 39% price correction. At almost the same time, from November 2007, Guangzhou's housing price also started dropping from an index level of 3.08, and reached a trough of 2.38 on February 2009. This represented a 23% price

correction. Both Guangzhou and Shenzhen are located in the Pearl River delta, the world's largest manufacturing center for exports. The housing price drops in these two cities were clearly related to the global economic crisis. The fact that our housing price indices for the two cities accurately pick up these crisis-induced price-adjustment episodes lends credence to our housing price indices.

Panels C and D also reveal that the per capita disposal income in Guangzhou nearly tripled during the same period, while it grew by only 68 percent in Shenzhen. Shenzhen's per capita disposal income growth was much smaller than the growth of the per capita GRP perhaps because Shenzhen had millions of migrant workers, whose outputs were included in the calculation of the GRP, but not the per capita disposal income for urban residents with *Hukou* (i.e., the official city residence registration).

[Table I about Here]

Table 1 reports, by tiers of city, the summary statistics of the housing price indices, the per capita Gross Regional Product (GRP) and the per capital Disposal Income (DI). We report these statistics separately for the periods from January 2003 through December 2007, from January 2009 through March 2013, and for the whole period of January 2003 through March 2013. All of the statistics are constructed using nominal values.

To aggregate the price indices for the four cities, we construct a price index for the tier by setting the initial index level of each city to be one at the beginning of the period and then taking an equal weighted average of the index levels of these cities for each subsequent month. The resulting index level represents the value of a housing portfolio constructed from investing one RMB into the housing index of each city in the first month and keeping the portfolio composition throughout the subsequent months. We also use the same method to construct indices for second and third tier cities.

Among first tier cities (Panel A), the housing price index for the tier rose from the base of 1 in January 2003 to 2.83 in December 2007. From January 2009, the housing price continued to rise, and in fact on average housing prices doubled again from January 2009 to March 2013.

Over the whole 10-year period from January 2003 to March 2013, the housing prices in the first tier cities increased by more than five folds!

Panel A also reports the growth of two measures of “purchasing power”: per capita GRP and disposal income. Both measures have increased significantly in the decade, from the base of 1 in January 2003 to about 2.5-2.6 in March 2013. But the housing price appreciation in first tier cities was nearly twice the magnitudes of the increases in the two measures of purchasing power.

B. Second and Third Tier Cities

[Figure 5 about Here]

Due to the large number of cities in second and third tiers, we cannot separately plot the housing price index for each city. Instead, we plot the price index for each of the tiers, together with measures of purchasing power in Figure 5.

In the left panel, the housing price appreciation in second tier cities is substantial, though not as breathtaking as those in the first tier cities. Overall, the price index rose from the base of 1 in January 2003 to 3.92 in March 2013. The price fluctuations are also more modest compared to those experienced in the individual first tier cities, though part of the moderation in price fluctuation is the result of averaging over 31 second tier cities.

A housing price appreciation of 292% in ten years is remarkable by any standard. It is larger than the magnitude of housing price appreciation during the U.S. housing bubble in 2000s and is comparable to the price appreciation during the Japanese housing bubble in 1980s. However, what is more surprising in Panel A is that the housing price appreciation in second tier cities is very much in accordance to the growth in measures of purchasing power. To the extent we believe that income growth, or growth in GRP, represents fundamental demand in housing markets, the housing price appreciation in the second-tier cities, though enormous, nonetheless does not appear to have significantly deviated from the increases in households' purchasing power.

In Panel B of Table 1, we report summary statistics for the 31 second tier cities in our sample. During the decade from 2003 to 2013, the second tier cities on average witnessed a housing price increase from the base of 1 in January 2003 to 3.92 in March 2013. There are, of course, substantial variations among the cities, with housing price increase ranging from 2.29 (in Yinchuan, the capital city of Ningxia Province in Northwestern China) to 6.85 (in Wenzhou, a coastal city in Zhejiang Province in Eastern China). In the same decade, the per capita GRP also nearly quadrupled, from a base level of 1 in January 2003 to 3.96 in March 2013. The increase in the per capita disposal income for urban residents, is somewhat lower, but nonetheless in the range of about 3.3, only slightly smaller than the increase in the housing price index.

The other columns in Panel B also reveal that the housing price appreciation in the second tier cities increased by 137 percent on average from January 2003 to December 2007, while the increase was about 64 percent from January 2009 to March 2013. The increases in housing prices in these two sub-periods are again commensurate with the corresponding increases in purchasing power, measured by either per capita GRP or disposal income.

Panel B of Figure 5 depicts the price index and measures of purchasing power for the 85 third tier cities. A remarkable feature of the plot is that despite the enormous housing price appreciation in third-tier cities during the decade, the housing price increase actually lagged the growth of disposal income. Panel C of Table 1 reports summary statistics for the third-tier cities. The housing price index slightly more than tripled, increasing from the base of 1 in January 2003 to 3.13 in March 2013. Again there is substantial heterogeneity across cities, with the price index changes ranging from 1.07 to 6.09. The tripling of the housing index of the third-tier cities is actually below the growth of the two measures of purchasing power in these cities in the same period: the per capita GRP went from 1 to 4.64, while the per capital disposal income for urban residents went from 1 to 3.29. This pattern, namely, enormous housing price appreciation but nonetheless below the increases in measures of purchasing power, also holds in the two sub-periods.

Overall, the housing prices across Chinese cities have experienced tremendous growth in 2003-2013. The housing price appreciation is particularly dramatic in first tier cities, rising over

five folds and substantially outpacing the growth of household purchasing power. The price appreciation in second and third tier cities, while remarkable relative to the housing bubbles experienced by Japan in 1980s and the U.S. in 2000s, is matched by equally impressive growth in household purchasing power during the same period.

It is possible to explain the dramatic housing price appreciation in first tier cities by limited housing supplies in these over-crowded metropolitan areas. As we discussed in Section 1, the total area of newly completed residential housing in first tier cities has substantially slowed down after 2005, while that of second and third tier cities has been steadily growing. However, supply is not the only factor that matters to housing markets. As the rising housing prices directly impact everyone's life, it is important to fully understand the financial burdens faced by home buyers, especially low-income home buyers.

4. Mortgage Borrowers

Our detailed mortgage data allows us to provide a comprehensive picture of mortgage borrowers in different cities, who take loans to buy homes. In this section, we summarize a set of characteristics of these mortgage borrowers, including household income, down payment, price-to-income ratio, home size, age, and marital status. In particular, we focus on discussing the financial burdens faced by these mortgage borrowers.

Note that households in the most wealthy fraction of the population may purchase homes using cash and thus do not appear in our mortgage data. For this reason, our mortgage data is particularly useful for analyzing the characteristics of relatively low income home buyers as opposed to that of high income buyers. We focus on analyzing two sets of borrowers in each tier of cities: One set has household income in the bottom 10% among all mortgage borrowers in a given city and a given year. We refer to this set the bottom-income borrower group. We also denote the borrower with income exactly at the 10 percentile of all borrowers by p10. The other set has household income in the middle range [45%, 55%] of all mortgage borrowers in a given city and a given year. We refer to this set the middle-income group and denote the borrower with exactly the median income of all borrowers by p50.

A. Household Income

[Figure 6 about Here]

Figure 6 depicts the time-series of the household income of p10 and p50 for first, second and third tier cities in Panels A, B, and C, respectively. In panels A and B, the left plot shows the annual income of p10 and p50 (which is averaged across all cities in the tier) in RMB from 2003-2012 and the right plot shows the position of p10 and p50 in the income distribution of the city population based on the income distribution reported by the Urban Household Survey (UHS). As income distribution is not available for third tier cities, Panel C shows only the annual income of p10 and p50.

Figure 6 shows steady growth in the household income of mortgage borrowers for both p10 and p50 across the three tiers of cities. In first tier cities, the annual household income of p10 grew from 39,000 RMB in 2003 to 92,000 in 2012 while the income of p50 grew from 87,000 in 2003 to 184,000 in 2012. In second tier cities, the income of p10 grew from 19,000 in 2003 to 58,000 in 2012 while that of p50 from 40,000 in 2003 to 99,000 in 2012. In third tier cities, the income of p10 grew from 15,000 to 51,000 while that of p50 from 28,000 to 83,000. This tremendous income growth of mortgage borrowers is largely consistent with the income growth of the overall urban population we discussed before.

For most of the first and second tier cities, the UHS provides income distribution of urban households. To specifically compare the income growth of mortgage borrowers with that of the urban population, we mark the position of p10 and p50 in the population income distribution reported by the UHS. As our data from the UHS covers only 2003-2009, we extrapolate the income distribution in 2009 into the subsequent years based on the city's average income growth.

The median-income borrower p50 came from the relatively wealthy fraction of the population. In first tier cities, p50 declined from the 85th percentile of the population in 2003 to the 59th percentile in 2009 and then climbed back to the 75th percentile. In second tier cities,

p50 declined from the 81.5th percentile in 2003 to the 62th percentile in 2010 and then climbed back to the 68th percentile in 2012.

The position of the low-income mortgage borrower p10 is particularly interesting. It indicates the extent to which low-income households in the population were participating in the housing markets. Overall, p10 was located at a position around the 25th percentile of the population in first tier cities and around the 30th percentile in tier-2 cities. These positions indicate that mortgage borrowers were not just coming from the top-income households and instead were reasonably well represented in the low-income fraction of the population.

Interestingly, despite the rapid housing price appreciation in first tier cities, p10 steadily declined from a position around the 35th percentile in 2003 to the 17.5th percentile in 2010 before it climbs back to the 26th percentile in 2012. This suggests that the rapidly growing prices in the recent years have not prevented households from the low-income fraction of the population from buying homes. In second tier cities, p10 stays in a range between the 28th and 40th percentile---it declined from a peak of the 40th percentile in 2005 to the 28.5th percentile in 2010 and then climbed back to the 35th percentile in 2012.

Taken together, Figure 6 shows steady increases in the annual household income of bottom- and middle-income mortgage borrowers across cities in the three tiers of cities. Furthermore, despite the tremendous housing price appreciation across these cities, mortgage borrowers were well represented in the population and the housing market participation of households from the low-income fraction of the population remained stable.

B. Down Payment

Mortgage down payment is a key variable that determines the leverage used by mortgage borrowers and serves as an equity buffer to prevent borrowers from defaulting on the loans in the event of a future housing price meltdown. Figure 7 depicts the fraction of down payment in the home value at the time of purchase. We separately examine two groups, the bottom-income group with household income in the bottom 10 percent of all mortgage borrowers in a

city and a given year and the other middle-income group with household income in [45%, 55%] of all mortgage borrowers.

[Figure 7 about Here]

The right panel shows that for mortgage borrowers in the middle-income group, down payment on average contributed to at least 35% of home values across the three tiers of cities. Interestingly, the left panel shows that for borrowers in the bottom-income group, the fraction of down payment was even higher---it was consistently above 38% across the three tiers.

These high levels of down payment are consistent with the strict mortgage loan policy imposed by the Chinese government on banks. Specifically, the policy restricts one housing unit from being used as collateral for more than one mortgage loan. In other words, a household cannot take a second mortgage on one housing unit. The policy also requires a minimum down payment of 30% on first mortgages. As detailed in Appendix A, this minimum down payment requirements had changed over time between two levels: 30% or 40%. Banks have requested even higher down payments on second mortgages, which are used by households to finance purchases of non-primary homes.

The high levels of mortgage down payment used by Chinese borrowers were in sharp contrast to the popular use of zero down payment loans and negative amortization loans during the U.S. housing bubble of 2000s. According to Mayer, Pence and Sherlund (2009), during 2003-2006, the U.S. housing bubble period, households with poor credit (the so-called subprime and Alt-A households) had commonly used mortgages with 5% or zero down payment to finance their home purchases. Some mortgages even allowed the borrowers to have negative amortization over time. When the U.S. housing prices started to decline after 2006, these borrowers were more likely to default on their mortgage loans, exacerbating the housing market decline. The high levels of down payments used by households throughout China mitigated the risk of household default in the event of a future housing market meltdown. Even if the housing prices decline by 30% across the country, the mortgage borrowers are still unlikely to default on their loans. This makes a U.S. style subprime credit crisis less of a concern for China.

C. Price-to-Income Ratio

[Figure 8 about Here]

Price-to-income ratio provides a convenient measure of the financial burdens faced by a household in acquiring a home. Figure 8 depicts the price-to-income ratio of mortgage borrowers in the full sample (top panel) and in the subsample of married borrowers (bottom panel). In each panel, there are two plots, the left plot covers the borrowers in the bottom-income group with a separate line for each of the three tiers of cities, while the right plot covers the borrowers in the middle-income group.

The financial burdens faced by the bottom-income group are particularly interesting. In this group, the price-to-income ratio started at a level slightly above 8 across the three tiers of cities in 2003. In first tier cities, this ratio remained at around 8 before 2008 and then climbed up to a peak of 10.7 in 2011 before dropping back to 9.2 in 2012. In second and third tier cities, this ratio was very similar and remained in a tight range around 8. It had a modest decline from a level slightly above 8 in 2003 to 7.2 in 2007 and then climbed back to a peak slightly below 9 in 2011 before dropping back to around 8 again.

The price-to-income ratio for the middle-income group was consistently lower than that for the bottom-income group. It was highest in the first tier cities and lowest in the third tier cities. Across the three tiers of cities, it had a similar pattern over time. In first tier cities, it had an expansion from 5.6 in 2003 to 8.3 in 2011 before dropping back to 7.5 in 2012. In second tier cities, it expanded from 5.7 in 2003 to 7.4 in 2010 before dropping back to 6.2 in 2012. In third tier cities, it expanded from 5.0 in 2003 to 6.4 in 2010 before dropping back to 6.2 in 2012.

It is useful to compare the price-to-income ratios observed in Chinese cities with that in other countries. Cheng, Raina and Xiong (2014, Table 9) examined home purchases by Wall Street employees and lawyers in the U.S. during 2000s and found that they had consistently used price-to-income ratios around three before, during and after the U.S. housing bubble that peaked in 2006. While the households they examined were from the relatively high-income fraction of the U.S. population, it is common for financial advisors in the U.S. to advise

households to purchase homes with price-to-income ratios around three.¹⁰ There are few studies of financial burdens faced by mortgage borrowers during the Japanese housing bubble. Indirectly, Noguchi (1991, Table 1.3) reported that the average ratio of condominium price (the price of a certain benchmark condominium) to annual income, i.e., the income of an average household which may or may not be a mortgage borrower, in Tokyo rose to 8.6 in 1989, which is consistent with the price-to-income ratios used by the bottom-income borrowers in China.

A price-to-income ratio of 8 or higher, which had been commonly used by mortgage borrowers in the bottom-income group throughout the Chinese cities, implies a substantial financial burden on the borrowers. The financial burdens are reflected in several dimensions. First, in order to qualify for the mortgage loans, these borrowers need to make a down payment of about 38% of the home value (Figure 7), which is equivalent to about three times of the borrower's household annual income. This large down payment would require many years of saving. In practice, many home buyers, who are typically in their early 30s (as we will show), rely on savings of their parents or other close family members to make the down payment.

Second, monthly mortgage payments also consume a substantial fraction of the household income. To illustrate this burden, consider a household, which bought a home at a price that is eight times of its annual disposable income. Suppose that it used its saving to make the down payment at three times of its annual income and took a mortgage loan that was five times its annual income. As we describe in Appendix A, currently all mortgage loans in China carry floating rate interest payments, with the rate determined by a benchmark lending rate set by People's Bank of China (see Appendix A). If the annual mortgage rate is 6%, a rather low rate relative to the rates observed in recent years, then the annual interest payment would consume $6\% \times 5 = 30\%$ of the household's annual income. Furthermore, the household also needs to pay back a fraction of the mortgage each year. Suppose that the loan has a maturity of 30 years (maximum maturity allowed in China) and linear amortization. Then, the household

¹⁰ In comparing the price-to-income ratio between China and the U.S., it is useful to note the difference in property taxes. It is common for home owners in the U.S. to pay annual property taxes in the range of 1-2% of home values to local townships, while home owners in China typically do not pay any property tax. The low holding cost allows Chinese households to maintain a home at a higher multiple to their income.

had to set aside another $\frac{5}{30} = 16.7\%$ of its annual income to pay down the mortgage. Together, serving the mortgage loan would consume 46.7% of its annual income.

As we will discuss later, a significant fraction of home buyers in the bottom-income group were unmarried. As they would eventually get married and as it is common for a married couple to both work in China, the household income of a single buyer may soon double upon his/her marriage. Then, the price-to-income ratio of single buyers may not accurately reflect their financial burdens. To isolate this issue, we also compute the price-to-income ratio of married couples in the bottom-income and middle-income groups in each tier of cities. The bottom panel of Figure 8 shows that the price-to-income ratio of married borrowers was very similar to that of the full sample with both married and unmarried borrowers across both income groups and different tiers of cities. This lack of difference may reflect the fact that Chinese banks follow a rigid system in using current household income to determine the amount of mortgage loans available to borrowers, regardless of their marital status.

The remarkable income growth of Chinese households during this decade also implies that the large financial burdens faced by mortgage borrowers might be temporary and would subside over time as their income grew. Again consider the household, which purchased a home at an initial price-to-income ratio of eight. Suppose that the household expected its income to grow at an annual rate of 10%, which was roughly the growth rate during this period. Then, it expected its income to rise to 1.6 times of its initial level in five years and then the ratio of the current home price to its future income in five years to be roughly five. Of course, this calculation depends on a crucial assumption that the 10% income growth rate would persist into the future. This assumption is *ex ante* strong despite that *ex post* the household income in China had been growing at this impressive rate for three decades.

Nevertheless, this simple calculation shows that the household's expected income growth rate is crucial for determining how much it is willing to pay for a home relative its current income. If the household expected its income to persistently increase at a high rate, the large financial burdens it faced in buying a home at eight times of its current annual income would be expected to be temporary. Furthermore, this expectation also motivates a similar expectation

about the income growth of other households, which may in turn lead to an expectation of housing prices to continue rising. Such expectation further motivates the household to take on enormous short-term financial burdens to buy the home. In this sense, the households' expectations about their income growth and future housing price appreciation are central for understanding the Chinese housing market boom. We will return to this issue in our later discussion.

D. Home Size

[Figure 9 about Here]

Home size is an important dimension for determining the consumption value of a home. Figure 9 depicts the size of the homes purchased by bottom-income and middle-income mortgage borrowers across three tiers of cities. Despite the large financial burdens endured by the mortgage borrowers, their homes were rather spacious. The bottom-income borrowers in first tier cities, which are the most expensive cities in China, bought the smallest homes in our sample. Even for these borrowers, the average size of their home was in a range between 72 and 80 square meters throughout the decade. For a typical family of three (a couple with a child due to China's birth control policy), this home size implies about 25 square meters per person, which is quite spacious in the standards of most large metropolitans in the world such as Hong Kong, New York, Singapore and Tokyo.

It is also useful to note the evident declining trend in the home size purchased by all groups in the three tiers of cities. The homes purchased by bottom-income borrowers in second tier cities on average declined from 90 square meters in 2003 to 80 in 2012, while the homes purchased by bottom-income borrowers in third tier cities declined from 109 square meters in 2004 to slightly above 90 in 2012. The homes purchased by middle-income borrowers tended to be bigger but also had a similar decline across all three tiers of cities.

E. Age and Marital Status

[Figure 10 about Here]

Figure 10 shows the age of mortgage borrowers in our sample. Across the three tiers of cities, the mortgage borrowers in our sample were on average in their early 30s. The borrowers in the bottom-income group tended to be slightly younger than those in the middle-income group.

[Figure 11 about Here]

Figure 11 summarizes the fractions of single men and single women among the mortgage borrowers in each income group and each tier of cities. A significant fraction of the borrowers are unmarried. Single men and single women contributed to at least 40% of the bottom-income mortgage borrowers across the three tiers of cities in each of the years in 2003-2012. This fraction was lower among the middle-income borrowers but nevertheless substantial.

Wei, Zhang and Liu (2014) argue that home ownership is a status good for unmarried men to strengthen their competitiveness in the marriage market due to the widespread sex imbalance in China. This argument implies that single men should be more eager to buy homes than single women. Consistent with this argument, the fraction of single men in mortgage borrowers was consistently higher than the fraction of single women in second and third tier cities across all years and across the bottom-income and middle-income borrower groups. However, in first tier cities, the fraction of single men was roughly the same as the fraction of single women among the middle-income borrowers, and the fraction of single men was even lower than the fraction of single women among the bottom-income borrowers throughout the sample period.¹¹ This suggests that while marriage market competition might be a determinant of home ownership in second and third tier cities, it is not relevant for understanding the particularly high housing prices in first tier cities.

F. Second Mortgages

An often discussed concern regarding the Chinese housing markets is that many urban households hold multiple homes and leave a significant fraction of homes vacant for prolong

¹¹ This pattern is consistent with casual observations that sex imbalance is less severe in first tier cities as people in these cities have been more open-minded about having girls and thus less prone to selecting sex of their children at birth.

periods of time. Our mortgage data allows us to separate second mortgages (i.e., mortgage loans taken by households to purchase non-primary homes) from first mortgages (i.e., mortgage loans taken to purchase primary homes) after 2010.¹²

[Table 2 about Here]

Table 2 summarizes the fraction of second mortgages among all mortgage loans issued in each tier of cities in each year between 2011 and 2013. This fraction offers a measure of the extent that households take loans to buy homes for investment purposes. As wealthy households may simply use cash to buy investment homes, such investment purchases by wealthy households do not appear in our mortgage data. Thus, the fraction of second mortgages under-estimates the home purchases driven by investment demands.

In first tier cities, the fraction of second mortgages was 5.3% and 5.2% in 2011 and 2012, respectively, and this fraction had a dramatic increase to 11.8% in 2013. In second and third tier cities, the fraction of second mortgages also had an increasing trend during this period, although the levels were much lower. In second tier cities, this fraction grew from 2.0% in 2011 to 2.4% in 2012 and 3.3% in 2013. In third tier cities, it grew from 1.0% in 2011 to 1.3% in 2012 and 1.8% in 2013. Taken together, mortgage-financed investment home purchases were much more pervasive in first tier cities than in second and third tier cities.¹³

In summary, our analysis of the mortgage data shows that despite the enormous housing price appreciation during the last decade, the participation of low-income households in the housing markets remained steady. Nevertheless, the relatively low-income home buyers endured severe financial burdens to buy homes commonly at prices over eight times of their

¹² As we explain in Section 6, in early 2010 the Chinese government raised the down-payment ratio and the interest rate on second mortgages to be higher than those for first mortgages. Since then, banks need to collect information about whether each mortgage is first or second.

¹³ The fraction of second mortgages in our mortgage data may appear substantially lower than the fraction of households owning multiple homes reported by Chinese Household Finance Survey (2012). According to this survey conducted in 2012, the fraction of urban households owning at least two apartments in China is 15.44%. Note that a significant fraction of the multiple homes owned by the surveyed households was probably old-style housing units that were assigned to the households by their employers as in-take compensation before the housing reform in late 1990s. These units tended to have undesirable quality and were different from the newly built homes, the typical homes bought by households in the recent years.

current income. This behavior reflected expectations of persistent high income growth and high further housing price appreciation.

5. Housing as an Investment Vehicle

The spectacular economic growth of China since 1980s has been accompanied by a high saving rate. According to Yang, Zhang and Zhou (2013), the gross national saving as a percentage of gross domestic product (GDP) averaged 35% during 1980s, 41% during 1990s, and surged to over 50% in 2000s. This high saving rate surpassed the rates of all major countries during the same period and was also higher than the prevailing rates in Japan, South Korea and other East Asian economies during the years of their miracle growth. Households, firms, and government have all contributed to the remarkably high saving rate of China. Roughly speaking, the saving by households and firms had each reached about 20% of the GDP during the 2000s.

Despite the high saving rate, households and firms in China have limited vehicles to invest their massive saving. Bank deposits are the predominant investment vehicles in China. Due restrictive capital controls of China, households and firms cannot freely invest their savings in capital markets outside China, although they could invest in the stock markets inside China, which are still small by size and have not offered attractive returns in the last two decades. Bond markets in China are even smaller in size. Given these limited investment choices, Chinese households often use housing as an alternative investment vehicle. In this section, we examine the performance of housing as an investment vehicle and, in particular, the link between housing prices and stock prices.

A. Investment Performance

We first compare the performance of housing relative to bank deposits and stock markets.

A1. Bank Deposits

[Figures 12 and 13 about Here]

Figure 12 shows that the total bank deposits in China rose from slightly above 20 trillion RMB in 2003 to over 100 trillion in 2013. The deposit rate is regulated by the central bank. As shown by Figure 13, the nominal bank deposit rate had remained in a narrow range between 2% and 4% in 2003-2013, while the national inflation rate had frequently surpassed the nominal deposit rate, for instance in 2004, 2008-2009, and 2011-2012, making the real deposit rate negative. The reoccurring negative real deposit rate had motivated Chinese households to search for alternative vehicles to invest their massive savings.

A2. Stocks

China established two stock exchanges in Shanghai and Shenzhen in early 1990s. Figure 12 shows that the market capitalization of all floating shares in the Chinese stock markets grew from less than 5 trillion RMB in 2003 to near 20 trillion in 2013. Despite this rapid growth, the size of the stock markets was still substantially smaller than the total bank deposits.

[Figure 14 about Here]

Figure 14 depicts the Shanghai stock market index, a widely followed index for Chinese stock markets, in 2003-2013. This period experienced a dramatic stock market boom and bust in 2006-2008, when the index rose from 1200 at the beginning of 2006 to a peak of 6092 in October 2007 and then plunged to just below 2000 in October 2008. This boom and bust cycle mostly coincided with the rise and fall of stock markets all over the world around the world financial crisis in 2008. Since 2008, the Shanghai stock market index recovered in 2009 to a level slightly above 3000, but declined again after 2010 to a level around 2000.

[Table 3 about Here]

Table 3 summarizes the risk and return from investing in Shanghai stock market index in 2003-2013. During this period, its annual return had an average of 7.3% and volatility of 51.5%. This large volatility is not surprising given the dramatic stock market boom and bust in 2006-2008. To isolate this boom and bust period, Table 3 also splits the sample into two sub-periods. In the first half (2003-2008), despite the market crash in 2008, the index return had an average

of 8.98% and a staggering volatility of 66.1%. In the second half (2009-2013), the index return had an average of 5.3% and a volatility of 33.9%.

A3. Housing

[Table 4 about Here]

Table 4 summarizes the annual returns of the housing indices of first, second, and third tier cities. During our full sample in 2003-2013, the housing index of first tier cities offered the highest average annual return at a staggering level of 15.7% and return volatility of 15.4%. The housing index of second tier cities offered a lower average return of 13.4% and also lower volatility of 9.9%. The index of third tier cities offered the lowest average return of 11.0% and also the lowest volatility of 7.5%. Relative to the stock index return in the same period, the housing indices across the three tiers all offered higher average returns and, more impressively, much lower volatility. Despite the economic turmoil after 2008, the volatility of housing returns had been remarkably low.

During the first half of the sample 2003-2008, the housing returns are particularly high for tier-1 and tier-2 cities, with tier-1 housing index offering an average return of 20.4% and tier-2 17.3%. During the second half in 2009-2013, average returns of both tier-1 and tier-2 indices are lower at 10.9% and 9.7%, which are nevertheless attractive relative to the average stock index return during the same period. The index return of tier-3 cities is stable across the two sub-samples at 11.7% and 10.3%, respectively.

The high housing returns and low housing return volatility reflect the steady growth of the housing prices during the last decade, which is in sharp contrast to the dramatic boom and bust experienced by the Chinese stock markets during the same period. In understanding the source of the remarkable housing returns during this period, one might argue that they originate from an inflating housing bubble and thus suffer from potentially large crash risk that is yet to materialize. That is, upon the bursting of the bubble, the performance of the housing indices may substantially drop and become in line with that of the Shanghai stock market index, which had already experienced the market crash in 2007-2008.

It is difficult to either validate or refute this bubble view of the Chinese housing boom. As we discussed earlier, this housing boom did come with rapid growth in the household income, which provided at least some support from the demand side, even though low-income home buyers endured severe financial burdens to buy homes.

The resilience of the Chinese housing markets through and post the world economic crisis in 2008 was in sharp contrast to the boom and bust cycle observed in the Chinese stock markets. To the extent that the stock prices reflected investors' expectations of the profitability of listed firms and ultimately the strength of the Chinese economy, their expectations stumbled in 2008 and never recovered yet. But the expectations reflected by the housing prices were far more resilient throughout this period. This contrast is puzzling. In the next subsection we further explore the link between housing and stock prices. In Section 6, we also provide one possible explanation for why investors' expectations about the housing markets may differ from those about the stock markets.

B. Housing Price Dynamics

While our sample is relatively short, it nevertheless allows us to uncover a few interesting observations about housing price dynamics in China.

B1. Price Momentum

[Table 5 about Here]

It is common for housing prices to exhibit price momentum. According to Case and Shiller (1989) and Glaeser and Gyourko (2006), housing prices in the U.S. exhibit momentum at the horizon of one to three years. That is, housing price increases in the past one to three years tend to predict further price increases in the subsequent year. Table 5 reports the regressions of the quarterly housing index returns of first-, second-, and third-tier cities in China on their own lags and the lags of each other. A common finding is that these quarterly housing returns all display momentum at one lag. In other words, if a housing price index experiences an increase in one quarter, it tends to rise again in the subsequent quarter. It is curious that the price momentum of Chinese housing indices occurs at such a short horizon of one quarter.

Table 5 also shows that index return of first-tier cities tends to lead that of second- and third-tier cities in the subsequent one quarter. This finding confirms a common wisdom that households in first-tier cities are financially more sophisticated and thus more responsive to news and shocks to the economy, causing the housing prices in first-tier cities to react faster to shocks as well.

B2. Segmented Housing Markets?

The drastically divergent performance of Chinese housing and stock markets around 2008 may give an impression that perhaps the two markets are segmented from each other. It might be the case that the investors in the stock markets and the buyers of residential homes were two separate groups of people and, as a result, the stock prices and housing prices reflected expectations of different people. To see whether this is the case, we examine the lead-lag relationship between stock prices and housing prices. Table 6 reports regressions of the quarterly returns of housing indices of first-, second-, and third-tier cities on three lags of the quarterly return of Shanghai stock market index, as well as three lags of the quarterly change of ten-year interest rate. The results from this table uncover a rather nuanced picture.

[Table 6 about Here]

Column 1 of Table 6 shows that the housing index return of first-tier cities has positive and significant coefficients on all three lags of the stock index return. That is, when the Shanghai stock market index rises in one quarter, the housing prices of first-tier cities tend to rise in the subsequent three quarters. This positive relationship is interesting and suggests that the housing prices of first-tier cities were closely following the stock prices. As stock markets are much more liquid than housing markets, it is not surprising that stock prices lead housing prices. Also recall from our discussion in Section 3, while the housing prices in the first-tier cities did not crash down in 2008 as stock prices did, each of the cities suffered from a sizable price correction in this period. This regression thus shows that the housing markets in first-tier cities were not segmented from the stock markets.

This regression also shows that the housing index return of first-tier cities has negative coefficients on all three lags of the ten-year interest rate change, with the coefficients of the first two lags being significant. The ten-year interest rate changes in China are mostly influenced by the central bank policies. The negative effects of interest rate changes on housing prices of first-tier cities are consistent with the basic economic notion that higher interest rates raise the cost of capital for home buyers and thus reduce housing prices.

To control for housing price momentum, Column 2 of Table 6 adds the three lags of the first-tier housing index return to the regression reported in Column 1. The coefficients of the three lags of stock market return and the three lags of interest rate change remain similar to those reported in Column 1, although only the coefficient of the third lag of stock market return remains significant likely due to the small sample size.

Columns 3-4 of Table 6 repeat the same regressions for the housing index returns of second-tier cities, and Columns 5-6 for third-tier cities. While the coefficients of the three lags of the stock market return are all positive in these regressions, both the magnitudes and *t*-statistics of these coefficients are substantially smaller than the corresponding ones for first-tier cities. The reduced magnitudes and *t*-statistics of these coefficients suggest that the link between stock markets and the housing markets of second-tier and third-tier cities is weaker than the link between stock markets and the housing markets of first-tier cities. This difference is consistent with the fact that stock market participation is much broader in first-tier cities than in second- and third-tier cities. In particular, the coefficients of the three lags of stock market returns for the third-tier housing return all become insignificant after controlling for its own lags.

Furthermore, the coefficients of the three lags of the interest rate change for second- and third-tier cities, while remaining negative, also have smaller magnitudes and less statistical significance than the corresponding coefficients for first-tier cities. In particular, the coefficients for third-tier cities are all insignificant with or without controlling for the housing return's own lags. This is a curious finding, which suggests that home buyers in third-tier cities were not sensitive to change rate changes. This is consistent with the earlier finding that they were not

responsive to stock price fluctuations either. Taken together, these findings suggest that home buyers in third-tier cities were rather different from typical stock investors and that the housing markets of third-tier cities might be segmented from the stock markets.

In summary, the housing index return of first-tier cities follows closely with the Shanghai stock market index return and the ten-year interest rate change, while the housing index return of third-tier cities does not respond to neither of them. This contrast suggests that the housing markets of third-tier cities might be segmented from the stock markets, the housing markets of first-tier cities were not.

B3. Spillover from Housing Markets

Could housing market fluctuations spill over into stock markets? In light of our earlier discussion regarding the role of housing as an investment vehicle, households may face a portfolio choice between allocating wealth to housing or stocks. When housing prices rise, extrapolative expectations, a type of investor bias widely acknowledged in behavioral economics and housing literature (e.g., Barberis, Shleifer and Vishny, 1998 and Shiller, 2000), may induce households to anticipate further housing price appreciation in the future and thus to move more capital from stocks into housing. Such a portfolio reallocation may cause stock prices to fall after an increase in housing prices. It is not *ex ante* obvious that this negative spillover effect would hold in the data, especially given our early finding of the stock market return positively leading the first-tier housing index return. Furthermore, as stock investors are widely distributed across the country rather than just in first-tier cities, one would expect such a spillover effect to be stronger following national housing price fluctuations than just housing price changes of first-tier cities.

[Table 7 about Here]

Table 7 examines this spillover hypothesis by regressing the quarterly return of Shanghai stock market index on the lagged one-year national housing return, measured by the average

return of first-, second- and third-tier housing indices.¹⁴ Indeed, Column 1 of Table 7 confirms that the coefficient of the lagged one-year national housing return is significantly negative. That is, as the national housing prices rise in the previous year, the Shanghai stock market index tends to fall, rather than rise. This intriguing finding is consistent with the spillover hypothesis. Column 2 of Table 7 further shows the regression of the quarterly stock market return on one-year lagged returns of the national housing index and the first-tier housing index. Interestingly, the coefficient of the lagged national housing return remains negative and significant, while the coefficient of the lagged first-tier housing return is negative but insignificant. This also confirms our earlier discussion that the spillover effect is likely to originate from the fluctuations of national housing prices rather than prices of first-tier cities.

In summary, by examining the dynamics of housing prices in China, we uncover several interesting findings. First, housing prices exhibit price momentum at a quarterly frequency, which is much faster than the typical housing price momentum observed in the U.S. Second, the lagged quarterly stock market index return positively predicts the quarterly housing index return of first-tier cities, although not that of third-tier cities, suggesting that while the housing markets of third-tier cities might be segmented from the stock markets, the housing markets of first-tier cities were not segmented from the stock markets. Finally, national housing price increases during the past year predict a negative quarterly return of the stock market index, suggesting a negative spillover effect from housing markets to stock markets.

6. The Roles of Government in Housing Markets

In China, the governments at the central and local levels have been both actively and intricately engaged in the housing markets. The powerful forces induced by government policies not only directly affect physical aspects of the housing markets such as supply of land

¹⁴ Due to pervasive opacity in housing markets, households and investors typically do not immediately observe housing price fluctuations in a city or at the national level. Instead, they realize the price changes only gradually through observations of housing transactions in the neighborhood, reading news, and conversations with others. Consequently, it might take a certain period of time, likely longer than one quarter, for extrapolative expectations to influence households' expectations about future housing returns. For this reason, we focus on one-year lags of housing returns in our analysis.

and availability of fund to buyers, but also delicately influence expectations and confidence of households about the housing markets. This is an important channel for understanding the drastically divergent expectations reflected by the housing and stock prices after 2008. In this section, we briefly discuss the role of government in housing markets, specifically first on the policy interventions of the central government and then the dependence of local governments on land sales for their fiscal revenues.

A. Interventions by Central Government

By 2007, housing prices in most Chinese cities had grown substantially, as we discussed in Section 3. In response, the central government implemented a series of monetary and fiscal policies to curb soaring prices and curtail speculative activities in housing markets. For example, in September 2007, the central government raised the minimum down payment ratio from 30 percent to 40 percent, raised the interest rate on second mortgages to 10 percent higher than the benchmark rate, and capped the monthly mortgage payment-to-income ratio at 50%. In April 2008, it imposed tax on capital gains from housing sales. The government also started to increase the construction of government-subsidized housing, such as affordable housing, low-cost housing, and public rental housing, to help relieve the pressure on housing markets.

These policies might have had some effects on housing prices, especially in cities of Guangzhou and Shenzhen during this period, though it is hard to distinguish the effects of the policies from that of the emerging global economic crisis. In any event, in October 2008 the central government abruptly reversed these policies, and installed a series of measures to support housing market recovery. It reduced the minimum mortgage rates to 70 percent of the benchmark rate and the down-payment ratio back to 30 percent. As part of its 4 trillion RMB stimulus package, it also designated the real estate sector as one of the primary industries for investment. As a result, the housing markets regained momentum in mid-2009 and started a new round of rapid price appreciation.

In early 2010, the government introduced a series of measures, some traditional and some less standard, to cool off what were widely considered once-again overheating housing markets. It again raised the down-payment ratio to 40% and the interest rate on second mortgages.

More importantly, starting from April 2010, following the guidelines of the central government, 39 of the 70 major cities in China introduced the *housing purchase restriction policies*.¹⁵ Under these policies, only those with local *Hukou* (household registration), or those who could show proof of employment in the city for certain consecutive years, were eligible for purchasing one or two new homes. Though not covered in our sample period, the slowdown in the Chinese economy has led to a slowdown of the residential housing market since the end of 2013. Many cities loosened the purchase restrictions from mid- 2014. Currently, the housing purchase restriction policies are in force only in the four first-tier cities.

The frequent interventions by the central government have created a sense among the households throughout China that the housing markets were too important to fall, as whenever the markets started to fall, the central government would provide supports to sustain the markets.

B. Land Sales and Fiscal Revenue of Local Governments

Land sales revenues have contributed to a substantial fraction of the local governments' budget. This feature was a result of the fiscal reform enacted in 1994. In the reform, the central government consolidated the provision for tax revenue collection and the sharing in order to redistribute tax revenues to less developed areas. As is well known, local officials in China were evaluated for promotion based, to a large extent, on regional economic growth (Li and Zhou, 2005), which provided strong incentives for investment in infrastructure and capital projects. However, unlike local governments in western countries, local Chinese governments do not have many sources of revenue from local taxes. In particular, local governments in China are not authorized to levy sales tax, property tax, and local income tax, which are important

¹⁵ The housing purchase restriction policy was initiated by the central government under the so-called "New National Ten Articles" and "New National Eight Articles" issued in April 2010 and January 2011 respectively, which provided guidelines that housing purchase restrictions should be implemented in first-tier cities and can be extended to second- and even third-tier cities on a need basis. In Beijing, for example, the policy requires that each household with household registration in Beijing can only buy a new apartment. Migrants living in Beijing are not allowed to buy any apartment unless they can provide documents to prove payment of taxes and social security contributions for the previous five consecutive years. Shanghai's policy is similar.

sources of revenue for local governments in western countries. Moreover, local governments in China are prevented from directly issuing debt to fund capital projects.

As a result of this central/local fiscal arrangement and the restrictions placed on local governments, China has developed a unique funding source for local governments to obtain capital necessary to fund required large-scale infrastructure investments---they increasingly rely on selling public land. Figure 15 shows the share of land revenue in city fiscal budget in 2003-2011 averaged across all cities, as well as among the first-tier, second-tier, and all other cities. At the national level, this share started at 68% in 2003 and came down to 42% in 2008 but only to bounce back to even higher than 70% in 2010 and 2011. Across the tiers of cities, this share is relatively low for first-tier cities as their municipal governments have more sources of revenues, but high for second-tier and other cities. For the cities outside the first- and second-tiers, revenue from land sales was particularly high, contributing to over 90% of their fiscal budget in some years such as 2003 and 2010.

[Figure 15 about Here]

The central government has also allowed the local governments to create a unique funding mechanism known as Local Government-Backed Investment Units, through which future land-sales revenue can be pledged as collateral.¹⁶ Local governments have used such investment units to access capital markets and issue bonds that would allow more large-scale infrastructure/capital investment, as well as other economic development and social insurance initiatives. This unique mixing of local governmental fiscal policies with local housing markets implies that a substantial drop of housing or land prices might lead to financial distress of local governments or even trigger defaults by Local Government-Backed Investment Units, which would be equivalent to defaults by the local governments. As a result, many households in China have been emboldened to believe that the housing markets were “too important to fall,”

¹⁶ According to the latest available statistics published by the National Audit Office, by the end of June 2013, the total volume of outstanding balance of local government debts reached 10.89 trillion RMB, equivalent to 19.15% of China's GDP in 2013, surpassing 9.81 trillion the total volume of central government debt at the same time. 37.23% of the local government debt used future land sales revenue as collateral.

with the belief that the central government would be forced to, just as it had done so in the past, institute policies to pump up the housing markets if they were to deteriorate.

Taken together, the frequent policy interventions of the central government in the housing markets and the heavy reliance of local governments on land sales revenue for their fiscal budget helped to create a belief among many households that the housing markets were too important to fail. This belief might have contributed to the resilient expectations reflected by the housing prices throughout the last decade.

7. Risks for the Chinese Housing Markets

As we have shown, the enormous housing price appreciation in Chinese cities in the last decade seems to be in line with the growth in income in second and third tier cities, but less so in first tier cities. At the same time, the new housing construction has slowed down significantly in first-tier cities since 2005, while it continues to increase in second and third tier cities. We also showed that among the bottom ten percent of the mortgage borrowers, the price-to-income ratio was often 8 or higher, and mortgage payments represent close to 50 percent of their income for such borrowers.

In this section, we discuss the key risk factors facing the Chinese housing markets. The most important risk factor is no doubt related to income growth rate. As Chinese economy enters a new phase of growth, the annual GDP growth rate will inevitably drop from its close to 10 percent growth in the last three decades. In 2014, the Chinese economy grew at 7.4% rate. As economic growth slows down, so will the growth of household disposal income. As we argued in Section 3C, the high price-to-income ratio among home buyers was likely sustained by the expectation of sustained high income growth; as such a significant slowdown of the expectation of income growth will lead to a commensurate decrease of sustainable price-to-income multiples for home buyers. As we have shown in Section 3, housing price growths in the last decade substantially outpaced that of income growth in first tier cities, but not in second and third tier cities, thus a housing price correction as a result of income growth slowdown is likely to have a more dramatic impact on the housing markets in first-tier cities.

The housing supply, however, is much more elastic in second and third tier cities than in first tier cities. The continued increase in new construction in second and third tier cities, as shown in Figure 1, has kept the housing price growth in these cities in line with their income growth, but also poses a unique risk to the housing market in these cities. However, it should be noted that new constructions are constrained by land sold for housing development, and how much land for sales is under the control of the local governments. Thus, risks from the glut of new supplies in second and third tier cities can be managed by the local governments if they have alternative sources of fiscal revenue.

Another near-term risk factor for the housing markets is the demographic trends. As is well known, 25 years after the initiation of the family planning policy, the Chinese population is rapidly ageing and is expected to decline from 2030. The prime age population for home buyers, those between 30 and 49, however, has already started to decline from 2005 for China as a whole.¹⁷ Using the 2000 Chinese Census micro data, we find that in 2030 the prime age population in China will decline to about 62% of the corresponding level in 2000. Of course, the ongoing urbanization in China is likely to draw a significant share of the rural population to cities (see Figure 2), and thus for the urban housing markets, the overall demographic trend may not be as relevant. Ongoing policy discussions in China regarding the relaxation of the one-child policy, as well as a relaxation or even abolishment of the strict Hukou policy, could significantly increase the demand of housing in the cities. Policies that relax Hukou system may become necessary to prevent the meltdown of the housing market if, for example, the economy and income growth slow down sharply.

We would also like to discuss the likely effects of some of the pending policy reforms in China that may have more subtle implications on the Chinese housing markets.

First, we consider the possible initiation of property tax and new fiscal reform. Property taxes are so far not assessed on homeowners in China, with the exceptions of Shanghai and Chongqing, where a small property tax on certain class of homes was assessed from the end of January 2011. In Shanghai, the property tax is at currently at 0.6% of the purchase price of

¹⁷ In Section 4E, we showed the average age of the mortgage borrowers is early 30s

second homes, while in Chongqing, the property tax is 0.5% on the purchase price of second homes, mansions and luxury apartments. The introduction of property tax in all cities is now on the policymakers' agenda. Part of the reason is a desire to increase the cost of speculative purchase of houses; and another part is the desire to have a different source of revenue for local governments that have, as we have shown, become increasingly reliant on land sales revenue in their budget.

An introduction of property tax will have several effects on the housing market. First, it makes house speculation less profitable. Speculation would remain profitable only if the expected housing price growth exceeds the opportunity cost of funds used for purchasing the house, plus the property tax assessment. If the property tax rate is chosen properly, it is possible that it could not only deter new speculative demand for housing, but also potentially drive current speculative holdings of houses to the market for sale. Second, the introduction of property tax, in conjunction with fiscal reform that provides local governments revenue sources that are not tied to selling land, is likely to fundamentally change the investors' expectation that real estate sector is "too important to fall" for the local government. As we argued in Section 6, the fact that local governments in China relies heavily on land sales revenue in its budget may have played an important role in investors' belief that housing prices are likely to continue to rise. Absent the conviction that real estate sector is "too important to fall," the perceived risk associated with investment in housing sector will rise, reducing the demand for speculative purchases. Third, property tax and other fiscal reform will also put a downward pressure on the land prices that the developers are willing to pay. Local governments are more willing to accept the lower land sales price due to the new revenue sources. Lower land price can further lower the cost of housing. All three effects of the imposition of property tax are likely to put a downward pressure on the housing market.

Another pending reform that may impact the housing markets is the unification of the administrative structure of the social security and retiree health insurance system. First-tier cities in China, such as Shanghai and Beijing, are privileged in many dimensions. Their economies are the most vibrant, thus they offer the most promising job opportunities and

career prospects for young people. They are also often where the best universities are located, thus they attract young college students. There are no differences in these dimensions between Chinese cities and large cities in the western world. However, the current social insurance system, particularly the health care and the health insurance system, in China is poorly designed to facilitate a transition of the housing stocks from the older generation to the young generation. Specifically, most of the best hospitals in China are located either in Beijing and Shanghai (affiliated with the medical school of the best universities), or in a few of the provincial capitals, such as Guangzhou and Chengdu. More importantly, the current health insurance system in China is mostly based on employment or pre-retirement employment, and they are implemented under a prefecture- or county-level planning framework, where the planning units have discretion over policy details and are responsible for balancing their own budget (see Fang, 2014, for an overview of the social insurance arrangement in China). Health insurance is not accepted nationwide. This means that, if the retirees in first-tier cities were to relocate to third-tier cities, say, they would not only experience more difficulty to access the best hospitals, but also have difficulty in having their medical expenditures covered by their health insurance. This creates strong disincentive for the elderly to relocate as they retire, leading to unnecessary competition between the young and the old for the limited housing resources in the first-tier and some second tier cities. As China attempts to unify the administrative structure of the health insurance system, and equalize the medical resources across different areas, it is possible that the retirees in first-tier cities will relocate to retirement communities located in cities that have good medical care facilities, leaving the job opportunities, educational resources and also housing resources to the young, creating a healthy life-cycle for first-tier city resident. This is likely to be stabilizing force for the Chinese housing markets.

Appendix

Appendix A: Residential Mortgages in China

A.1 Borrowing Requirement

The borrower should have a stable source of income and good credit record, and be between 18 to 65 years of age. Generally, loan to value ratio should be lower than 30%, and loan term should be less than 30 years. To apply for the mortgage loan, the applicant should provide a real estate certificate or purchase contract and proof of down payment from the developer, proof of income (this proof is the main document for housing mortgage loan applications in China), other property proof (such as another real estate certificate, stock, fund, cash deposit, vehicle permits etc.). According to the requirements announced and implemented by China Banking Regulatory Commission (CBRC) in "Guidelines for the risk management of real estate loans of commercial banks" in 2004, the borrower's ratio of monthly mortgage payment to income should be lower than 50%, and the ratio of monthly debt payment to income should be lower than 55%.

A.2 The Scope of Collateral

In China, the collateral of mortgage can only be houses, which include villas with the down payment ratio of a villa being higher than that of other types of houses. Housing age (from the housing completion date) usually should be no more than 20 to 30 years, and housing age plus the loan period should be no more than 30 to 40 years. In other countries, such as US, the collateral of a mortgage can belong to the borrower himself or others. However, in China, the collateral of mortgage has to belong to the borrower.

A.3 Loan Application Procedure

Applicants should first submit all required documents. After receiving the application form filled by the applicant together with all relevant documents, the bank carries out eligibility investigation. The most important factor for the bank to investigation is the income statement and good credit record. Individual credit record can be checked by the rating system of the People's Bank of China. This rating system was under trail operation in December 2004, and began running officially from January 2006. Upon approval, the bank and the borrower sign a mortgage contract. The borrower then opens a mortgage account at the mortgage bank for making mortgage payment. Every month, the borrower makes a specified payment to the bank according to the mortgage contract.

A.4 Mortgage Interest Rate

In China, mortgage interest rate is regulated by the central bank of China, known as the People's Bank of China. Interest rates determined by the People's Bank of China can be executed by commercial banks after approval by the State Council. All banks should follow the same lending rules set by the People's Bank of China. According to the regulation by the People's Bank of China, the mortgage interest rate should be a multiple of the same level benchmark lending rate. Before 2006 August, the multiple was 0.9; from 2006 August to 2008 October, the multiple was 0.85; from 2008 October to 2010 March, the multiple was 0.7; after 2010 March, the multiple for the first house was 0.85, and for the second house the multiple was 1.1. In addition, before 2010, the real mortgage interest rate was the lowest interest rate regulated by the People's Bank of China. However, from 2011, because of the reach of credit risk measurement techniques and tools of banks, mortgage interest rates higher than the lowest interest rates regulated by the People's Bank of China started to increase. Currently, the benchmark lending interest rate is 5.6% for mortgage loans with a term of 6 months or below; for loans with a term above 5 years, the benchmark lending interest rate is 6.55%. The spread between long term and short term is 95 basis points.

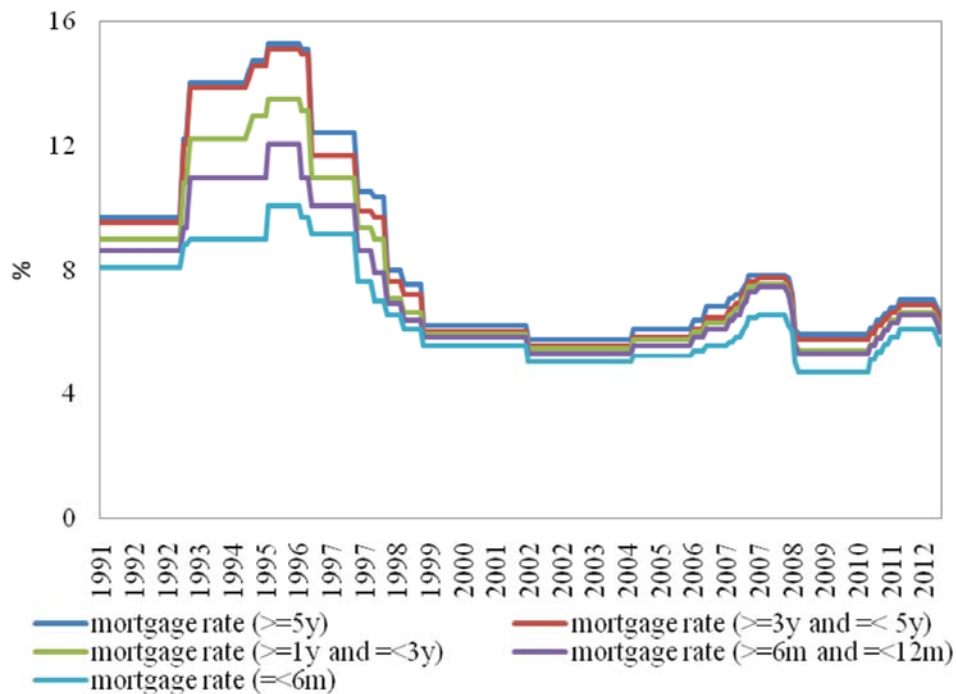


Figure A1: Mortgage Rates in China. This figure is from The People's Bank of China. In China, mortgage interest rate is determined by the People's Bank of China, the central bank of China. All banks should follow the same lending rules set by the People's Bank of China.

One special feature of China mortgage loans is that all loans in the current market are adjustable rate mortgages (ARM), and there is no fixed rate mortgage (FIX). Upon closer inspection, during 2007 to 2008, some commercial banks issued a small number amount of fixed rate mortgages but these disappeared in a very short time. During the mortgage payment term, if the People's Bank of China changes the interest rate, all the interest rates of mortgage loans will be adjusted according to the newest interest rate. A small number of mortgage loans are adjusted in the next month or next quarter, while the majority of mortgage loans will be adjusted on the first day of the next year. Figure 3 shows the lending interest rates announced by the People's Bank of China from 1991 to 2012.

A.5 Payment Method

If the loan term is one year or shorter, both principal and interest rate must be repaid as a lump sum at maturity; if the loan term is longer than one year, the loan may be repaid in equal installments of the principal plus interest, or in equal instalments of principal. The borrower may choose either method, but there is only one payment method for each loan, and after the method is specified in the contract, it may not be changed. Just as stated in the loan application procedure, once the mortgage contract has been signed, the borrower should open a mortgage account at the mortgage bank for making mortgage payment. Borrowers should make a specified monthly payment to the bank according to the mortgage contract. Every month, borrowers can choose different payment decisions on their mortgage: continue to make payment, default, full prepayment, or partial prepayment.

A.6 Mortgage Termination

Default and full prepayment are two channels to terminate the mortgage contact during mortgage term. The default number in China is very small. Besides cultural reasons, one main difference of mortgage default between China and the United States is that all mortgage loans in China are recourse loans. This allows the mortgage lenders or banks to collect from the borrowers' assets to recover the loan loss. It means that once defaulted, all the assets of borrowers will be taken away to cover the loss of mortgage lenders. Full prepayment and partial prepayment are very popular in China. The motivation of full prepayment in China is quite different from that of the United States market due to the special rule of mortgage interest rate – once the People's Bank of China announces a rate change, all mortgage interest will be adjusted according to the change, and all banks use the same lending rate benchmark. Hence, all prepayment observed in the sample are payoffs or partial prepayments rather than refinances. In China, mortgage refinance is not allowed.¹⁸

¹⁸ Refinancing is the process of paying off an existing loan by taking a new loan and using the same property as security. This is not allowed in China.

Appendix B: List of Cities by Tiers

- First tier includes: Beijing, Shanghai, Guangzhou, and Shenzhen
- Second tier includes the following 35 cities with the bracket denoting cities that are missing from our sample: [Beihai], Changchun, Changsha, Chengdu, Chongqing, Dalian, Fuzhou, [Guiyang], Haikou, Hangzhou, Harbin, Hefei, Hohhot, Jinan, Kunmin, [Lanzhou], Nanchang, Naijin, Nanning, Ningbo, Qingdao, [Sanya], Shenyang, Shijiazhuang, Suzhou, [Taiyuan], Tianjin, Urumqi, Wenzhou, Wuhan, Wuxi, Xi'An, Xiamen, Xining, Yinchuan, Zhengzhou
- Third tier includes the following 85 cities: Xuancheng, Fuyang, Chuzhou, Huangshan, Anqing, Bengbu, Wuhu (from Anhui province); Ningde, Zhangzhou, Quanzhou (from Fujian province); Jieyang, Zhongshan, Dongguan, Qingyuan, Yangjiang, Heyuan, Shanwei, Huizhou, Zhaoqing, Jiangmen, Foshan, Shantou, Shaoguan (from Guangdong province); Hengshui, Langfang, Zhangjiakou, Baoding, Xingtai, Qinhuangdao, Tangshan (from Hebei province); Jiamusi, Qiqihar (from Heilongjiang province); Zhumadian, Nanyang, Luohe, Xuchang, Puyang, Xinxiang, Luoyang, Kaifeng (from Henan); Changde (from Hunan province); Xilingol, Baotou (from Inner Mongolia); Jiangyan, Suqian, Zhenjiang, Yancheng, Huai'an, Lianyungang, Nantong, Changzhou, Xuzhou (from Jiangsu province); Fuzhou, Shangrao, Yichun, Xinyu, Jiujiang, Pingxiang, Jingdezhen (from Jiangxi province); Songyuan, Jilin (from Jilin province); Wuludao, Chaoyang, Tieling, Panjin, Yingkou, Dandong, Anshan (from Liaoning province); Liaocheng, Dezhou, Rizhao, Zaozhuang (from Shandong province); Yuncheng (from Shanxi province); Dazhou, Nanchong, Leshan, Mianyang, Deyang, Luzhou (from Sichuan province); Changji (from Xinjiang); Taizhou, Jinhua, Shaoxing, Huzhou, Jiaxing (from Zhejiang province).

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Figure 1: Per Capita Area of Newly Built Residential Housing

For each tier of cities, we divide its annual flow of newly-constructed residential housing, measured in square meters, by its urban population in 2012. NBS provides annual city-level information on space of newly-constructed residential housing from 2002-2013, and on resident population from 2005-2012, for 35 large cities only. These cities include all four tier-1 cities: Beijing, Shanghai, Guangzhou and Shenzhen. The other 31 cities all belong to the tier-2 cities defined in the paper. We use the aggregate of these 31 cities to compute the per capita area built for tier-2 cities. We then subtract these 35 cities from the national aggregates on newly constructed urban housing and urban population to get measures for Tier-3 (and other) cities. Resident population includes all persons residing 6 months or more in the area governed by the city in the current year (in contrast to hukou population). We assume all resident population in Tier-1 and Tier-2 cities are urban, which leads to a slight overestimation of urban population in Tier-1 and Tier-2 and a slight underestimation of urban population in Tier-3 (and other) cities. In 2012, China has a total population of 13.5 billion, out of which 7.2 billion are urban and 6.3 billion are rural. Out of those 7.2 billion who live in cities, 0.7 billion reside in Tier-1, 2.4 billion in Tier-2, and 4.1 billion in Tier-3 by our baseline calculation.

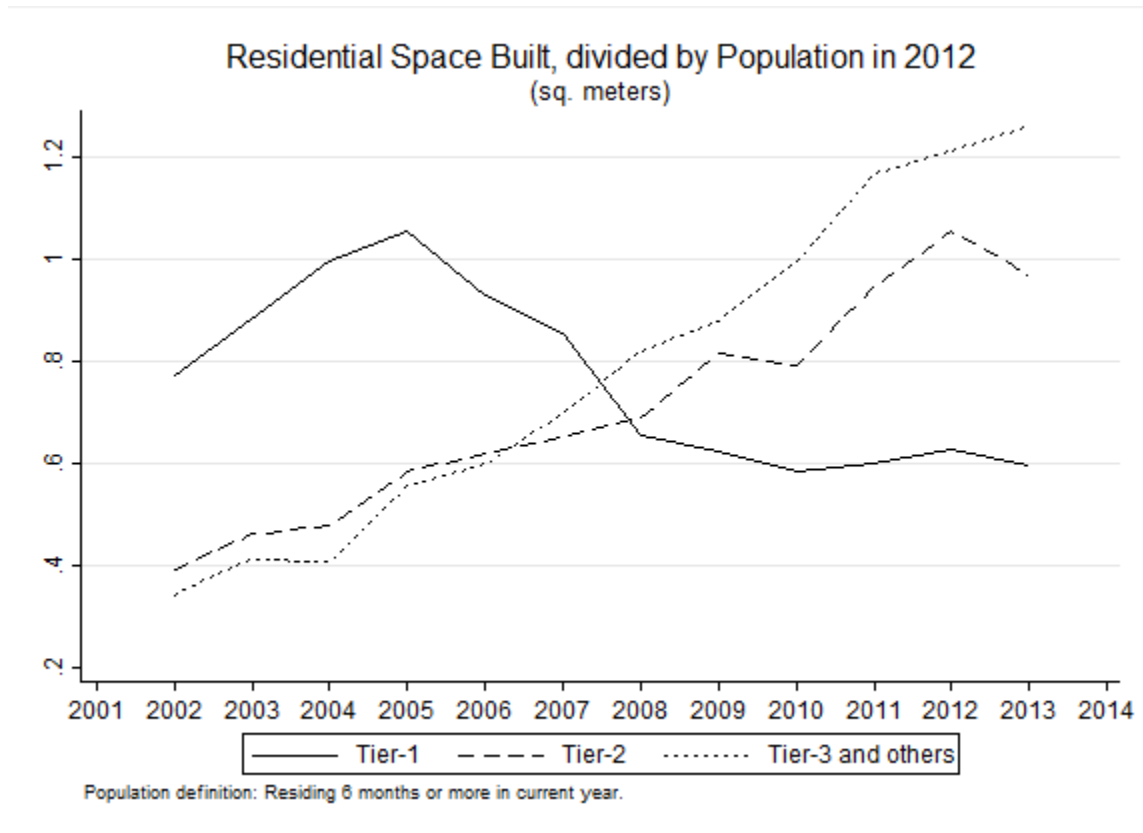


Figure 2: Population in Three Tiers of Cities

There are two lines in each panel. The solid line depicts the total population within the jurisdiction of each tier of cities, while the dashed line depicts the population within the city proper of each tier.



Figure 3: An Illustration of Index Construction Method

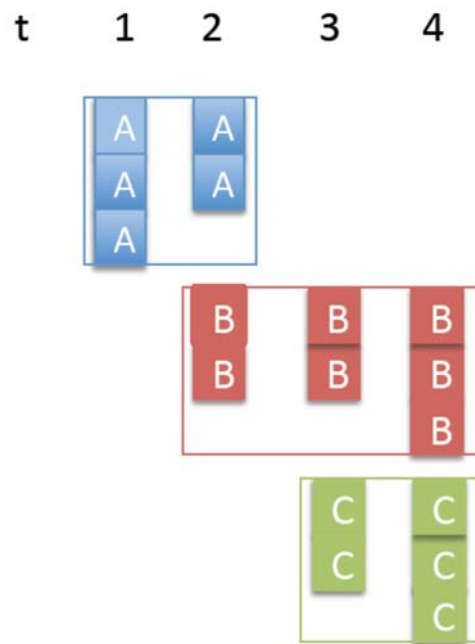


Figure 4: Housing Price Indices for First Tier Cities

This figure depicts the monthly housing price indices in four separate panels for the four first-tier cities Beijing, Shanghai, Guangzhou, and Shenzhen, together with two measures of households' purchasing power: per capita GRP and disposal income (urban). The per capita GRP measures the per capital value of output in the whole city and the per capita disposal income (urban) measures the per capital income received by urban residents of the city.

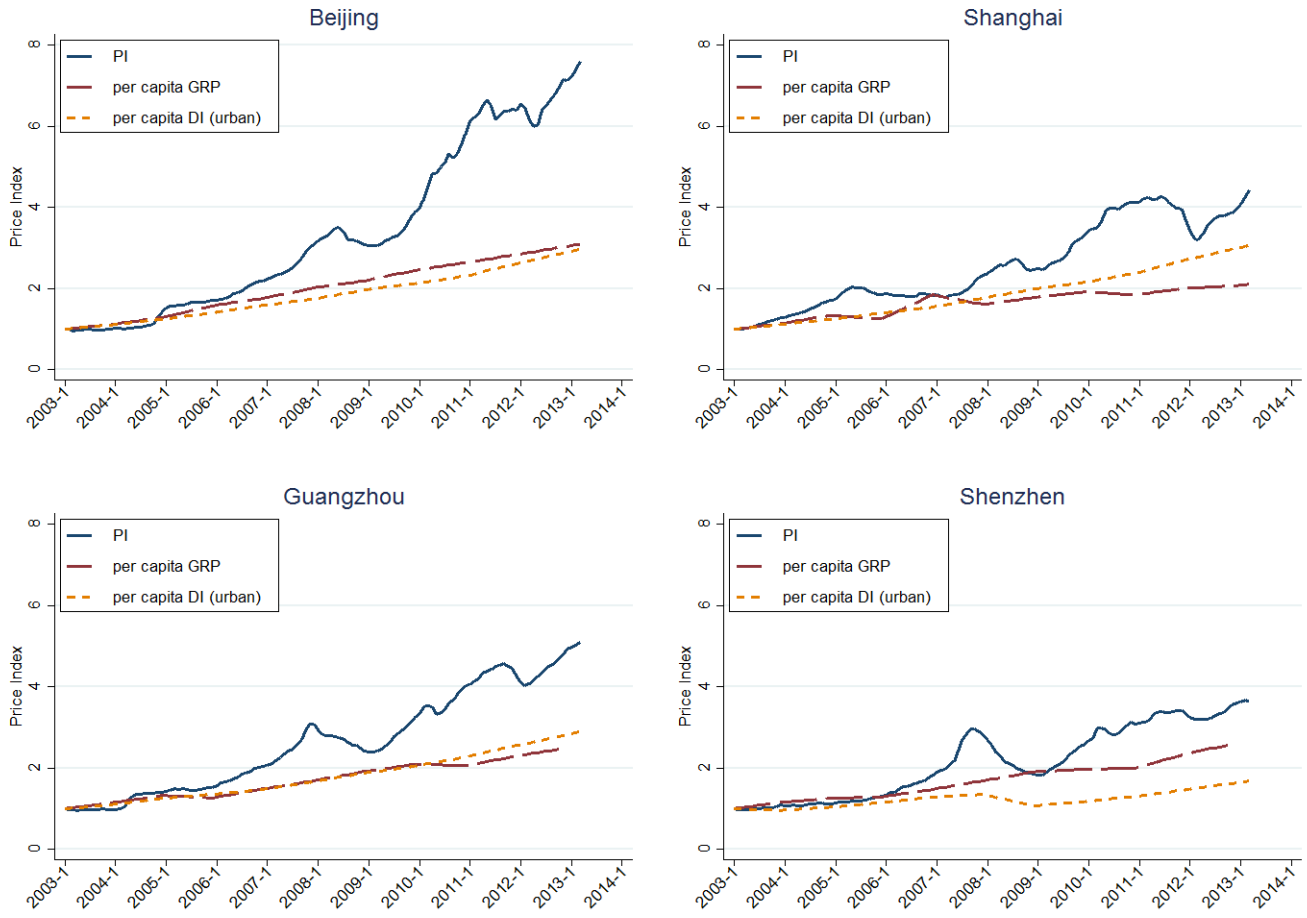


Figure 5: Housing Price Indices for Second and Third Tier Cities

This figure depicts the monthly housing price indices in two separate panels for second and third tier cities, together with two measures of households' purchasing power: per capita GRP and disposal income (urban). The per capita GRP measures the per capita value of output in the whole city and the per capita disposal income (urban) measures the per capita income received by urban residents of the city.

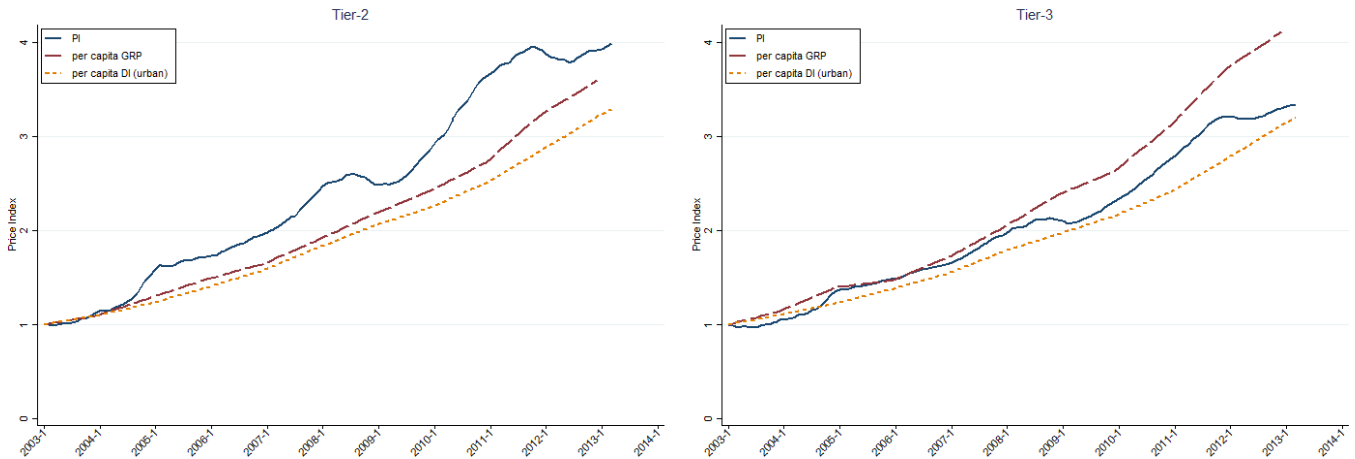
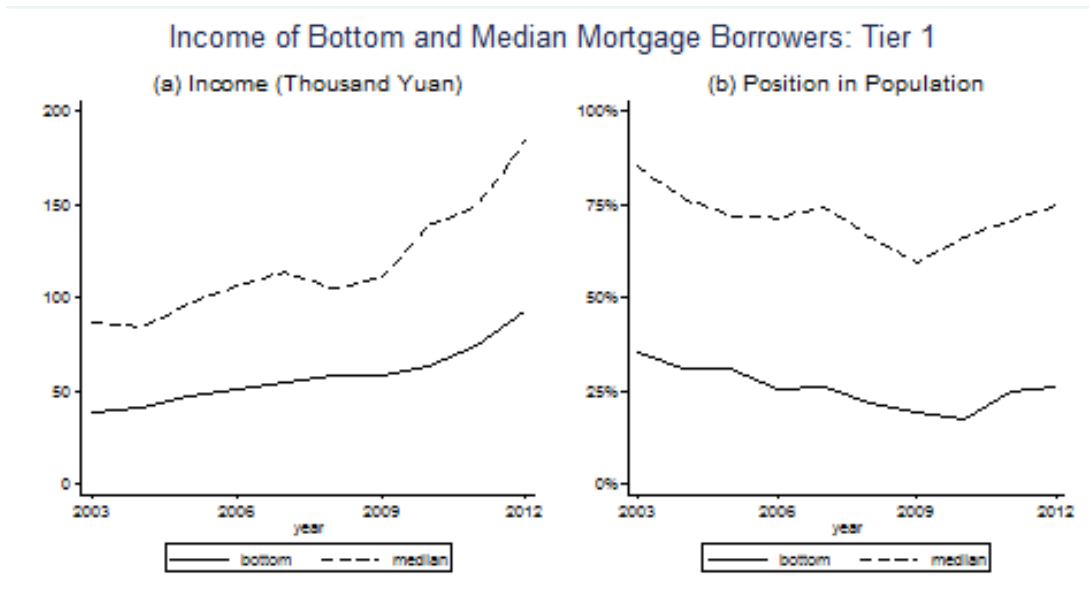
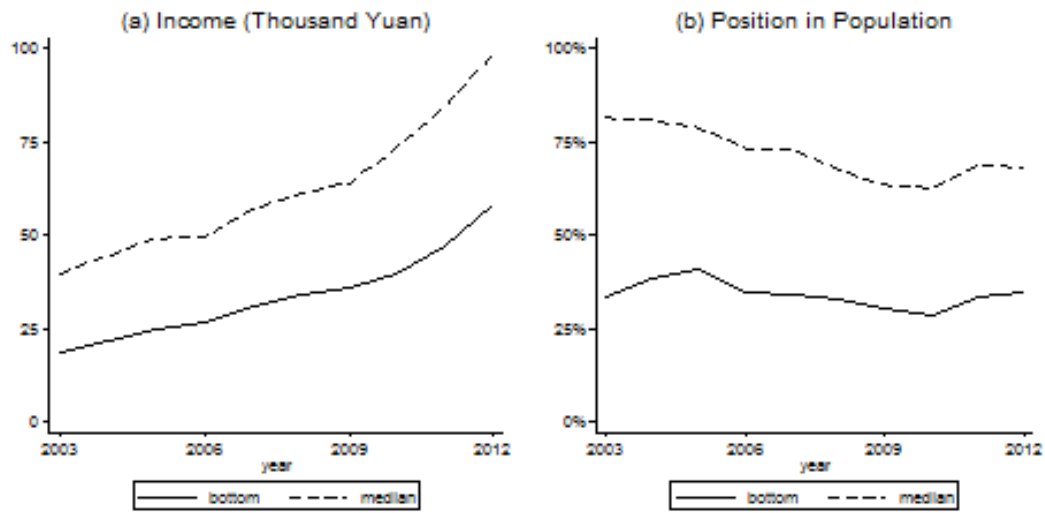


Figure 6: Annual Income of Mortgage Borrowers

This figure depicts the time-series of the household income of p10 and p50 for first, second and third tier cities in Panels A, B, and C, respectively. In panels A and B, the left plot shows the annual income of p10 and p50 (which is averaged across all cities in the tier) in RMB from 2003-2012 and the right plot shows the position of p10 and p50 in the income distribution of the city population based on the income distribution reported by the Urban Household Survey (UHS). Panel C shows only the annual income of p10 and p50.



Income of Bottom and Median Mortgage Borrowers: Tier 2



Income of Bottom and Median Mortgage Borrowers: Tier 3

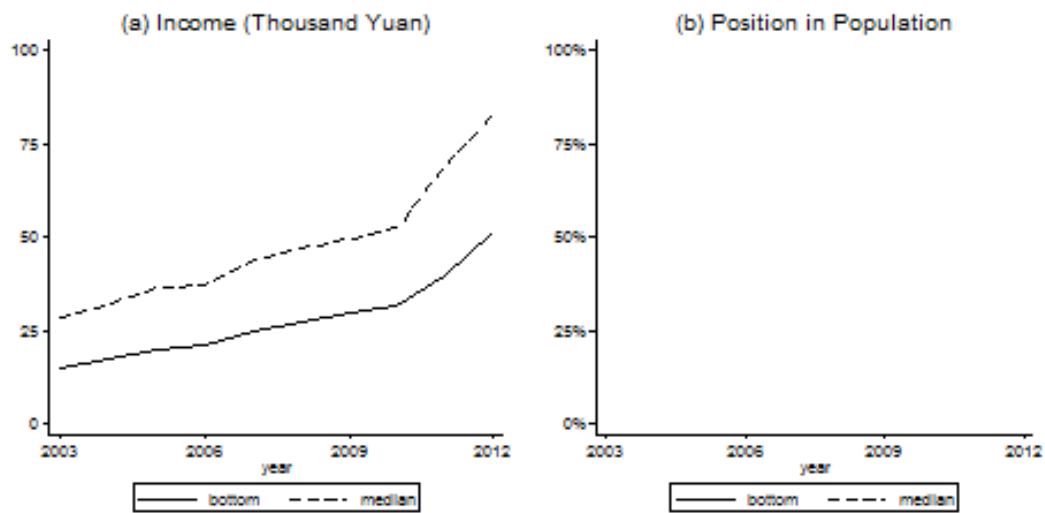


Figure 7: Mortgage Down Payment

The left panel depicts the fraction of mortgage down payment in the home value at the time of purchase for bottom-income borrowers in first, second, and third tier cities, and the right panel depicts the fraction of down payment for middle-income borrowers in the three tiers of cities.

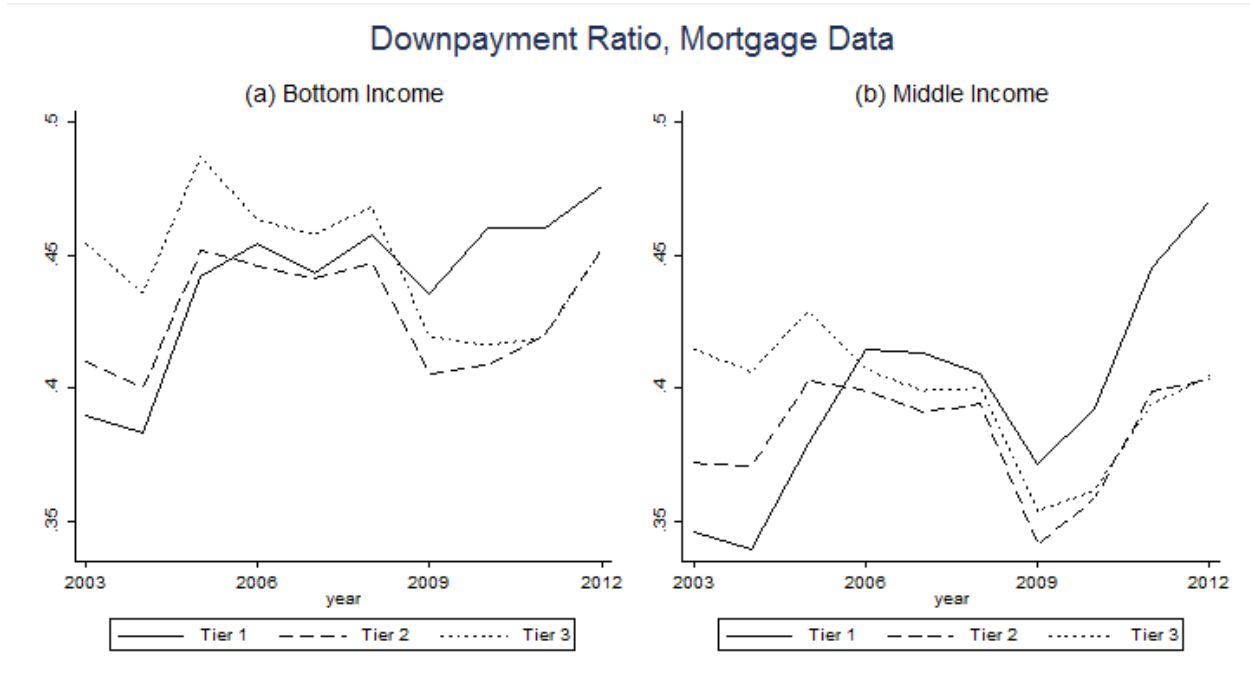


Figure 8: Price-to-Income Ratio of Mortgage Borrowers

This figure depicts the price-to-income ratio of mortgage borrowers in the full sample (top panel) and in the subsample of married borrowers (bottom panel). In each panel, there are two plots, the left plot covers the borrowers in the bottom-income group with a separate line for each of the three tiers of cities, while the right plot covers the borrowers in the middle-income group.

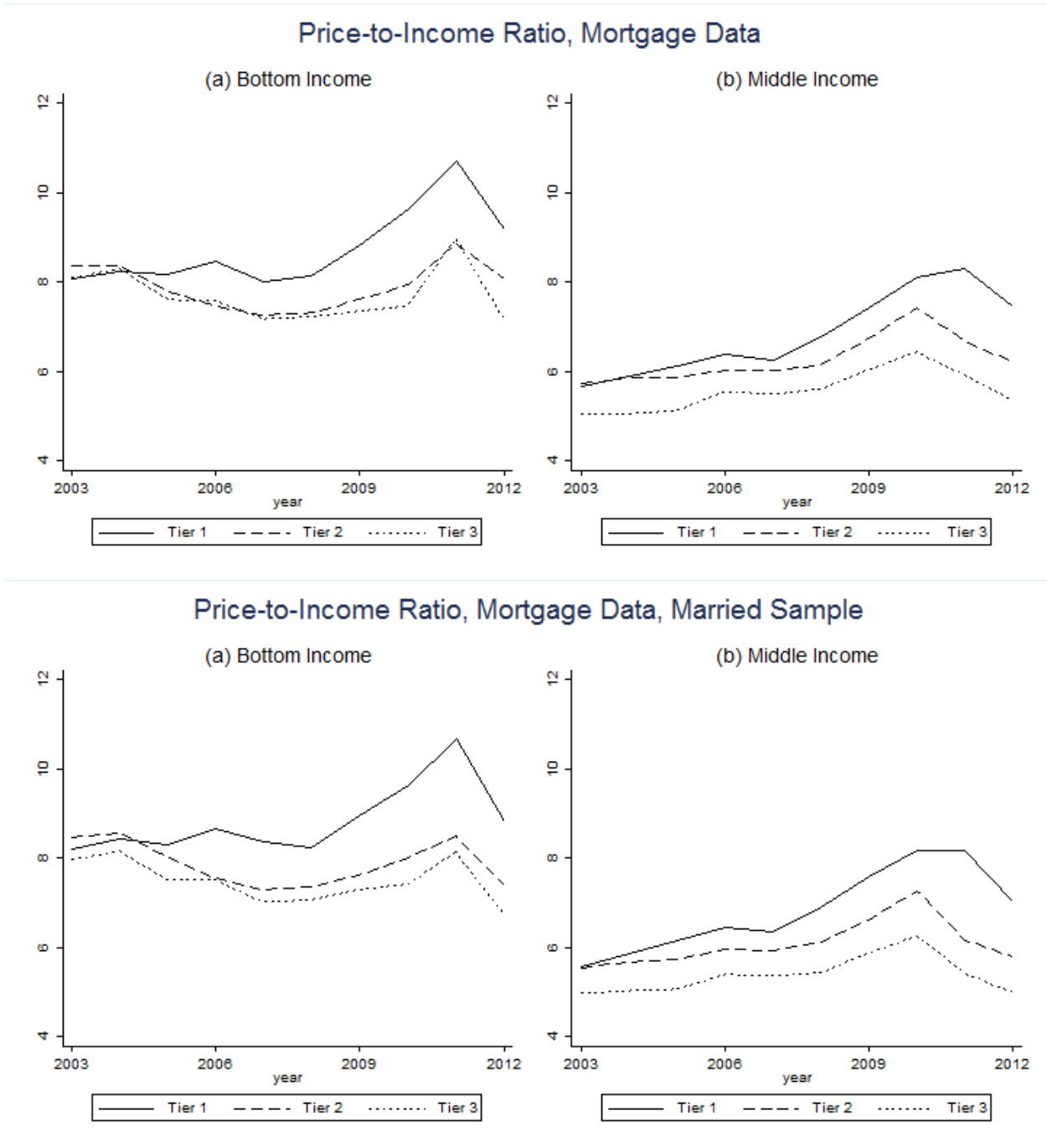


Figure 9: Size of Homes Purchased by Mortgage Borrowers

The left panel depicts the home size of bottom-income borrowers in first, second, and third tier cities, while the right panel depicts that of middle-income borrowers.

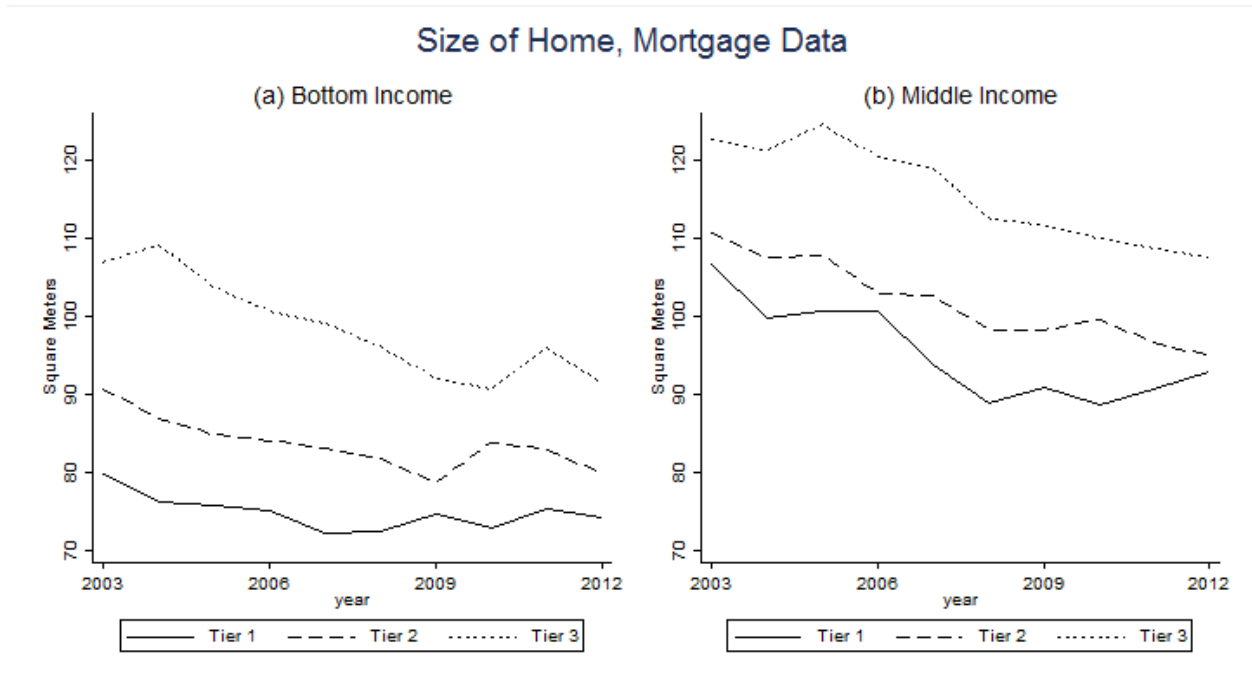


Figure 10: Age of Mortgage Borrowers

The left panel depicts the age of bottom-income borrowers in first, second, and third tier cities, while the right panel depicts that of middle-income borrowers.

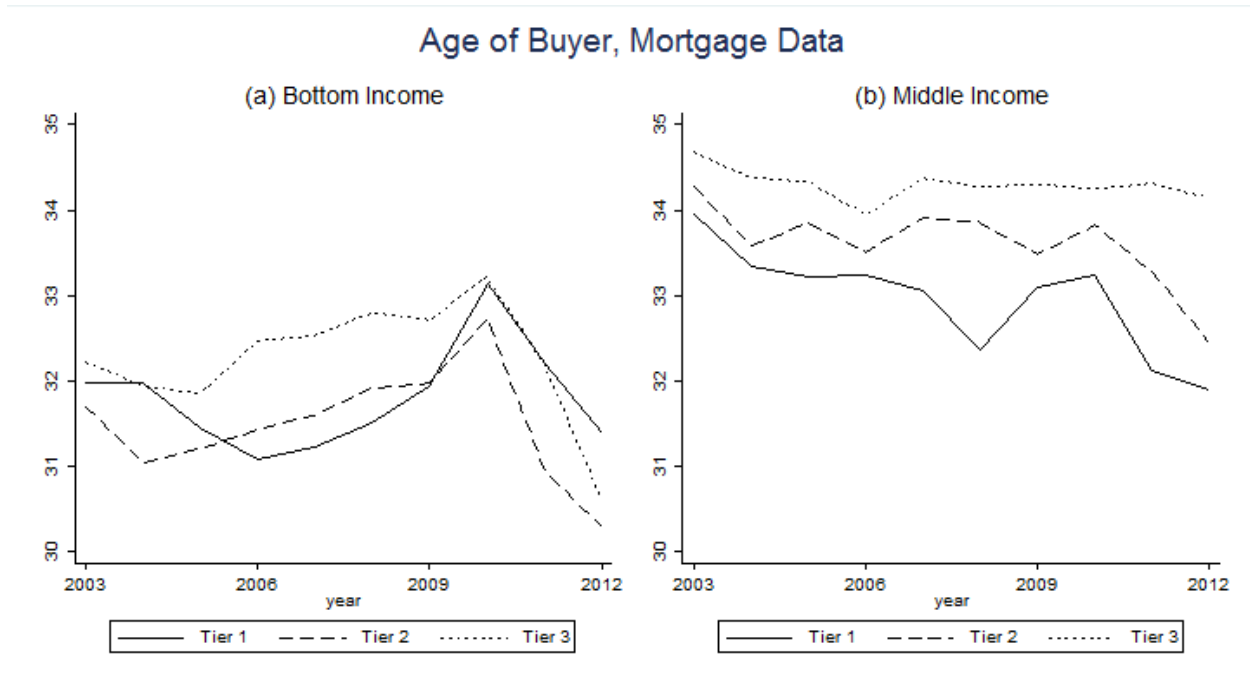


Figure 11: Marital Status of Mortgage Borrowers

The top panel depicts the fractions of single men and single women among middle-income borrowers in three separate plots for first, second, and third tier cities, while the bottom panel depicts these fractions among bottom-income borrowers in three separate plots for first, second, and third tier cities.

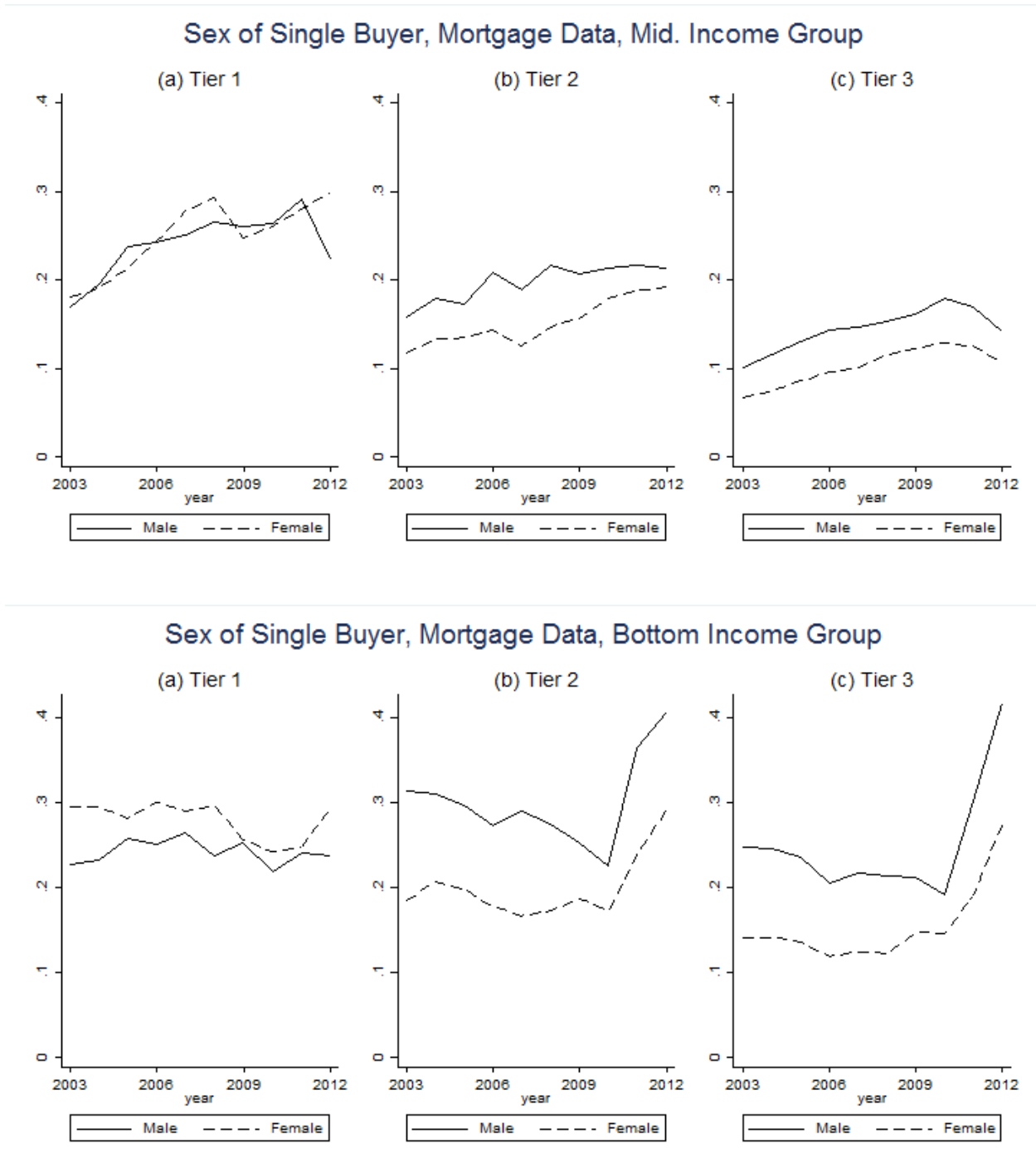


Figure 12: Bank Deposits and Stock Market Capitalization

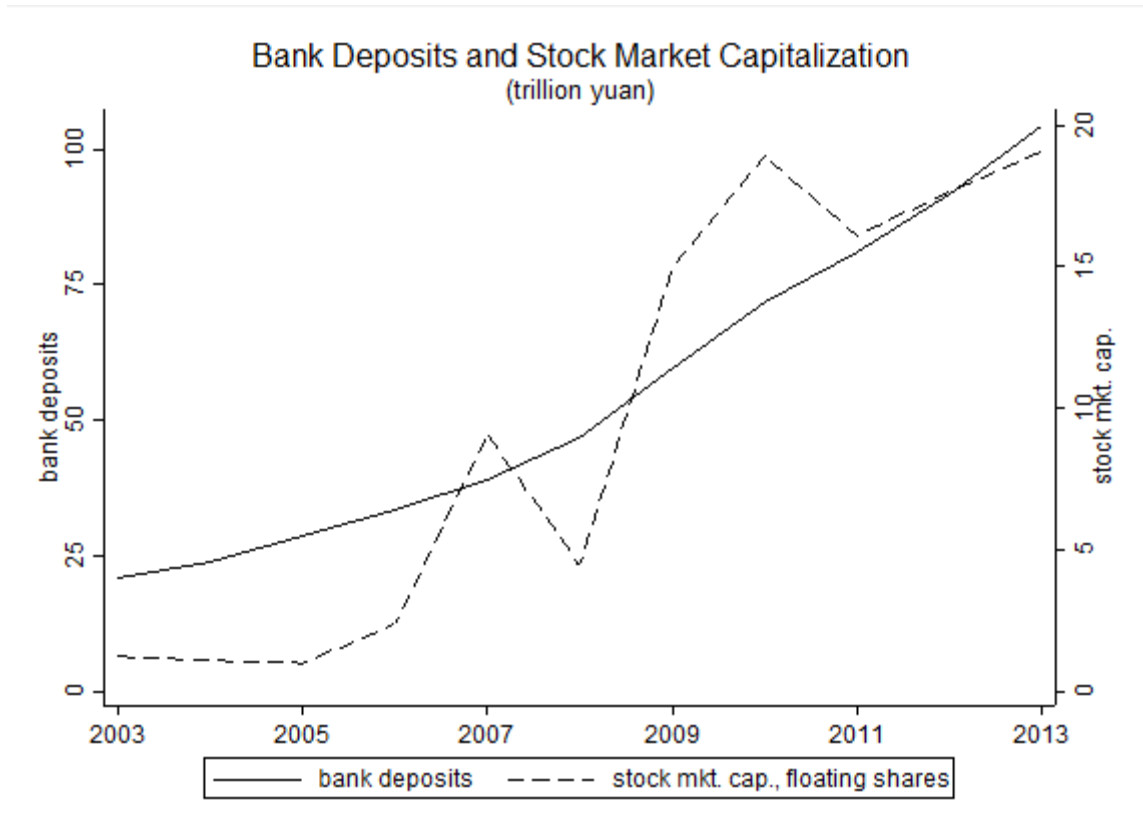


Figure 13: Bank Deposit Rate and National Inflation

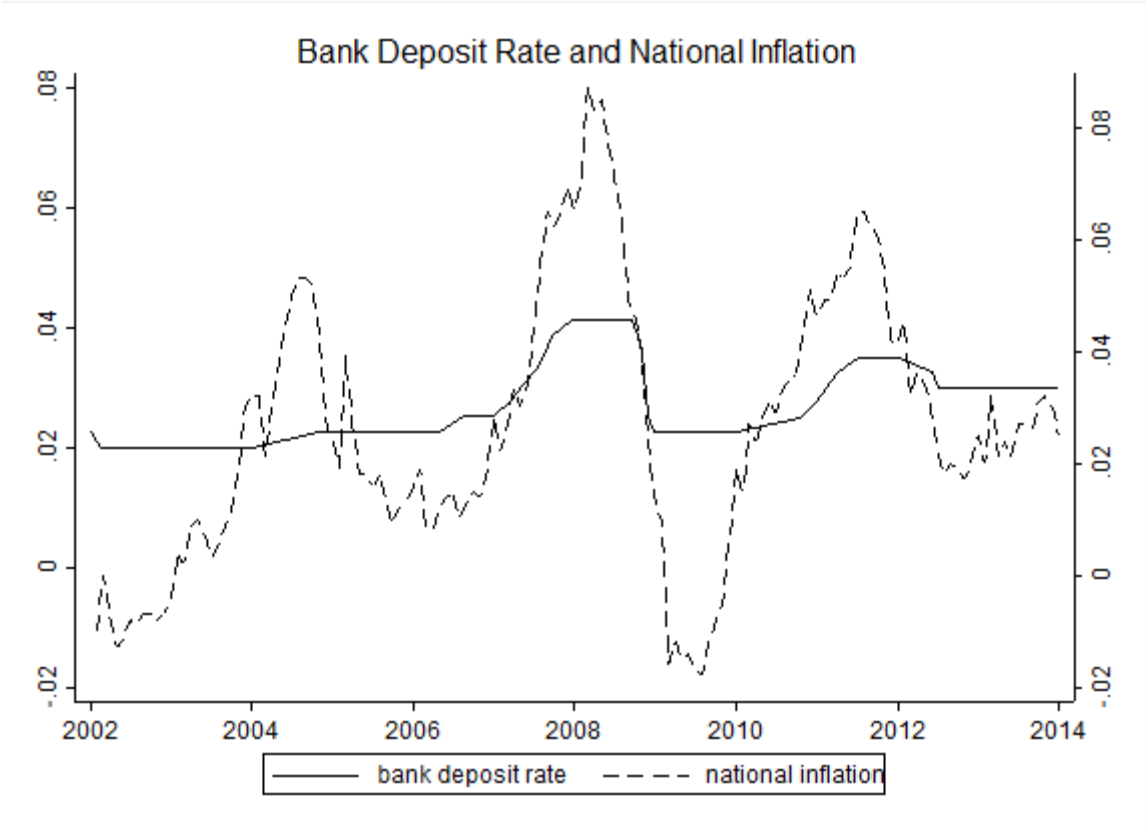


Figure 14: Shanghai Stock Market Index



Figure 15: Share of Land Revenue in City Budget

The top panel depicts the national average of share of land sales revenue in city fiscal budget, while the bottom panel depicts the average among first-tier cities, second-tier cities and all other cities. Data Source: China Municipal Statistical Yearbook and China National Land Resource Yearbook.

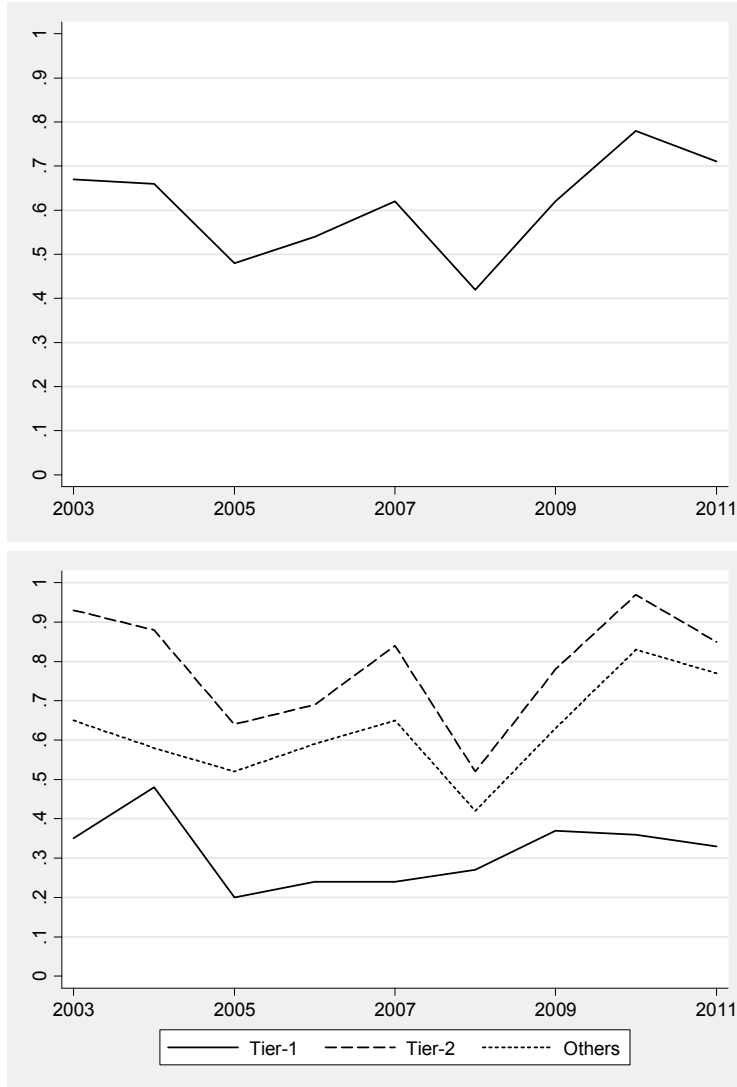


Table 1: Summary Statistics of Housing Price Appreciation and Growth of GRP and Disposal Income, by Tier of Cities.

	January 2003 - December 2007					January 2009 - March 2013				January 2003 - March 2013			
	Obs	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Panel A: Tier 1 Cities													
Housing Price Index	4	2.829	0.357	2.327	3.094	2.103	0.293	1.785	2.486	5.199	1.707	3.655	7.6
Per capita GRP index	4	1.755	0.183	1.613	2.024	1.299	0.1	1.16	1.374	2.558	0.398	2.075	3.043
Per capita DI index (urban)	4	1.633	0.192	1.352	1.765	1.528	0.019	1.504	1.549	2.656	0.655	1.679	3.071
Panel B: Tier 2 Cities													
Housing Price Index	31	2.37	0.638	1.11	4.155	1.635	0.247	1.196	2.462	3.92	0.934	2.292	6.849
Per capita GRP index	30	2.01	0.485	1.051	3.176	1.667	0.199	1.224	2.111	3.958	1.207	1.519	6.498
Per capita DI index (urban)	30	1.804	0.218	1.309	2.398	1.605	0.089	1.506	1.982	3.324	0.504	2.2	4.704
Panel C: Tier 3 Cities													
Housing Price Index	85	1.83	0.542	0.613	3.422	1.629	0.26	1.188	2.74	3.132	1.041	1.07	6.088
Per capita GRP index	85	2.186	0.479	1.027	3.581	1.747	0.235	1.156	2.308	4.639	1.459	1.352	9.899
Per capita DI index (urban)	74	1.792	0.174	1.339	2.494	1.627	0.072	1.438	1.796	3.293	0.387	2.237	4.781

Table 2: Fraction of Second Mortgages

	2011	2012	2013
First-Tier Cities	5.3%	5.2%	11.8%
Second-Tier Cities	2.0%	2.4%	3.3%
Third-Tier Cities	1.0%	1.3%	1.8%

Table 3: Summary Statistics of Annual Returns of Shanghai Stock Market Index (2003-2013)

	Mean	Std. Dev.	Skewness
2003-2013	.073	.515	-.153
2003-2008	.0898	.662	-.337
2009-2013	.053	.339	1.182

Table 4: Summary Statistics of Annual Returns of Housing (2003-2013)

Full Sample (2003-2013)			
	Mean	Std. Dev.	Skewness
First-Tier Index	.157	.154	-.674
Second-Tier Index	.135	.0989	.564
Third-Tier Index	.110	.075	.092
Before 2009 (2003-2008)			
	Mean	Std. Dev.	Skewness
First-Tier Index	.204	.105	-.059
Second-Tier Index	.173	.099	.852
Third-Tier Index	.117	.095	-.028
After 2009 (2009-2013)			
	Mean	Std. Dev.	Skewness
First-Tier Index	.109	.191	-.249
Second-Tier Index	.097	.094	.474
Third-Tier Index	.103	.059	-.057

Table 5: Lead-Lag between Quarterly Returns of First-, Second-, and Third-Tier Housing Indices

	Tier-1 Return	Tier-2 Return	Tier-2 Return	Tier-3 Return	Tier-3 Return
L.Tier-1 Return	0.732*** (0.154)		0.325*** (0.113)		0.146** (0.0625)
L2.Tier-1 Return	-0.218 (0.182)		0.158 (0.155)		-0.0341 (0.0668)
L3.Tier-1 Return	-0.105 (0.109)		0.0737 (0.138)		0.142* (0.0765)
L.Tier-2 Return		0.480** (0.192)	0.126 (0.328)		
L2.Tier-2 Return		-0.00515 (0.221)	-0.187 (0.194)		
L3.Tier-2 Return		-0.0740 (0.147)	-0.0686 (0.154)		
L.Tier-3 Return				0.890*** (0.199)	0.635*** (0.200)
L2.Tier-3 Return				-0.442* (0.258)	-0.473** (0.231)
L3.Tier-3 Return				0.107 (0.166)	0.0287 (0.150)
Constant	0.0246** (0.0100)	0.0206*** (0.00752)	0.0167** (0.00672)	0.0134*** (0.00476)	0.0147*** (0.00486)
R^2	0.411	0.219	0.413	0.480	0.593
Observations	37	37	37	37	37

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Regressions of Quarterly Housing Returns on Stock Return and Interest Rate Change

	Tier-1 Return	Tier-1 Return	Tier-2 Return	Tier-2 Return	Tier-3 Return	Tier-3 Return
L.Stock Return	0.0787** (0.0310)	0.0618 (0.0372)	0.00860 (0.0317)	0.0149 (0.0318)	0.0138 (0.0214)	0.0205 (0.0159)
L2.Stock Return	0.0833* (0.0451)	0.0615 (0.0443)	0.0326 (0.0285)	0.0451 (0.0377)	0.0202 (0.0175)	0.0213 (0.0187)
L3.Stock Return	0.109** (0.0475)	0.0803* (0.0456)	0.0994** (0.0373)	0.0938** (0.0394)	0.0367* (0.0202)	0.0222 (0.0191)
L.Interest Rate Change	-3.597* (1.898)	-4.112* (2.039)	-1.094 (1.128)	-3.494* (1.908)	0.633 (0.666)	-1.606 (0.999)
L2.Interest Rate Change	-4.844** (2.006)	-3.981* (2.159)	-2.695* (1.420)	-3.538* (1.967)	-1.099 (0.886)	-1.178 (0.987)
L3.Interest Rate Change	-2.050 (1.578)	-1.709 (1.925)	-1.130 (1.016)	-1.435 (1.647)	-0.0318 (0.445)	0.572 (0.827)
L.Tier Return		0.381* (0.186)		0.366* (0.181)		0.903*** (0.193)
L2.Tier Return		-0.130 (0.205)		0.0919 (0.197)		-0.306 (0.226)
L3.Tier Return		0.0822 (0.177)		0.208 (0.191)		0.132 (0.156)
Constant	0.0420*** (0.00573)	0.0288*** (0.00955)	0.0347*** (0.00560)	0.0117 (0.00928)	0.0307*** (0.00339)	0.00793 (0.00630)
R^2	0.568	0.633	0.288	0.470	0.252	0.612
Observations	37	37	37	37	37	37

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Regression of Stock Returns on Housing Returns

	Quarterly Stock Return	Quarterly Stock Return	Quarterly Stock Return	Quarterly Stock Return
Housing Return (Previous Year, National Average)	-3.741*** (1.262)	-3.582** (1.474)		
Housing Return (Previous Year, Tier 1)		-2.554 (18.45)		-11.60 (16.66)
10-yr Interest Rate Change (Previous Year)			-1.304 (0.784)	-0.973 (0.748)
Constant	0.540** (0.220)	0.522* (0.261)	0.259 (0.174)	0.219 (0.177)
R^2	0.130	0.131	0.060	0.072
Observations	36	36	36	36

Standard errors in parentheses
 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$