Real Estate Boom and Misallocation of Capital in China*

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Abstract

This paper analyzes how real estate shocks affect corporate investment in China. In addition to the widely documented collateral channel, we also uncover two other channels: *the speculation channel*—rapidly rising commercial land prices induce manufacturing and service firms to buy more commercial land, which is unrelated to their core businesses, and to reduce other investments and innovation activities; and *the crowding out channel*—in response to rising land prices, banks grant more credit to land-holding firms, crowding out financing to non-land-holding firms. Through both channels, a 100-percentage-point increase in land price leads to 2.1-3.8 percentage points of TFP losses due to misallocation of capital.

Keywords: Land Prices, Collateral Channel, Speculation Channel, Crowding Out Channel, Misallocation of Capital

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It is widely acknowledged that the collapse of the real estate market in mid 2000s triggered the Great Recession in the U.S. and the bursting of the real estate bubble in the early 1990s was a primary culprit of the prolonged stagnation in Japan. Understanding the effects of real estate price fluctuations on firm and household behavior is thus important for understanding long run economic growth and business cycles (Liu, Wang and Zha, 2012). It also has important policy implications on how government should restrain real estate bubbles and intervene during the collapse of real estate markets.

The literature has documented ample evidence regarding an important collateral channel, through which rising real estate prices affect firm investment by mitigating financial constraints faced by firms. Gan (2007) shows that in Japan after the burst of its real estate bubble in the early 1990s, land-holding firms reduced investment more than non-land-holding firms. Chaney, Sraer and Thesmar (2012) find that in 1993-2007, the representative U.S. firm invested 6 cents in response to one-dollar increase in its land collateral.

Real estate price fluctuations may also affect allocation of capital and firm investment through two other channels. First, an increase in real estate prices may induce firms to speculate on future real estate price appreciation and pursue more real estate investments unrelated to their core businesses, which we call a "*speculation channel*."[1] Second, in response to an increase in real estate prices, banks may grant more credit to land-holding firms, crowding out credit to firms without land holdings, which we call a "*crowding out channel.*"[2] Through these channels, a real estate boom may have complex and nuanced effects on different firms—it can relax financial constraints of land-holding firms, induce them to speculate in real estate and to reduce other investments and innovation activities, and crowd out financing to non-land-holding firms.

In this paper, we use China's real estate market as a laboratory to systematically examine these channels for real estate shocks to affect firm investment. China provides a unique setting for this purpose due to several reasons. First, investment in the real estate sector has become a crucial part

[1] Miao and Wang (2014) argue that a bubble in one sector attracts more capital to be allocated to the sector, and crowds out investment in other sectors. Chen and Wen (2014) build a model to analyze how a self-fulfilling housing bubble can create severe resource misallocation to the housing sector.

[2] Bleck and Liu (2014) emphasize that banks allocate more credit to firms in the bubble sector and less to firms in other sectors. Chakraborty, Goldstein and MacKinlay (2014) provide evidence for a crowding out effect during the recent U.S. housing bubble—when U.S. banks made more mortgage lending, they decreased commercial lending.

of the Chinese economy, directly accounting for 14% of China's GDP in 2013 and further driving investments in a wide range of peripheral firms. Second, China has experienced rapid housing price appreciations, averaging nearly 400% across the country from 2003 to 2013 according to Fang et al. (2015). This dramatic real estate boom put the potential effects of real estate shocks under a magnifying lens. Third, there is also substantial heterogeneity in the real estate boom experienced by different cities, offering a rich cross-section for analyzing heterogeneous effects of the real estate boom. In particular, the "housing purchase restriction" policies adopted by 46 Chinese cities during the boom also provide a natural experiment to identify causal effects of real estate shocks.

By hand-collecting land transactions in 330 cities in China from 2000 to 2015 and by matching the land transaction data with publicly listed manufacturing and service firms, we examine the three aforementioned channels for real estate shocks to affect firm investment. Specifically, we analyze how land price fluctuations affected the investment of land-holding and non-land-holding firms. Each parcel of land in China is restricted by the local government to be used for exclusive purposes: industrial land designed for industrial and manufacturing facilities, commercial land for commercial and business facilities, and residential land for residential facilities. Due to the rapid demands for commercial and residential facilities during China's urbanization process, commercial land and residential land have experienced substantially more dramatic price appreciations than industrial land. Interestingly, while commercial land and residential land cannot be directly used for developing the core businesses of the publicly listed manufacturing and service firms in our sample, these firms have been actively engaged in acquiring commercial land and residential land—contributing to over 30% of their gross investments in our sample. We are particularly interested in examining how these firms invested in commercial land and residential land, which we pool together hereafter as commercial land, as opposed to industrial land in response to price fluctuations of commercial land and industrial land.

We uncover several interesting findings. First, increases in land value lead to a significant increase in gross investment of land-holding firms, which is consistent with the evidence for the collateral channel documented by Gan (2007) and Chaney, Sraer, and Thesmar (2012).

By decomposing firm investment into three components, investment unrelated to land, industrial land investment, and commercial land investment, we further show that an increase in land value leads non-real estate firms to invest more in each of these components and, in particular, an increase in the share of commercial land investment and a decrease in the share of non-land investment. More importantly, in response to price appreciations of commercial land in its headquarter city, a land-holding firm in our sample tends to increase commercial land investment and reduce non-land investment. Furthermore, commercial land price appreciations are also associated with lower new patents by land-holding firms, indicating reduced innovation activities in these firms. Taken together, these findings all lend support to the speculation channel, through which a real estate boom attracts land-holding firms to pursue speculative investment in the real estate sector rather than using their available financing to develop their core businesses.

We also provide evidence for the crowding out channel by using loan-level data. In response to real estate shocks, bank branches located in cities with larger appreciations of land prices and, in particular, larger commercial land price appreciations, granted more loans with collaterals, especially with real estate collaterals, and fewer loans without collaterals. In a subsample of firms without land holdings, we further find that these firms made less investments when their headquarter cities experienced larger land price increases. These findings suggest that while real estate booms boost investments of land-holding firms through the collateral channel, they may also crowd out investments of firms without land holdings.

The usual endogeneity argument of real estate shocks being potentially correlated with firms' investment opportunities is not a particular concern to our analysis of the speculation channel and the crowding out channel. This argument implies that in response to positive real estate shocks, land-holding firms increase non-land investments and innovation activities and that firms without land holdings also increase their investments. Our findings contrast these endogeneity implications and thus render this endogeneity argument less concerning.

Nevertheless, we also exploit a natural experiment using the housing purchase restriction policy adopted by 46 Chinese cities as an exogenous shock to control for other potential endogeneity concerns. Specifically, as a government effort, 46 cities adopted a policy of restricting housing purchases by households in 2010, which slowed down the housing price booms in these cities relative to other cities without adopting this policy. By using a difference-in-difference approach to compare the investments by firms in the cities adopting the restriction policy relative to firms in other cities, we confirm that firms that hold land in cities adopting the restriction policy had lower investment than those holding land in cities not affected by the policy. In particular, they had lower commercial land investment but larger non-land investment. In the meantime, firms without land holdings had larger investment in the treatment cities than those in the control group. These findings provide not only additional identification tests but also sharper evidence for the speculation and crowding out channels.

Comparing firms with and without land holdings further reveals that land-holding firms are less financially constrained and are more likely to be state-owned enterprises (SOEs). More importantly, landholding firms tend to be more inefficient than firms without land holdings. The existing literature has also documented consistent evidence that SOEs in China, although less financially constrained, are more inefficient than the financially-constrained non-SOEs (Hsieh and Klenow, 2009; Liu and Siu, 2011; Dollar and Wei, 2014). Combining these observations with our findings above yields interesting implications for understanding the consequences of the speculation and crowding out channels of real estate shocks in China. First, rising land prices during the recent real estate boom tend to enlarge the gaps in financial constraints faced by firms with and without land holdings, especially between SOEs and non-SOEs. Consequently, the real estate boom leads to more severe misallocation of capital by worsening the constraints of those financially constrained firms, mostly non-SOEs which tend to be more efficient. Second, even for land-holding firms, which are more likely inefficient SOEs, rising land prices induce them to take more real estate investments unrelated to their core businesses. This speculative behavior feeds back to the real estate boom and crowds out the firms' non-real estate investment. This effect introduces an additional source of inefficiency into the real estate boom.

Motivated by the above argument, we explore the impact of the real estate boom on capital misallocation in China. Following Hsieh and Klenow (2009), we measure capital misallocation by TFP losses. We show that 1% increase in average land prices leads to 0.05-0.08% of aggregate TFP losses due to the misallocation of capital, indicating that the overall distortion created by the real estate boom is substantial. In sum, while our analysis confirms the collateral channel for real estate shocks to stimulate firm investment, our findings of the speculation and crowding out channels highlight offsetting effects that a real estate boom may exacerbate inefficiency in the real economy and thus caution a common argument that real estate booms boost the economy by stimulating firm investment.

The paper is organized as follows. Section I introduces the institutional background of China's real estate market and presents summary statistics of some key variables. We describe the empirical hypotheses designed to analyze the three channels of real estate price shocks in Section II and present the empirical results in Section III. Section IV explores a quasi-policy experiment, and Section V analyzes the effect of real estate shocks on resource misallocation. Section VI concludes the paper.

I. Institutional Background and Data Summary

Even since the real estate market reform since 1990s, there has been an enormous real estate boom in China. The Chinese government's economic stimulus package of 4 trillion RMB in 2009 against the backdrop of the Global Financial Crisis further fueled the surge in real estate prices. See Fang et al. (2015) for a detailed coverage of this real estate boom. Our analysis focuses on investments of publicly listed firms during this housing boom, including their purchases of land across Chinese cities.

Land Transactions

With China's rapid economic development since the 1990s, Chinese cities gradually sprawled out beyond their original limits, and there was growing demand to "urbanize" more rural land for the city expansion. By constitution, all land in China belongs to the state. In 1998, the 15^{th} National Congress of the Communist Party of China passed a statutory bill granting local governments the *de jure* ownership over land in their geographical jurisdictions (Lin and Ho, 2005; Kung, Xu and Zhou, 2013). The related Land Management Law (1998) also authorizes local government to sell the usufruct right for up to 70 years over the land they own. The land transactions between local governments and private buyers constitute the primary land market. Those private buyers who obtain the usufruct right through a leasehold from local governments can also choose to sell the leasehold to a third party in the secondary land market. However, compared to the primary land market, the total size of the secondary land market only accounts for 3.75% in term of land payment from 2000 to 2015 Our study focuses on land purchases by publicly listed firms during this period in both primary and secondary land markets.

There are rigid zoning restrictions confining each parcel of urban land to specific usages.[3] There are three types of land acquired by firms in our sample: industrial land designated for industrial and manufacturing facilities, commercial land for commercial and business facilities, and residential land for residential facilities. The local government first assigns the usage category to each parcel of land in its annual land development plan, and then sells the leasehold written on the land to private parties.[4] It is difficult for the buyer to change the usage category after acquiring the land from the primary land market.[5] As a result, when a manufacturing firm acquires a parcel of either commercial or residential land, it cannot use the land for developing its core business and the purpose of acquiring the land is instead likely to be for speculation of future price appreciation. This consideration motivates us to examine purchases of commercial and residential land made by manufacturing firms separately from industrial land. Interestingly, as commercial and residential land experienced substantially greater price appreciations than industrial land, many manufacturing firms were heavily engaged in acquiring commercial and residential land.

Our land holding data come from the Ministry of Land and Resources, which keeps record of all land transactions in China. We first obtain a complete land transaction dataset covering all 1.65 million land transactions between 2000 and 2015 in China from the website of the Land Transaction Monitoring System by the Ministry (http://www.landchina.com/). This dataset contains detailed information on land buyers, land area, total payment, land usage, locations and transaction prices. We then match the land transactions by all publicly listed firms (including their

[3] The Chinese Land Management Law classifies urban land to non-development land and development land, with the latter being further divided into specific usages such as residential (R), administration and public services (A), commercial and business facilities (B), industrial and manufacturing (M), logistics and warehouse (W), road, street and transportation (S), municipal utilities (U), green space and square (G), and so on.

[4] According to the Land Management Law, the typical lease term is 70 years for residential usage, 40 years for commercial usage and 30 years for industrial usage. The leasehold sales can take the form of open auctions or case-by-case negotiation. To restrain corruption in the primary land market, in 2002 the Ministry of Land and Resource issued the No. 11 regulation "Regulation on the Transaction Method of Leasehold Sale of Land by Local Government", which requires leasehold sales for commercial and residential development should use open auctions. Many believe the mandatory open auctions of commercial and residential land further fueled the skyrocketing increase of the land price (Cai et al., 2009).

[5] According to the Land Administration Law published in 1998, to change the use category requires permission from both the local government and the Bureau of Real Estate Administration in the central government.

subsidiaries) in this period. In total, we find 38,213 land transactions by 2,174 listed firms across China in our sample. The total area of land involved in these transactions is 2,054,506,896 square meters, and the total payment is 2341.2 billion RMB (which is equal to 366.6 billion US dollars at an exchange rate of 6.387 RMB/dollar), accounting for 14.76% of the total payment for all land transactions by both listed and non-listed firms during this period.

Land Price Indices

To facilitate our analysis of land purchased by the firms in our sample, we construct a set of land price indices for 330 prefectural level cities in China. To specifically examine the purchases of commercial and residential land by manufacturing firms, we pool these two types of land together and, with the risk of confusing the terms, simply call them commercial land hereafter throughout the paper. We construct three sets of price indices, an overall land price index covering industrial, commercial, and residential land, an industrial land index covering just industrial land, and a commercial land index covering both commercial and residential land.

Following Deng, Gyourko and Wu (2012) and Fang et al. (2015), we adopt the hedonic price regression approach to generate a set of quality-free land price indices for each of the cities by running the following regression on the sample of all land transactions of type *k* (overall, commercial, or industrial) in the city:

$$lnP_{i,k,c,t} = \beta_{k,c,0} + \sum_{s=1}^{T} \beta_{k,c,s} \cdot 1_{s=t} + \theta_{k,c} X_i + \varepsilon_{i,t},$$

where $lnP_{i,k,c,t}$ is the price of land parcel *i* in the sample of type-*k* transactions in year *t* in city *c*, $\beta_{k,c,t}$ is the time dummy for year *t* capturing the quality-free land price appreciation during the year, the vector X_i is a set of land parcel characteristics to control for the parcel level heterogeneity, including 1) the shortest distance to the city center (identified by the brightest 1% grids as showed in the annual average nighttime light density data) [6]; 2) county/district dummy (6-digit administrative unit); 3) the size of the land parcel; 4) subcategories of land usage (54 types); 5) the

[6] The grid-level nighttime luminosity data are obtained from the Global DMSP-OLS Nighttime Lights provided by the Earth Observation Groups in the National Centers for Environmental Information.

method of transaction (an indicator for transaction through invited bidding, listing bidding, English auction, or bilateral agreement); and 6) a subjective evaluation of land quality (11 ranks)[7]. The base year (*t=0*) for each city is the year when the first land parcel was sold in that city. Thus, the price index $LandPriceIndex_{k,c,t}$ for the *k*-th type of land in year *t* in city *c* is simple given by:

$$LandPriceIndex_{k,c,t} = \begin{cases} 1 & if\ t = 0 \\ \exp(\beta_{k,c,t}) & if\ t = 1,2,\ldots \end{cases}$$

To minimize the influence of outliners, before running the regressions, we delete land parcel transaction observations that are above 90th or below 10th percentile for each city year, based on the per unit land price. To further remove the outlier in the indices, after obtaining the land price index from the regressions, we further set the index value to be missing if it grows more than 5 times or drops more than 5 times from previous year.[8] In the end, we fill all the missing values using linear interpolation method.

Figure 1 depicts the fluctuations of land prices over time. The red line represents the price index for commercial land from 2000 to 2015 by taking average across the 330 cities in our sample, and the blue line the price index for industrial land. The figure shows that commercial land has experienced a dramatic price appreciation from a level of 1 in 2000 to over 10 in 2015, while industrial land has a much more modest appreciation from 1 to about 3.7 over the same period. As we mentioned earlier, the substantial greater price appreciation of commercial land is also a key reason that motivates us to separately examine the purchases of commercial land by manufacturing firms, instead of simply pooling together all land acquired by the firms.

Figure 2 depicts the three land price indices, together with the land price index provided by Deng et al. (2012), for 12 major cities. As is shown in the figure, our commercial land price index is largely consistent with that constructed by Deng et al. (2012). It is also noteworthy that there is substantial heterogeneity in the land price growth across these cities during our sample period.

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[7] The quality score of each land parcel is rated by the official in charge before the transaction based on the surrounding infrastructure, e.g. whether the land parcel is located in area with supply of water, electricity, and road etc.

[8] If $LandPriceIndex_t/LandPriceIndex_{t-1}$ is larger than 5 or smaller than 1/5, then $LandPriceIndex_t$ will be set to be missing.

Land Values

To quantify the effect of the real estate boom on firm investment, it is useful to measure the value of each firm's land holdings over time. Rather than assuming that a firm's land holdings are all in its headquarter city (as in Chaney, Sraer, and Thesmar, 2012), we take advantage of our detailed information of each land parcel held by the firm in different cities and the constant-quality land price indices in the respective cities to directly measure the value of the firm's land holdings.[9] Specifically, we compute the value of landing holdings by firm i in year t, $LandValue_{i,t}$, by

$$LandValue_{i,t} = \sum_j \sum_k \sum_{h=1}^{t-1} LandPayment_{i,j,k,h} \times \frac{LandPriceIndex_{j,k,t}}{LandPriceIndex_{j,k,h}},$$

where $LandPayment_{i,j,k,h}$ is the payment firm i made to acquire a land parcel of type k (commercial or industrial) in city j in year h, which was kept till year t; $LandPriceIndex_{i,k,h}$ and $LandPriceIndex_{i,k,t}$ are the price indices of type k land in city j at years h and t, respectively. Year 1 represents the initial year in our sample. In this expression, we estimate the year-t market value of each land parcel by using the corresponding land price index to adjust its initial purchase value for any price change.[10]

Firm Investment

We focus on publicly listed firms and obtain the financial information of each publicly listed firm from the China Stock Market & Accounting Research Database (CSMAR), which is maintained by GTA Information Technology. Following the literature, we exclude firms in real estate, mining, construction and financial sectors to have a sample of manufacturing and service firms[11]. We use annual data in our analysis, and the annual sample has 30,344 firm-year observations from 2000 to 2015, representing 3,112 unique firms.

[9] Our data show that a significant fraction of the Chinese firms' land holdings are in non-headquarter locations (about 77% in term of areas or 74% in term of initial cost). Given the substantial land price heterogeneity across cities, it is important to account for the location of a firm's land holdings.

[10] As we assume that firms' land holdings before year 1 were zero, our analysis under-estimates their actual land holdings.

[11] The industry classification of a firm is defined based on its core business which is provided by China Securities Regulatory Commission (CSRC).

We scale a firm's investment by its lagged net fixed assets. We further classify the gross investment into three categories: 1) non-land investment, which refers to investment not directly related to land acquisitions, 2) commercial land investment, i.e., the expenditures on buying new commercial land, and 3) industrial land investment, namely the expenditures on buying new industrial land. Investments of the second and third types are directly obtained from our land transaction data, while the first type is measured as the difference between firm's gross investment and the sum of the commerial and industrial land investments. We delete observations when the gross investment is smaller than the land investment.

Innovation Activities

We measure a firm's innovation activities by its number of new patents. Specifically, there are three types of patents: invention patents, utility model patents, and design patents. Our measure uses the sum of a firm's patents in the first two types as the measure of the firm's innovation activities, because the literature has argued that design patents involve limited technological advancements and should not be considered as genuine innovations (e.g. Tan et al., 2016). Our results remain robust if we use all three types of patents.[12] The data for new patents are obtained from Patent Reference Database (1985-2015), which are released by the State Intellectual Property Office. The Patent Reference Database records every patent application submitted to the SIP Office between 1985 and 2015. We then match the firm data with the patent data using a firm's full name, including the names of its subsidiaries. We measure a firm's innovation activities by the number of successful new patent applications (i.e., applications that are eventually granted) submitted by the firm in a given year. In total, we have 57,234 patents granted to 1,330 listed firms in our sample from 2000 to 2015.

Summary Statistics

[12] We do not use R&D expenditure as a measure of innovation activities because the literature has pointed out a number of issues with R&D expenditure. First of all, it captures only one particular input of innovation, thus missing other unobservable inputs (Aghion, VanReenen, and Zingales, 2013). Also, it is sensitive to accounting norm regarding whether it should be capitalized or expensed (Acharyaand and Subramanian, 2009). Besides, the information disclosed on R&D may be inaccurate. As a result, using patent applications instead of R&D expenditure to measure innovation activities has become standard in the literature (e.g., Aghion et al., 2005; Nanda and Rhodes-Kropf, 2012; Seru, 2011; He and Tian 2013).

We provide variable definitions in Appendix A and report the summary statistic of the main variables in Table 1. Panel A covers all publicly listed firms with 23,828 firm-year observations in our sample. About 64.57 percent (1,784 out of 2,763) of the publicly listed firms have purchased at least one land parcel in the sample period.[13] The average firm investment in a year is 448.5 million RMB, with land investment accounting for about 27 percent of firm's investment (1-0.733). Land value accounts for around 25 percent of a firm's fixed asset. As we assume firms' initial land holding at year 2000 to be zero, this number is a lower bound. Commercial land is the major part of the land held by these firms, accounting for 75 percent of the total land value. Over the sample period, the annual land price has an average of 30.7 percent with substantial variations—it rises by 86.1 percent at 90^{th} percentile but drops by 10.7 percent at 10^{th} percentile. The price change is right skewed with the median being substantially lower than the mean at around 18 percent. Note that this is not the raw land price, but rather the land price index constructed by taking out other factors. This land price variation reflects both the time series and cross-sectional changes of land prices in the sample. The firms' investment scaled by their lagged net fixed asset has an average value of 0.549. The Tobin's Q is on average around 2, and the total asset is around 6.7 billion yuan.

Panel B of Table 1 provides summary statistic on firms with at least one piece of land, while Panel C on the firms without any land during our sample period. By design, these land-holding firms have higher land value and make more land investment. Also, the data show that these land-holding firms are relatively larger in terms of asset and sales, has slightly lower Tobin's Q, but higher cash flow.

Figure 3 plots the average investment size by the firms in our sample for each year between 2000 and 2015, and further divide the investment into three types: non-land investment, commercial land investment, and industrial land investment. The average size of firm investment experienced a rapid increase from a level around 122 million RMB in 2000 to a level slightly above 818 million RMB in 2010, and then flattened out at this level after 2010. Interestingly, while there was almost no land investment before 2006, commercial land investment grew substantially to a level around 269 to 368 million RMB in 2010-2015, contributing to more than 33 to 46% of total

[13] The majority of our sampled firms purchased land after 2006. If we define the land ownership at the firm-year level, the percentage of land holding is 20%.

investment. In contrast, while industrial land investment also grew during this period, it remained minimal with an annual share less than 3%. The substantial quantity of commercial land investment by these manufacturing and service firms is the key focus of our analysis.

II. Empirical Hypotheses

In this section, we introduce a series of empirical hypotheses organized to examine three distinct channels for real estate shocks to affect firm investment. First, the existing literature has documented strong evidence for the *collateral channel* of real estate shocks: an increase in land value will increase the collateral value of real estate assets and thus enhance the debt capacity of land-holding firms. Gan (2007) finds that the burst of the real estate bubble in Japan in the early 1990s adversely affects the debt capacity and investment of land-holding firms more than that of non-land-holding firms. Chaney, Sraer, and Thesmar (2012) show that a $1 increase in land collateral value allows U.S. firms to raise investment by $0.06 during the housing boom from 1993 to 2007. Motivated by these studies, we expect real estate shocks to have a similar effect on Chinese firms, as stated in the following hypothesis.

Hypothesis 1 (the Collateral Channel): Greater land values allow land-holding firms to borrow more and invest more.

Real estate shocks not only allow land-holding firms to increase their investment through the collateral channel, but may also induce firms with financing (such as land-holding firms) to speculate in real estate. That is, firms may increase investment in the real estate sector even when their core businesses are not related to real estate, aiming to gain from future real estate price appreciations. We call this channel the *speculation channel*. [14]

As well appreciated by the literature, it is difficult to identify a housing bubble. This is because a housing boom may reflect either rational learning of agents and firms regarding future real estate fundamentals in presence of realistic uncertainty, e.g., Pastor and Veronesi (2003, 2006), or their behavioral biases in over-extrapolating past price increases into the future, e.g., Case and Shiller

[14] The macro literature has also developed theoretical models to show that a bubble in the real estate sector may attract more capital to be allocated to the sector, e.g., Miao and Wang (2014), Chen and Wen (2014).

(2003), Gennaioli, Shleifer and Vishny (2015), Barberis, Greenwood, Jin and Shleifer (2016). It is even more challenging to determine whether the housing boom in China is a bubble, as the boom is still ongoing, even though many commentators believe the recent housing price appreciations are not supported by economic fundamentals.

The objective of our analysis is neither to identify whether there is a housing bubble in China nor to examine the financial returns from investing in the housing boom. Instead, we are primarily interested in analyzing whether real estate shocks induce Chinese firms to make more or less efficient investments. Anchored on this objective, we examine not only the total investment made by land-holding firms in response to a positive real estate shock, but more importantly specific types of investment taken by them. In particular, we examine whether firms take more investments to further develop their core businesses, or buy more land, and if they buy more land, whether they buy more industrial land or commercial land (which cannot be used for manufacturing facilities). While an individual firm may choose to transform its business models over time for idiosyncratic reasons, one would not expect manufacturing and service firms to systematically increase real estate investments in response to real estate shocks except for speculation over future price appreciations.

To make this effect as clear as possible, we also examine whether firms expand or reduce their innovation activities in response to positive real estate shocks. Note that the literature has argued that when corporate managers are myopic, a real estate bubble may lure firms to direct more resources away from innovation activities into the real estate sector (Aghion et al., 2013; Kaplan and Minton, 2006; Stein, 1989, 2003). While our study does not aim to identify whether the housing boom in China is a bubble, any evidence of the real estate boom inducing firms to reduce innovation activities would also indirectly reflect the firms' increased investments in real estate speculation. Taken together, we summarize the speculation channel in the following hypothesis.

Hypothesis 2 (the Speculation Channel): A positive real estate shock not only gives land-holding firms more financing but may also induce them to pursue more housing speculation and reduce innovation activities.

Given the limited supply of capital in the economy, the increased financing made available to land-holding firms after a positive real estate shock implies a reduction in the financing available to non-land-holding firms. We call this channel for real estate shocks to affect the financing and investments of non-land-holding firms the *crowding out channel*. Through this channel, we expect that a positive real estate shock to adversely affect the investment of non-land-holding firms across the board, including land and non-land investments and innovation activities, as stated below.

Hypothesis 3 (the Crowding Out Channel): A positive real estate shock makes less financing available to non-land-holding firms and thus causes them to reduce investments across the board.

In what follows, we exploit China's housing boom in the past decade to examine these three distinct channels for real estate shocks to affect firm investment. It shall be clear that these channels are also relevant for firm investment in other countries.

III. Empirical Results

This section reports empirical findings on how real estate shocks affect firm investment through the three economic channels highlighted by Hypotheses 1-3.

A. The Collateral Channel

We first examine the collateral channel, as hypothesized in Hypothesis 1. Following Chaney, Sraer, and Thesmar (2012), we use the following regression specification to examine how real estate shocks affect firms' gross investment:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha + \beta \cdot \frac{LandValue_{i,t-1}}{K_{i,t-1}} + \theta X_{it} + \varepsilon_i + \delta_t + \epsilon_{it} \quad (1)$$

The dependent variable $\frac{I_{i,t}}{K_{i,t-1}}$ measures firms' gross investment in year t normalized by its total fixed asset in year $t-1$. The key explanatory variable $\frac{LandValue_{i,t-1}}{K_{i,t-1}}$ is the firm's total land value in year $t-1$ normalized by its total fixed asset in year $t-1$. The coefficient β measures the effect of an increase in the firm's land value on its gross investment. The control variables X_{it} including Tobin's Q, end-of-year cash flow normalized by lagged fixed asset, total sale (logged), and total firm asset (logged). We also include firm fixed effect ε_i and year fixed effect δ_t. The standard errors are clustered at the firm level.

Table 2 Panel A columns (1) to (3) report the regressions results. Specifically, column (1) uses firms' total land value (lagged) as an explanatory variable. Similar to Chaney, Sraer and Thesmar (2012), we find a significant positive effect of land value on gross investment. This effect is not only statistically significant at 1 percent level, but also economically large. The estimated coefficient of total land value shows that if the land value increases by ￥1, the gross investment increases by ￥0.12. [15] This estimate is larger than the collateral effect in the U.S. data estimated by Chaney, Sraer and Thesmar (2012), who find that a $1 increase in land collateral value raises corporate investment by $0.06.

Columns (2) and (3) separately examine the effects of firms' commercial land value and industrial land value on their gross investment. It is perhaps not surprising that only commercial land has a positive and significant impact on firms' gross investment, as the price appreciations of commercial land were substantially more dramatic than that of industrial land in our sample period. The estimated coefficient of the commercial land value is close to that of the total land value at around 0.09, while the industrial land value by itself has an insignificant impact. Overall, Table 2 provides evidence in support of the collateral channel—land-holding firms substantially increase their gross investment in response to increases in the values of their land holdings, consistent with Hypothesis 1, and this effect stems primarily from the values of their commercial land holdings.

To address the potential endogeneity problem between land prices and firms' investment opportunities, Chaney, Sraer and Thesmar (2012) adopt a land supply elasticity variable as an instrument variable. We have also followed their procedure to implement an IV test. The IV estimates yield qualitatively and quantitatively similar results as the OLS estimates, confirming that firms' land holdings have a significantly positive effect on corporate investment, and this effect is mainly driven by commercial land holdings. To save space, we do not report the results from this IV estimation.

B. The Speculation Channel

[15] A recent study by Deng, Gyourko, and Wu (2014) finds no such results. In contrast to their sample of 35 large cities, our data cover 330 cities. Furthermore, they do not differentiate residential land from commercial land, which experienced substantially different price fluctuations during our sample period.

We now examine the speculation channel, as posited by Hypothesis 2, by investigating what type of investment land-holding firms increase in response to an increase in their land values and whether these firms' investments of different types interact with local land price changes. Specifically, we adopt the following regression specification:

$$Y_{i,t} = \alpha + \beta \cdot \frac{LandValue_{i,t-1}}{K_{i,t-1}} + \gamma \cdot \Delta LandPriceIndex_{i,t-1} + \eta \cdot \frac{LandValue_{i,t-1}}{K_{i,t-1}} \cdot \Delta LandPriceIndex_{i,t-1} + \theta X_{it} + \varepsilon_i + \delta_t + \epsilon_{it} \quad (2)$$

where $Y_{i,t}$ measures firm i's investment in year t in each of the three types (non-land, commercial land, or industrial land investment), scaled by either the previous year fixed asset (K_{it-1}) or by the contemporaneous gross investment (I_{it}).

According to Hypothesis 2, land-holding firms may react to a positive real estate shock by using their improved financing capacity to acquire more land, rather than in further developing their core businesses. Note that the explanatory variable $\frac{LandValue_{i,t-1}}{K_{i,t-1}}$ captures not only the collateral effect highlighted in hypothesis 1 but also the speculation effect as a larger land collateral value gives the firm greater capacity to engage in land speculation. To help isolate the speculation effect, we also include an additional variable $\Delta LandPriceIndex_{i,t-1}$, which measures the land price appreciation in the headquarter city of firm i in the previous year and thus directly captures the real estate shock that induces the firm to engage in speculation of further land price appreciation.[16] In our analysis, we examine shocks to different land price indices: the overall land price index, commercial land index, and industrial land index. We are particularly interested in the interaction term of the land price shock and the firm's land value, $\frac{LandValue_{i,t-1}}{K_{i,t-1}} \cdot \Delta LandPriceIndex_{i,t-1}$. As a firm can engage in further land speculation only when it has financing, Hypothesis 2 posits that the coefficient of this interaction term should be positive for land investment.

We also include the same control variables as in regression (1), including Tobin's Q, end-of-year cash flow normalized by lagged fixed asset, total sale (logged), and total firm asset (logged).

[16] One may ask whether price appreciation in the previous one year is the most relevant price shock. We also examine past price appreciation in different time horizons such as two years and three years ***

We also include firm fixed effect ε_i and year fixed effect δ_t. The standard errors are clustered at the firm level.

Table 3 reports the regression results when the dependent variables are the three components of firm investment scaled by the fixed asset, while Table 4 reports the results when investment share of each type is used as the dependent variable. Table 3 shows that land value increases cause land-holding firms to increase all three types of investment, consistent with the collateral effect. The magnitude of β is much larger for non-land investment. This result is, at least in part, due to the fact that non-land investment accounts for a major fraction of firm investment, especially in the earlier years of our sample, as shown in Figure 3.

To address this issue, Table 4 uses the share of each type of investment as the dependent variable. It shows that 1 standard deviation increase of land value over K is associated with 12% decrease in non-land investment share, around 8% increase in commercial land investment proportion, and 1% increase in industrial land investment share.[17] The significant increase for land investment and the significant decrease for non-land investment are consistent with the speculation hypothesis in that a land-holding firm shifts a substantial fraction of its investment from its core business to unrelated commercial land investment.

Furthermore, Tables 3 and 4 show that the interaction term of land value and land price change is significantly negative for non-land investment, significantly positive for commercial land investment, and insignificant for industrial land investment. These results again support the speculation channel: when land price appreciates, the increased investment generated through collateral channel goes mainly to commercial land investment, neither to industrial land investment nor to non-land investment. Panels B and C of Table 3 and 4 further shows that the aforementioned results are mainly driven by appreciations of commercial land price.

Overall, Table 3 and 4 find supporting evidence for the speculation channel—in response to an increase in commercial land price, land-holding firms increase investment in commercial land and reduce non-land investment. Given the dramatic price appreciations for commercial land

[17] There three coefficients do not add up to 1 because each regression is estimated separately with other control variables.

across China in our sample period, this investment strategy has been highly profitable in terms of financial returns. However, as these firms are all in the manufacturing and service industries, pursuing this strategy is speculative and hinders their core businesses.

To further explore the speculation channel, we also examine how real estate shocks affect land-holding firms' innovation activities. Specifically, we use natural logarithm of one plus the number of successful new patent applications as proxy for a firm's innovation activities. The specification is the same as used in Table 3, except that the dependent variable is now the innovation proxy. The results show that land value increase reduces firms' new patent applications. A one standard deviation increase of land value is associated with about 4%-5% decrease in new patent applications.[18] More importantly, this effect is much stronger when commercial land price appreciates in the firm's headquarter city. This finding suggests that in response to a positive real estate shock, land-holding firms cut down rather than elevate their innovation activities.

Taken together, Tables 3 and 4 supports the speculation channel—in response to an increase in land price, especially an increase in commercial land price, land-holding firms switch investments from their core businesses and innovation activities to speculative commercial land investment. It is useful to note that the usual endogeneity argument of real estate shocks being potentially correlated with firms' investment opportunities cannot explain our findings of land-holding firms increasing the share of commercial land investment at the expense of reduced share of non-land investment and reduced innovation activities. This argument implies that these firms should at least maintain the share of investment to develop their core businesses even if they choose to pursue more land investments.

C. The Crowding Out Channel

We now explore the impact of real estate shocks on non-land-holding firms by examining Hypothesis 3. We first investigate how banks allocate credit when land prices rise. If banks tilt their lending toward borrowers with land collaterals, they may cut down other types of loans. This behavior by banks in response to a real estate boom naturally leads to a crowding out effect against

[18] This finding is also consistent with Shi et al., (2016), who find that the average real estate prices in the headquarter cities negatively affect both R&D expenditure and patents output of publicly listed firms in China.

non-land-holding firms. To examine this crowding out effect, we collect a loan level dataset for the publicly listed firms in our sample from the firms' public announcements. The data is obtained from RESSET and CSMAR. It covers 81,872 loans made by the 2,862 Chinese publicly listed firms from 2000 to 2015. For each bank loan, we collect information on collateral and bank branch of the lender.

We adopt the following specification for the test:

$$Collateral_{i,b,t} = \zeta + \lambda * \Delta LandPriceIndex_{b,c,t} + \theta X_{i,t} + \mu_{ib} + \iota_{bt} + \tau_{bc} + \pi_{i,b,c,t} \qquad (3)$$

The dependent variable is the collateral characteristics for loan i lent by bank branch b in year t. The key explanatory variable is the land price change in year t for the city where the bank branch b is located. All regressions have controlled for a set of firm-level variables X_{it} including Tobin's Q, firm's end-of-year cash flow normalized by lagged fixed asset, total sale (logged), total firm asset (logged) as well as firm fixed effect interacted with bank branch fixed effect μ_{ib}, bank branch city fixed effects ι_{bt} and bank branch fixed effect interacted with year fixed effect τ_{bc}.

Table 5 reports the loan level results. The dependent variable in column (1) is a dummy variable which equals to one if loan i has real estate collateral and zero if otherwise. The result in Panel A indicates that a rise in land prices in the bank branch city leads to an increase in the probability of lending with real estate collaterals. In column (2), we further test whether the land price increase also affects the lending decision regarding whether the loan has non-real-estate collateral. Similarly, the rising land price also increases the probability of lending with non-real-estate collateral, to a smaller degree. In contrast, the rising land price in a city decreases the probability for the bank branch located in the city to grant loans without collateralized assets, as shown in column (3). Column (4) tries an alternative specification with a categorical dependent variable, which takes value of zero if the loan goes without collaterals, one if the loan has non-real estate collateral, and two if it has real estate collateral. The regression result is consistent with the findings reported in columns (1)-(3): an increase of land price in a bank branch city raises the likelihood of loans with real estate collaterals and reduces that of loans without collaterals. This table clearly shows that when a city experiences land price appreciation, bank lending will significantly favor firms with real estate collaterals, crowding out loans available for non-land-holding firms.

Panels B and C of Table 5 replace the land price index in the bank branch city with commercial or industrial land price indices, respectively. The crowding out effect of commercial land price is similar to that of the overall land price while the effect is marginal for industrial land price. Overall, the loan-level results provide evidence for the crowding-out channel of real estate shocks (in particular commercial land price shocks) from the perspective of bank lending.

We next return to the firm side to examine how real estate shocks affect investment and innovation activities of non-land-holding firms. We focus on a sample of non-land holding firms. Specifically, we conduct a within-group comparison of gross investment and new patent applications by non-land-holding firms located in cities with fast land price growth and low land price growth, by using the following regression specification:

$$Y_{it} = \alpha + \beta * \Delta LandPriceIndex_{i,c,t-1} + \theta X_{it} + \varepsilon_i + \delta_t + \epsilon_{it} \qquad (4)$$

The dependent variables are the gross investment normalized by the lagged fixed asset and new patent applications respectively. The key explanatory variable is the land price growth for the city where the firm's headquarter is located. The control variables are the same as before.

Table 6 reports the results on the effects when average land price, commercial land prices and industrial land prices are used respectively. The results show that an increase of average land price in the headquarter city significantly decreases both gross investment and new patent applications. In terms of magnitude, when the growth rate of land price increases by one standard deviation, the firms located in that city reduced its investment by about 0.12 (0.565*0.211), which is about 30% of increase comparing to the mean of the non-land investment (0.12/0.41). Also, one standard deviation increase of the growth rate of land price in the headquarter city relates to around 20% (0.565*0.357) decrease of new patent applications. Columns (3) to (6) show that the both commercial land price and industry land price raise have important effect with commercial land has much larger impacts.

Taken together, Tables 5 and 6 provide evidence that real estate shocks adversely affect non-land-holding firms by making it more difficult for these firms to get bank loans and thus to invest and carry out innovation activities.

IV. A Quasi-Policy Experiment

Throughout our sample period, the Chinese real estate markets were under a boom cycle. One may argue that the aformentioned evidence on the collateral, sepeculation, and crowding out channels is simply driven by a steady increase of land prices over the sample period and it is hard to tell whether a burst of real estate boom will have symmetrical effects on firm investment through these channels. Fortunately, a nationwide policy experiment on restricting housing purchases in a list of cities after 2010 provides a unique opportunity to examine the effects of real estate shocks when the policy experiment caused these cities to suffer substantial land price declines relative to other cities.

The rapid and persistent increases in housing prices across China since 2000, especially in the first- and second-tier cities, prompted the central government to adopt tough measures in 2010 to cool down the soaring housing markets. Under such conditions, the State Council issued "No. 10 Paper of the State Council" on April 17, 2010, urging local governments to take actions to "resolutely curb the soaring housing prices, and effectively solve the housing problems of urban residents".

Following the guidance from the State Council, the city government of Beijing issued a rule on April 30, 2010, which restricts each household to purchase only one additional property in the city, and became the first city to adopt the "housing purchase restriction policy". It was soon followed by more local governments. Up to the end of 2011, 46 cities adopted this property purchase restriction policy. In year 2014 and 2015, most of the 46 cities (with the exception of the four first-tier cities Beijing, Shanghai, Guangzhou, and Shenzhen) abolished the purchase restriction policy. Appendix A shows the list of these cities and their announcement date and abolishing date of the purchase restriction policy.

This restriction policy created a negative demand shock to the real estate sector in the affected cities. As the restriction policy only imposed constraints on the housing demand of households, it did not directly affect manufacturing and service firms and thus can serve as an exogenous real estate shock to study how the shock may affect firm investment. There are several potential concerns about this shock. First, as the purchase restriction was gradually adopted across the 46 cities, its adoption by an individual city might be anticipated by the public before the announcement. Second, the public might expect the purchase restriction to be eventually reversed by the government when the housing boom slows down (as indeed happened later for most of the cities). If either of these concerns holds true, we would not observe a significant price drop after the announcement. This in turn would make it difficult to observe any subsequent effect on firm investment. We shall just resolve these concerns by first examining the land price change around the announcement of the purchase restriction policy.

We estimate the impact of the "purchase restriction policy" on the land price of the affected cities by analyzing land price changes around the policy announcements of the 46 cities relative to other cities. We consider in total 19 quarters around the announcement quarter. The regression is at city-quarter level, as specified below:

$$LandPriceIndex_{j,t} = \alpha + \sum_{\epsilon t} \beta_{\epsilon t} * Treated_j * EventTime_{j,t,\epsilon t} + \sum \lambda_j * t * City_j + \varepsilon_t + \gamma_j + \mu_{j,t} \quad (5)$$

$Treated_j$ is a dummy variable taking value of 1 if city j is one of the 46 cities affected by the policy. $EventTime_{j,t,\epsilon t}$ takes value 1 if calendar quarter t is event quarter ϵt, and 0 otherwise. The subscript ϵt represents event quarter, which takes values from -9 to 9, with 0 representing the quarter when the policy was announced. The regression controls for city fixed effects, time fixed effects and city specific time trend ($\sum \lambda_j \times t \times City_j$).

The results are reported in Figure 5. The bars in the figure shows the estimated value of the coefficients β over event time, while the dotted lines quantify the 95th confidence interval. For commercial land reported in Panel A, while the β estimates display a decreasing trend before the announcements, none of the pre-event β estimates are significantly different from 0, indicating that only modest price declines in the cities relative to other cities were caused by the real estate market's anticipation of the announcements. The difference becomes significantly negative in post-event quarters, indicating that the policy had negative impacts on commercial land prices in the 46 treated cities.

Given the purchase restriction policy only applied to residential homes, this demand shock only applied to commercial land used for real estate development but not to industrial land designated for industrial uses. Panel B shows exactly this pattern: unlike the price effect on commercial land, the average price of industrial land in the treated cities did not change after the announcement of the purchase restriction policy.

Since the purchase restriction policy indeed induced price drops in commercial land of the treated cities, we then adopt a difference-in-differences (DID hereafter) design to test whether the price decrease affected corporate investment. The regression is specified as follows:

$$Y_{i,t} = \alpha + \beta * Treated_i * PolicyPeriod_{i,t} + \sum_i \lambda_i * t + \varepsilon_i + \zeta_t + \varphi_{i,t} \quad (5)$$

This regression uses panel data at firm-year level, where $Y_{i,t}$ is an investment variable of firm i in year t, $Treated_i$ is a dummy variable taking value of 1 if firm i holds any land in at least one of the 46 treated cities and 0 otherwise. $PolicyPeriod_{it}$ takes value of 1 if city i is a treated city and year t is after the policy announcement and before its abolishing date, and 0 otherwise. The regression controls for firm fixed effects, year fixed effects and firm-specific time trends. All regressions also include Tobin's Q, cash flows, total sale revenues, and total assets of the firms. β captures the DID effects.

Table 7 reports the regression results. In implementing the DID estimation, we use three different control groups. In Panel A, the control group is all non-treated firms, which include all publicly listed firms owning land but not in the treated cities and firms owning no land at all. One concern about our DID test is that the purchase restriction policy may coincide with the change of investment opportunities in treated cities, thus affect firms' investment decisions. If that is the case, the effect identified from the above regression may not be due to the policy, but rather due to the change of investment opportunities. To address this concern, we use a second control group in Panel B, which includes all non-landholding firms with their headquarters in one of the 46 treated cities. This control group has similar investment opportunities as the treated firms, but they do not experience the negative shocks on land values as the treated firms do. Another concern about this method is that firms' decision of purchasing a land is not random. Thus, the land-holding firms may be fundamentally different from those firms without land. To address this concern, we construct a third control sample in Panel C: firms which own land but not in the treated cities.

Columns (1)-(3) use non-land investment, commercial land investment and industrial land investment as the dependent variable, respectively. Using different control groups yields very similar results across Panels A-C. The restriction policy has significant negative impacts on commercial land investment, and significantly positive impacts on non-land investment. The impact on industrial land investment is insignificant. To be more specific, comparing to unaffected firms, land-holding firms affected by the restriction policy increase their non-land investment by 0.26, which is more than 60% of increase when comparing to the mean of non-land investment in the whole sample (0.26/0.42). Their commercial land investment decreases by about 35% (0.049/0.14). These effects are both statistically and economically significant. Column (4) reports the results on innovation activities. The negative price shock causes the affected firms to significantly increase their new patent applications by 8%.

Table 7 and Table 3 together offer interesting implications. While the large price appreciations of commercial land observed in our sample period induced firms to shift from non-land investment to commercial land investment, the negative price shock induced by the purchase restriction policy caused firms to switch back from commercial land investment to non-land investment, which directly benefits the firms' core businesses. Furthermore, the large commercial land price appreciations reduced firms' innovation activities, while the negative price shock boosted firms' innovation activities. These results lend support to Hypotheses 2.

We next move to examine the effect of the restriction policy on firms without land. Previously we find that a positive shock in real estate price crowds out investments of no-land-holding firms. Hypothesis 3 posits that a negative price shock on real estate assets should trigger a reversal of the crowding-out effect by producing a favorable effect on investments and innovation activites of non-land-holding firms. The results reported in Table 8 exactly confirm this hypothesis. For non-land-holding firms, if their headquarter cities adopted the housing purchase restriction, they had significantly higher investments and new patents than other non-land-holding firms located in cities without adopting the purchase restriction (showed by columns (1) and (2)). The effect of the policy shock is robust after we control for the firm specific time trend in columns (3) and (4). The magnitude is also sizeable. The investment of the affected non-land-holding firms increased by about 0.22 during the restriction period, which represents more than 30% of the increase relative to the mean of the investment by non-land-holding firms (0.22/0.60). Compared to the control firms, the affected firms increased the successful new patent applications by around 16%.

In sum, a negative price shock in the real estate market has led to a reversal of both speculation and crowding outing effects. As a robustness check, in the DID tests, we also implement the test using a pre-2012 subsample, which is before any of the 46 cities abolished the restriction policy. The results remain similar, and are not reported here to save space.

V. The Real Estate Boom and Resource Misallocation

According to our previous analysis, the real estate boom prompted land-holding firms to speculate on commercial land and reduce innovation activities (the speculation channel) and crowded out financing and investment of firms without land (the crowding out channel). If the speculation and crowding out effects are sufficiently large and dominate the collateral effect, the real estate boom may lead to resource misallocation and thereby adversely affect the efficiency of the real economy. In this section, we examine the net effect of the real estate boom on the efficiency of resource allocation across the firms.

We first construct a measure of the efficiency of resource misallocation. Hsieh and Klenow (2009) propose a measure of TFP (total factor productivity) loss due to resource misallocation. In what follows, we simply follow their measure. The data needed to calculate the TFP loss include firm-level sales (revenues), capital, and labor. We use the firm-level industrial census data from 2000 to 2007, plus 2012 and national taxation statistics dataset 2008 to 2011 to calculate the aggregate TFP loss at the prefectural city level.[19]

To systematically examine whether there is a correlation between real estate boom and resource misallocation, we run the following regression:

$$TFPLoss_{p,t} = \alpha + \beta * LandPriceIndex_{p,t} + \sum_{p} \lambda_p * t + \varepsilon_p + \zeta_t + \varphi_{p,t} \qquad (6)$$

[19] We do not use the industrial census data from 2008 to 2011 due to the lack of industrial value added for these years.

The dependent variable is the TFP loss at city *p* in year *t*, and the key explanatory variable is the land price in the city. All regressions control for city-fixed effect, year fixed effect and city specific linear time trend.

Table 9 reports the results for the effect of land price on aggregate TFP loss. Columns (1)-(4) use a simple average of aggregate TFP losses over 47 manufacturing sectors in each city *p* at year *t*, while columns (5)-(8) use the weighted average (by industrial output). Columns (1) and (5) point to a significantly positive effect of land price on the aggregate resource misallocation. Columns (2) to (4) and (6) to (8) replace the overall land price index with the commercial or industrial land price index, which show both types of land price significantly increase aggregate TFP loss. However, when we add both types of land price into the regression, only the commercial land price index has a significant effect (columns (4) and (8)). The OLS estimates show that a 1% increase in the overall land price index leads to 2.1-3.8% of aggregate TFP loss due to resource misallocation, suggesting that the overall distortion due to the real estate boom is substantial (columns (1) and (5)).

VI. Conclusion

In this study, we investigate the consequences of real estate shocks on firm investment, using China's real estate market as a laboratory. In addition to confirm the well-known collateral effect of positive real estate shocks allowing firms with land holdings to investment more, we also uncover two other effects. Specifically, by decomposing firm investment into commercial land investment, industrial land investment, and non-land investment, we show that the real estate boom in China caused land-holding firms to make more real estate investment, especially to commercial land, and cut back non-land investment and innovation activities, revealing a speculation effect. Interestingly, we also observe a reversal of this effect when 46 cities adopted the housing purchase restriction policy and subsequently experienced land price drops relative to other cities.

By analyzing loan-level data, we also document a crowding out effect. Bank branches located in cities with greater land price appreciations granted more collateralized loans, especially loans with real estate collaterals, and fewer loans without collaterals. Consequently, non-land-holding firms in cities that experienced greater land price appreciations invested less. Interestingly, we also observe a reversal of this crowding out effect in the 46 cities when they adopted the purchase restriction policy.

Due to resource misallocation caused by the speculation and crowding out effects, we also find that across different cities, real estate shocks are positively correlated with inefficient resource allocation. Specifically, a 1% increase in the overall land price index in a city is associated with 2.1-3.8% of aggregate TFP loss of firms induced by resource misallocation in the city. Taken together, our findings caution the common view that real estate booms help to mitigate firms' financing constraints and thus boost the economy by stimulating firm investment.

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Table 1: Summary Statistics

Panel A presents summary statistics of the full sample of all publicly listed firms excluding firms operating in the finance, insurance, real estate, construction, and mining industries. The upper part of Panel A reports the summary statistics of firm variables, land values and land prices for the full sample of firms, while Panel B reports the corresponding variables for only land-holding firms (firms ever recorded as having purchased land).

Variables	Mean	Standard Deviation	Median	P10	P90
Panel A			**Full Sample (N= 23,828)**		
Corporate Investment (million *yuan*)	448.457	2199.174	94.419	7.88	775.468
Corporate Investment/Kt-1	0.549	0.958	0.237	0.034	1.272
Non Land Investment (million yuan)	309.403	1939.232	85.96	2.828	730.253
Non Land Investment/Kt-1	0.398	0.717	0.187	0.017	0.873
Non Land Investment Share	0.733	0.717	1	0.922	1
Land Investment ^{Commercial} (million yuan)	130.479	1439.599	0	0	201.707
Land Investment ^{Commercial}/Kt-1	0.140	0.616	0.000	0.000	0.195
Land Investment ^{Commercial} Share	0.232	0.713	0	0	0.817
Land Investment ^{Industrial} (million yuan)	8.575	130.396	0	0	20.061
Land Investment ^{Industrial}/Kt-1	0.010	0.102	0.000	0.000	0.000
Land Investment ^{Industrial} Share	0.035	0.146	0	0	0.057
Land Value (million yuan)	385.573	2745.848	0	0	480.529
Land Valuet/Kt-1	0.245	1.001	0	0	0.382
Price Change	0.307	0.565	0.185	-0.107	0.861
Price Change ^{Commercial}	0.319	0.59	0.203	-0.196	0.9
Price Change ^{Industrial}	0.185	0.427	0.106	-0.152	0.588
Tobin's Q	2.009	1.501	1.549	0.525	4.402
Cash Flow (million yuan)	872.337	3629.215	162.657	-184.91	1866.47
Sale (million yuan)	4566.694	15396.89	1190.628	226.55	8553.385
Total Asset (million yuan)	6658.421	21039.2	2152.897	637.408	11903.16
New Patent Applications	13.125	118.666	0	0	19
Panel B			**Sample of Land-holding Firms (N=18,723)**		

Corporate Investment (million *yuan*)	527.733	2484.62	113.265	11.275	910.649
Corporate Investment/Kt-1	0.576	0.984	0.256	0.041	1.338
Non Land Investment (million yuan)	345.248	2238.7	92.256	3.145	830.912
Non Land Investment/Kt-1	0.378	0.664	0.186	0.017	0.827
Non Land Investment Share	0.652	0.817	1	0.788	1
Land Investment ^{Commercial} (million yuan)	171.343	1648.257	0	0	32.108
Land Investment ^{Commercial}/Kt-1	0.184	0.700	0.000	0.000	0.368
Land Investment ^{Commercial} Share	0.304	0.416	0	0	0.834
Land Investment ^{Industrial} (million yuan)	11.142	149.348	0	0	3.759
Land Investment ^{Industrial}/Kt-1	0.014	0.117	0.000	0.000	0.0002
Land Investment ^{Industrial} Share	0.046	0.166	0	0	0.098
Land Value (million yuan)	506.742	3138.398	9.2	0	739.456
Land Valuet/Kt-1	0.322	1.137	0.008	0	0.546
Price Change	0.311	0.57	0.185	-0.11	0.872
Price Change ^{Commercial}	0.32	0.589	0.209	-0.2	0.906
Price Change ^{Industrial}	0.189	0.437	0.106	-0.169	0.617
Tobin's Q	1.898	1.44	1.458	0.499	4.076
Cash Flow (million yuan)	960.393	3846.062	180.185	-189.372	2112.015
Sale (million yuan)	5246.239	17217.04	1378.902	266.943	9996.409
Total Asset (million yuan)	7566.611	23001.42	2418.381	702.092	13789.48
New Patent Applications	15.762	135.584	0	0	21

Panel C	**Sample of Non-land-holding Firms (N=5,701)**				
Corporate Investment (million *yuan*)	203.928	761.297	52.192	3.53	380.941
Corporate Investment/Kt-1	0.463	0.867	0.187	0.018	1.059
Tobin's Q	2.318	1.621	1.822	0.646	5.257
Cash Flow (million yuan)	619.861	2886.226	125.549	-168.76	1284.226
Sale (million yuan)	2494.627	6818.037	808.015	156.673	4723.287
Total Asset (million yuan)	3894.131	12946.87	1552.947	517.889	6654.356
New Patent Applications	4.741	17.7	0	0	13

Table 2. The Effect of Land Value on Firm Gross Investment

This table investigates the effect of land value on firm investment from 2000 to 2015. The dependent variable is the gross firm investment (normalized by one-year lagged K, a firm's total asset). The key independent variables are a firm's total land value, commercial land value and industrial land value (all lagged one year and normalized by one-year lagged K). All specifications use fixed effects estimation include both year and firm fixed effects, and control for Tobin's Q, firm's end-of-year cash flow (normalized by lagged K) and total sale (normalized by lagged K) and total firm asset (logged) and cluster observation at firm level. Robust standard errors are in parentheses with * for p<0.10, ** for p<0.05, and *** for p<0.01; constant terms are not reported.

	Gross Investment		
	(1)	(2)	(3)
Land Value $_{t-1}$	0.120***		
	(0.019)		
Land Value $_{t-1}^{Commercial}$		0.094***	
		(0.021)	
Land Value $_{t-1}^{Industrial}$			0.073
			(0.056)
Tobin's Q	0.024***	0.026***	0.026***
	(0.007)	(0.007)	(0.007)
Sale	0.012**	0.012**	0.012**
	(0.005)	(0.005)	(0.005)
Cash Flow	0.016***	0.017***	0.018***
	(0.003)	(0.003)	(0.003)
Total Asset	0.095***	0.090***	0.091***
	(0.018)	(0.018)	(0.018)
Number of Obs.	24545	24545	24545
Adj. R-squared	0.321	0.312	0.308

Table 3. The Effects of Land Value on Different Types of Firm Investment and Innovation Activities

This table investigates the effects of land value on different types of firm investment and innovation activities from 2000 to 2015. The key independent variables are a firm's lagged land value and its interaction terms with the lagged overall land price change (Panel A), the lagged commercial land price change (Panel B), and the lagged industrial land price change (Panel C). We divide a firm's gross investment into three components: non-land investment, commercial land investment, and industrial land investment, and use annual (successful) new patent applications as a proxy for the firm's innovation activities. All specifications use fixed effects estimation including both year and firm fixed effects, and control for each firm's Tobin's Q, end-of-year cash flow, total sale, and total firm asset, and cluster observations at firm level. Robust standard errors are in parentheses with * for p<0.10, ** for p<0.05, and *** for p<0.01; constant terms and control variables are not reported.

	Non-Land Investment		Commercial Land Investment		Industrial Land Investment		New Patents	
Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Land Value $_{t-1}$	0.128***	0.142***	0.028***	0.021***	0.042***	0.043***	-0.047***	-0.048***
	(0.025)	(0.026)	(0.005)	(0.005)	(0.006)	(0.006)	(0.009)	(0.009)
Price Change$_{t-1}$	-0.037***	-0.023**	0.009**	-0.001	-0.001	0.000	0.000	0.000
	(0.011)	(0.011)	(0.004)	(0.003)	(0.002)	(0.001)	(0.011)	(0.012)
Land Value$_{t-1}$*Price Change$_{t-1}$		-0.054***		0.026***		-0.003		0.001
		(0.020)		(0.007)		(0.006)		(0.004)
Number of Obs.	23828	23828	23828	23828	23828	23828	23828	23828
Adj. R-squared	0.415	0.417	0.137	0.147	0.259	0.259	0.787	0.787
Panel B	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Land Value $_{t-1}$	0.137***	0.150***	0.029***	0.023***	0.040***	0.043***	-0.044***	-0.040***
	(0.026)	(0.027)	(0.005)	(0.005)	(0.006)	(0.007)	(0.009)	(0.009)
Price Change $_{t-1}^{Commercial}$	-0.046***	-0.034***	0.012***	0.005	0.003	0.001	0.018*	0.023**
	(0.012)	(0.012)	(0.004)	(0.003)	(0.002)	(0.001)	(0.011)	(0.012)
Land Value$_{t-1}$*Price Change$_{t-1}^{Com}$		-0.043**		0.019***		-0.008		-0.012***
		(0.018)		(0.005)		(0.005)		(0.004)

Number of Obs.	23828	23828	23828	23828	23828	23828	23828	23828
Adj. R-squared	0.422	0.424	0.140	0.146	0.269	0.272	0.788	0.788

Panel C	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Land Value $_{t-1}$	0.127***	0.118***	0.029***	0.028***	0.041***	0.041***	-0.039***	-0.039***
	(0.026)	(0.025)	(0.005)	(0.005)	(0.006)	(0.006)	(0.010)	(0.01)
Price Change $_{t-1}^{Industrial}$	0.031**	0.018	0.002	-0.001	0.000	-0.000	0.001	0.000
	(0.014)	(0.013)	(0.004)	(0.003)	(0.003)	(0.002)	(0.013)	(0.014)
Land Value $_{t-1}$*Price Change$_{t-1}^{Ind}$		0.071*		0.012		0.001		0.001
		(0.038)		(0.008)		(0.012)		(0.006)
Number of Obs.	23828	23828	23828	23828	23828	23828	23828	23828
Adj. R-squared	0.417	0.418	0.139	0.14	0.263	0.263	0.785	0.785

Table 4. The Effect of Land Value on the Shares of Different Types of Firm Investment

This table investigates the effects of land value on the shares of different types of firm investment from 2000 to 2015. The key independent variables are a firm's lagged land value and its interaction terms with the lagged overall land price change (Panel A), the lagged commercial land price change (Panel B), and the lagged industrial land price change (Panel C). We divide a firm's gross investment into three components: non-land investment, commercial land investment, and industrial land investment, and calculate the share of each component to the gross investment. All specifications use fixed effects estimation including both year and firm fixed effects, and control for each firm's Tobin's Q, end-of-year cash flow, total sale, and total firm asset, and cluster observations at firm level. Robust standard errors are in parentheses with * for $p<0.10$, ** for $p<0.05$, and *** for $p<0.01$; constant terms and control variables are not reported.

	Non-Land Investment Share		Commercial Land Investment Share		Industrial Land Investment Share	
Panel A	(1)	(2)	(3)	(4)	(5)	(6)
Land Value $_{t-1}$	-0.128***	-0.121***	0.077***	0.086***	0.010***	0.007**
	(0.023)	(0.023)	(0.012)	(0.022)	(0.003)	(0.003)
Price Change$_{t-1}$	-0.011	-0.002	0.003	0.003	0.001	-0.002
	(0.015)	(0.013)	(0.007)	(0.006)	(0.003)	(0.003)
Land Value$_{t-1}$*Price Change$_{t-1}$		-0.022**		0.022*		0.000
		(0.007)		(0.013)		(0.014)
Number of Obs.	23828	23828	23828	23828	23828	23828
Adj. R-squared	0.307	0.307	0.321	0.321	0.248	0.249
Panel B	(7)	(8)	(9)	(10)	(11)	(12)
Land Value $_{t-1}$	-0.138***	-0.113***	0.071***	0.077***	0.009**	0.006*
	(0.027)	(0.024)	(0.013)	(0.013)	(0.004)	(0.004)
Price Change $_{t-1}^{Commercial}$	0.004	0.004	-0.006	0.001	-0.000	-0.003
	(0.012)	(0.010)	(0.007)	(0.005)	(0.003)	(0.003)
Land Value$_{t-1}$*Price Change$_{t-1}^{Com}$		-0.024**		0.051**		0.006
		(0.011)		(0.023)		(0.005)

Number of Obs.	23828	23828	23828	23828	23828	23828
Adj. R-squared	0.314	0.314	0.330	0.330	0.254	0.255

Panel C	(13)	(14)	(15)	(16)	(17)	(18)
Land Value $_{t-1}$	-0.131***	-0.128***	0.079***	0.078***	0.010***	0.010***
	(0.023)	(0.024)	(0.012)	(0.013)	(0.004)	(0.004)
Price Change $_{t-1}^{Industrial}$	0.007	0.014	-0.003	-0.005	-0.005	-0.006*
	(0.018)	(0.015)	(0.009)	(0.008)	(0.003)	(0.003)
Land Value $_{t-1}$*Price Change$_{t-1}^{Ind}$		-0.027		0.006		0.003
		(0.040)		(0.019)		(0.004)
Number of Obs.	23828	23828	23828	23828	23828	23828
Adj. R-squared	0.307	0.307	0.323	0.323	0.250	0.250

Table 5. Land Prices and Accessibility of Bank Loans, Loan-Level Analysis from 2000 to 2015

This table reports the effects of land price changes in bank branch cities on accessibility of bank loans using loan-level data, covering all bank loans to publicly listed firm in China from 2000 to 2015. The dependent variable in Columns (1), (5), (7) is a dummy variable, which equals to 1 if the loan has real estate (land or building) as collateral. The dependent variable in Columns (2), (6) and (10) is a dummy indicating whether the loan has non-real estate collateral. The dependent variable in Columns (3), (7) and (11) is also a dummy variable, which equals to 1 if the loan is made without collateral of any kind. Finally, the dependent variable in Columns (4), (8) and (12) is an ordinal variable with three categories: 2 if the loan has real estate collateral, 1 if the loan has non-real estate collateral, and 0 if the loan has no collateral. The key independent variable is the land price change in the city where the bank branch is located. Panel A uses the overall land price index change, Panel B uses the commercial land price index change, and Panel C uses the industrial land price index change. All specifications include a number of fixed effects: firm*bank branch, bank branch city, firm headquarter city, and control for other variables. Robust standard errors are in parentheses with * for p<0.10, ** for p<0.05, and *** for p<0.01; constant terms and control variables are not reported.

	Loans with Real Estate Collateral	Loans with Non-Real Estate Collateral	Loans without Collateral	Real Estate Collateral =2; Non-Real Estate Collateral=1; No Collateral=0
Panel A	(1)	(2)	(3)	(4)
Price Change$_{t-1}$ (Bank Branch City)	0.019***	0.011***	-0.015***	0.019***
	(0.001)	(0.001)	(0.002)	(0.002)
Number of Observations	47321	47321	47321	47321
Adj. R-squared	0.298	0.276	0.296	0.289
Panel B	(5)	(6)	(7)	(8)
Price Change $_{t-1}^{Commercial}$ (Bank Branch City)	0.013***	0.006***	-0.012***	0.017***
	(0.001)	(0.001)	(0.001)	(0.002)
Number of Observations	47008	47008	47008	47008
Adj. R-squared	0.300	0.277	0.299	0.293
Panel C	(9)	(10)	(11)	(12)
Price Change $_{t-1}^{Industrial}$ (Bank Branch City)	0.006	-0.002	-0.008*	0.018**
	(0.004)	(0.003)	(0.004)	(0.007)
Number of Observations	45516	45516	45516	45516
Adj. R-squared	0.305	0.288	0.303	0.296

Table 6. Effects of Land Price Fluctuations on Non-land-holding Firms

This table investigates the effects of land price fluctuations on non-land-holding firms. All regressions use only the sample of non-land-holding firms. The key dependent variables are firm investment (columns (1), (3) and (5)) and logged annual (successful) new patent applications (columns (2), (4) and (6)). The key independent variables are lagged overall land price change (columns (1) and (2)), lagged commercial land price change (columns (3) and (4)), and lagged industrial land price change (columns (5) and (6)). All specifications include both year and firm fixed effects, control for a firm's Tobin's Q, end-of-year cash flow, total sale, and total firm asset as control variables, and cluster observations at firm level. Robust standard errors are in parentheses with * for p<0.10, ** for p<0.05, and *** for p<0.01; constant terms and control variables are not reported.

	Corporate Investment	New Patent Applications	Corporate Investment	New Patent Applications	Corporate Investment	New Patent Applications
	(1)	(2)	(3)	(4)	(5)	(6)
Price Change$_{t-1}$	-0.211***	-0.357***				
	(0.041)	(0.047)				
Price Change $_{t-1}^{Commercial}$			-0.192***	-0.263***		
			(0.043)	(0.037)		
Price Change $_{t-1}^{Industrial}$					-0.087*	-0.192***
					(0.045)	(0.059)
Number of Observations	2595	2595	2551	2551	2581	2581
Adj. R-squared	0.409	0.779	0.408	0.781	0.408	0.773

Table 7. Land Value and Firms Investment, DID Estimation

This table studies the effects of the purchase restriction policy on firm investment. The key independent variable is the interaction of treated firms and the post event dummy variable. The treated firms refer to firms holding land in the 46 citied that adopted the purchase restriction policy. The post event dummy indicates the particular quarter after the purchase restriction policy was announced in the pertinent cities. The dependent variables are a firm's not-land investment (columns (1), (5), and (9)), commercial land investment (columns (2), (6), and (10)), and industrial land investment (columns (3), (7), and (11)). All variables are normalized by lagged K (the firm's total asset). Columns (4), (8), and (12) use a firm's annual (successful) new patent applications as dependent variables. Panel A reports the results using the full firm sample, Panel B uses only firms that held land or located in the 46 cities, and Panel C uses only the sample of land-holding firms. Control variables include Tobin's Q, cash flows, total sale revenue and total asset of the firms. All specifications include both year and firm fixed effects, control for firm-specific time trend, and cluster observations at firm level. Robust standard errors are in parentheses with * for p<0.10, ** for p<0.05, and *** for p<0.01; constant terms and control variables are not reported.

	Non-Land Investment	Commercial Land Investment	Industrial Land Investment	New Patent Applications
Panel A: Firms Holding No Land in the Purchase Restricted Cities as Control Group				
	(1)	(2)	(3)	(4)
Treated Firms*Policy Period	0.260***	-0.049***	0.003	0.083***
	(0.034)	(0.008)	(0.004)	(0.028)
Number of Observations	22756	23696	23696	23696
Adj. R-squared	0.448	0.153	0.154	0.793
Panel B: Non-Land-Holding Firms in the Purchase Restricted Cities as Control Group				
	(5)	(6)	(7)	(8)
Treated Firms* Policy Period	0.583***	-0.432***	-0.027	0.165**
	(0.170)	(0.057)	(0.025)	(0.078)
Number of Observations	4830	5234	5234	5234
Adj. R-squared	0.666	0.450	0.456	0.895
Panel C: Land-Owner Firms Holding No Land in the Purchase Restricted Cities as Control Group				
	(9)	(10)	(11)	(12)
Treated Firms* Policy Period	0.200***	-0.068***	0.002	0.015
	(0.037)	(0.011)	(0.005)	(0.030)
Number of Observations	17129	18068	18068	18068
Adj. R-squared	0.410	0.159	0.165	0.791

Table 8. The Policy Shock on Non-land-holding Firms in the Treated Cities, 2000-2015

This table studies the effect of the purchase restriction policy on non-land-holding firms. All specifications use only the sample of non-land-holding firms. The key independent variable is the interaction of treated firms and the post event dummy. Treated firms refer to non-land-holding firms located in the 46 cities that adopted the purchase restriction policy. The post event dummy indicates the particular quarter after the purchase restriction policy is announced in the pertinent cities. The dependent variable is the firm's gross investment in columns (1) and (3), and logged annual (successful) new patent applications in columns (2) and (4). All specifications include both year and firm fixed effects, control for firm specific time trend, and cluster observations at firm level. Robust standard errors are in parentheses with * for p<0.10, ** for p<0.05, and *** for p<0.01; constant terms and control variables are not reported.

	Investment	New Patent Applications	Investment	New Patent Applications
	(1)	(2)	(3)	(4)
Treated Cities* Policy Period	0.195***	0.134***	0.220***	0.160***
	(0.051)	(0.052)	(0.064)	(0.057)
Firm Specific Time Trend	No	No	Yes	Yes
Number of Observations	5628	5628	5628	5628
Adj. R-squared	0.645	0.733	0.741	0.799

Table 9. Land Prices and TFP Loss from Misallocation, 2000-2012

This table investigates the effects of land price change on the aggregated manufacturing firms' TFP loss at city level. This analysis uses a city-year panel. The TFP loss is calculated using the measure of Hsieh and Klenow (2009), which is the percentage of output gain from a hypothetical reallocation of resources to the real output. Columns (1) to (4) use the simple average of TFP loss over 47 manufacture sectors, while columns (5) to (8) use the average of TFP loss weighted by sector-wide output. All specifications include both city and year fixed effects. Robust standard errors are in parentheses with * for p<0.10, ** for p<0.05, and *** for p<0.01; constant terms are not reported.

	Average TFP Loss				Weighted Average TFP Loss			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Price Change$_{t-1}$	0.092***				0.259***			
	(0.025)				(0.035)			
Price Change $_{t-1}^{Commercial}$		0.086***		0.054*		0.263***		0.238***
		(0.027)		(0.028)		(0.032)		(0.038)
Price Change $_{t-1}^{Industrial}$			0.035	0.036			0.089*	0.077
			(0.028)	(0.033)			(0.052)	(0.061)
Number of Observations	1288	1227	1185	1074	1288	1227	1185	1074
Adj. R-squared	0.591	0.580	0.600	0.581	0.542	0.546	0.553	0.566

Figure 1. Land Prices, 2000-2015

This figure depicts the land price indices for overall, commercial, and industrial land between 2004 and 2015. We take the average for the annual price growth calculated from the corresponding price indices for each of the 330 cities and normalize year 2004 to 1.

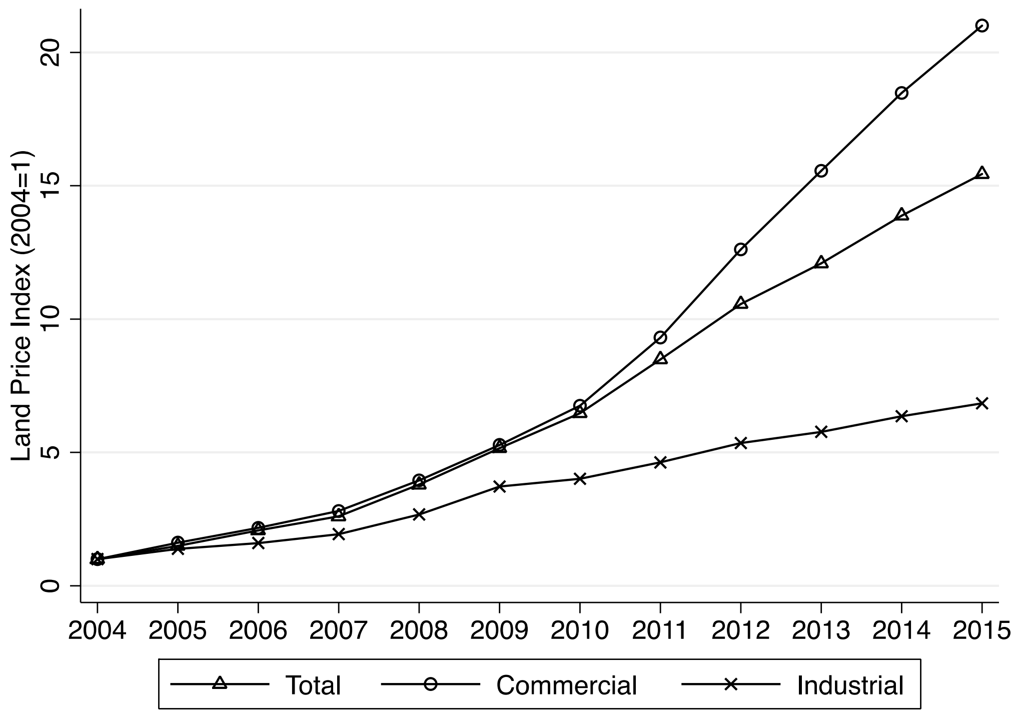


Figure 2. Land Price Indices in 12 Cities

This figure compares different real estate price indices over 2004-2015 in 12 major cities of China. The blue line is the overall land price index (label "l"), red line the commercial land price index (label "c"), green line the industrial land price index (label "l"), all constructed by the authors, while the yellow line is the land price index provided by Wu et al. (2012), label "d", obtained from http://real.wharton.upenn.edu/~gyourko/chineselandpriceindex.html.

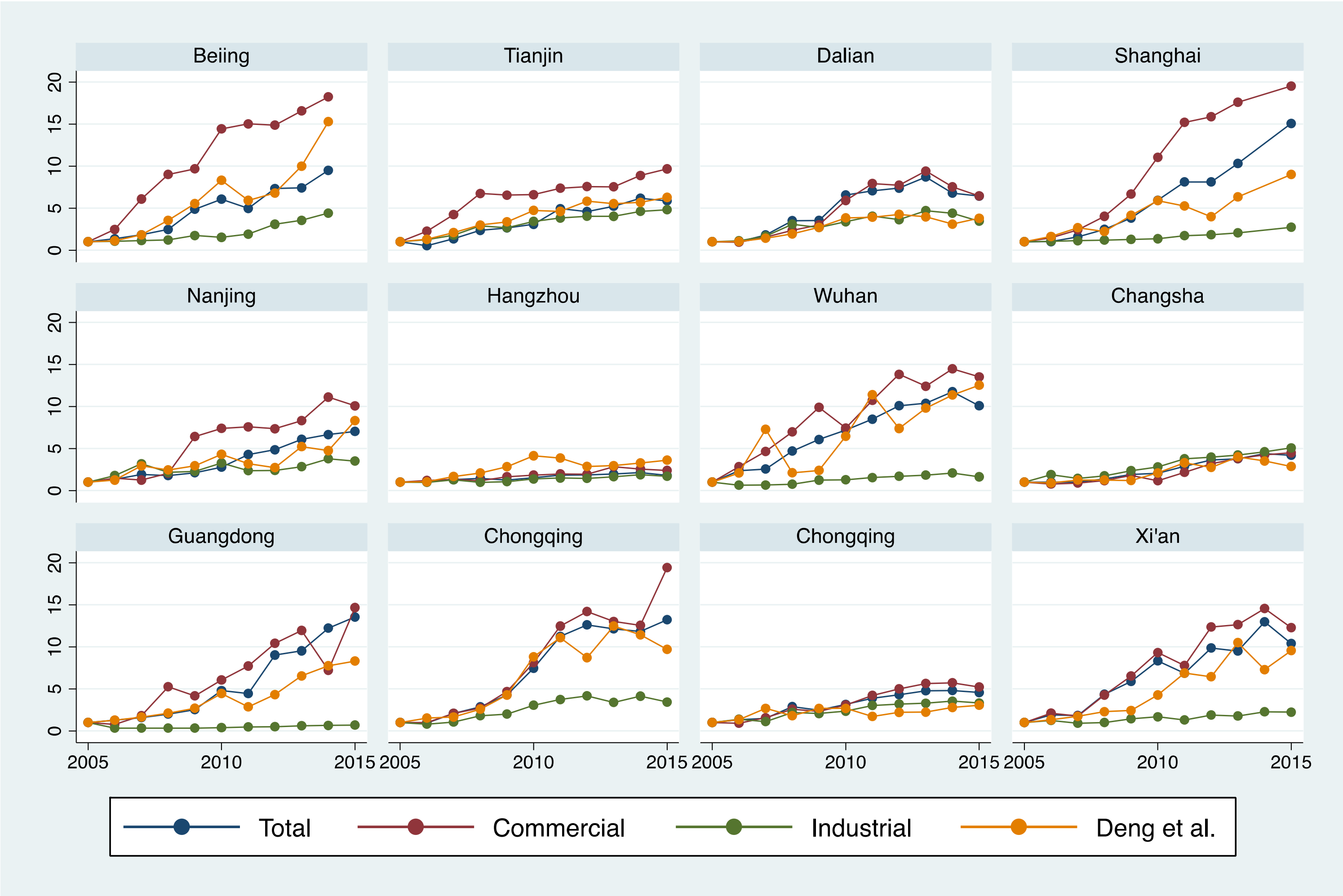


Figure 3. Firm Investment, 2000-2015

This figure depicts the average quantity of firm investment, divided into three components: non-land, commercial land, industrial land, for all publicly listed firms in our sample from 2000 to 2015.

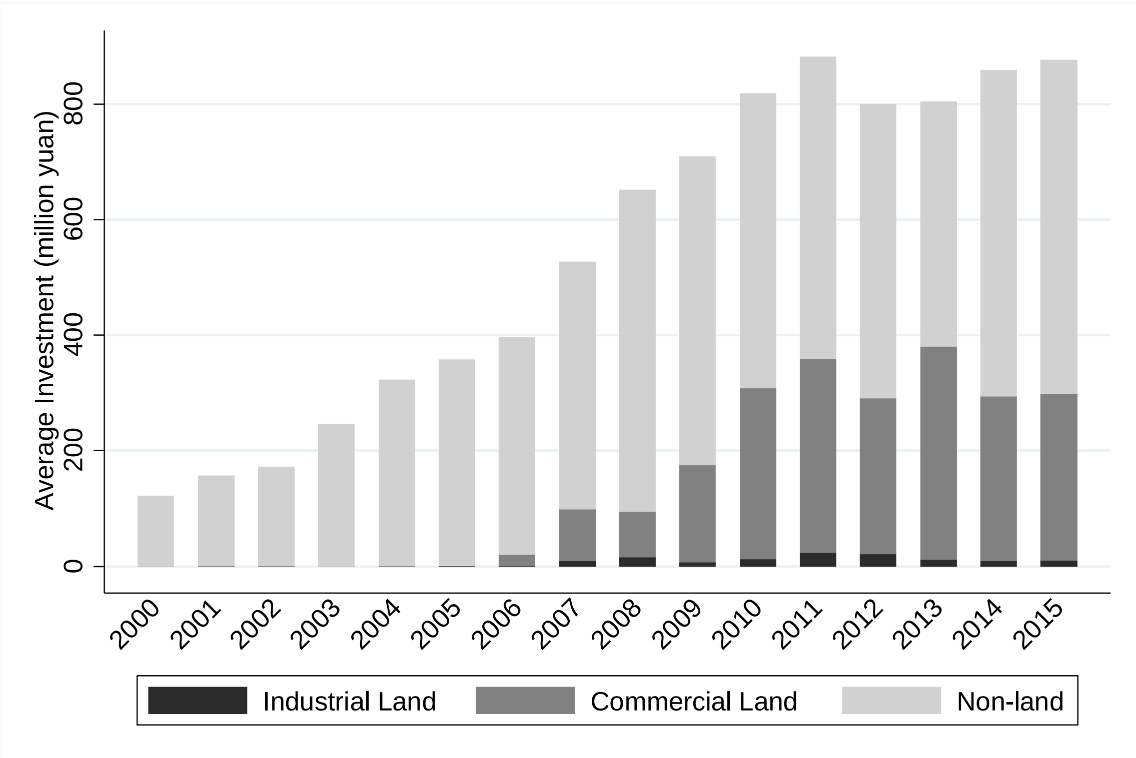
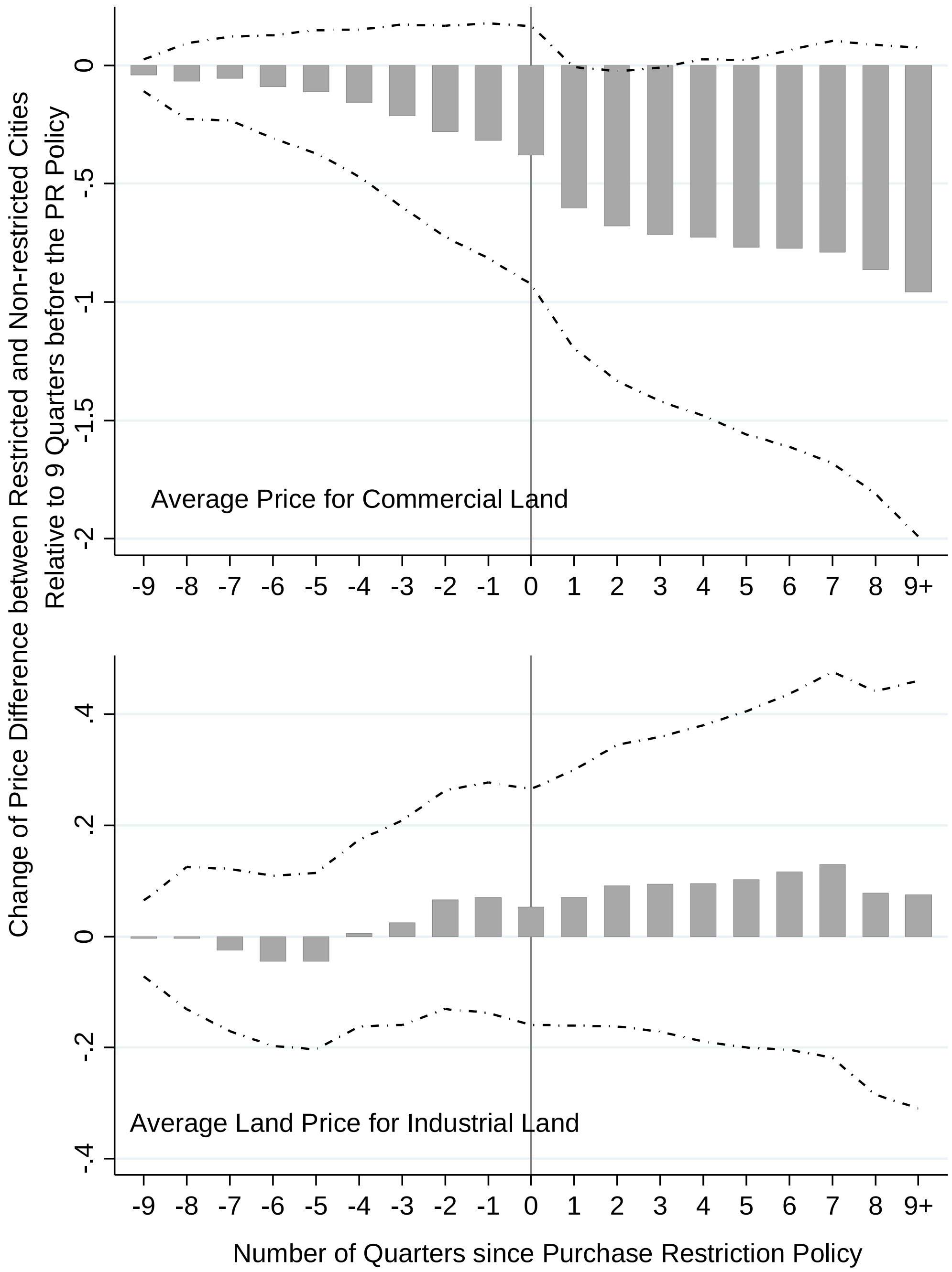


Figure 4. The Effect of Purchase Restriction Policy on Land Prices, DID Estimation

This figure plots the difference-in-difference estimators by the pre- and post-policy treatment quarters. The upper panel uses the city average price for commercial land as the dependent variable (y-axis) and the lower panel uses the city average price for industrial land as the dependent variable (y-axis). The x-axis is the number of quarters since the announcement of the housing purchase restriction policy.



Appendix A. Variable Definition

Variable Name	Definition
Land-holding Firm	A dummy variable indicates a firm has holding land in our sample period from 2000 to 2015.
Corporate Investment	Corporate investment is measured as capital expenditures divided by the lagged book value of PPE and capital expenditures are calculated as the sum of cash paid for the acquisition of fixed assets, intangible assets and other long-term assets in the annual statement of cash flows.
Land Value	Land value is the market value of land assets holding by company normalized by lagged PPE.
Tobin's Q	Tobin's Q is measured as the market value plus total debt normalized by the book value of the firm.
Cash Flow	Cash flow is computed as the net operating cash flow divided by lagged PPE. Sales revenue is measured as cash received from sales of goods and services divided by lagged PPE.
Sale	Sale is defined as the natural logarithm of annual sale revenue.
Total Asset	Size is expressed as the natural logarithm of current total assets.
New Bank Loan	New bank loan is defined as the new loans a firm got within a given year from different banks, which is normalized by lagged book value of PPE.
Change in Total Debt	Change in total debt measure the change of book value of (long term debt + short term debt) at year t, which is normalized also by lagged PPE.
Firm-specific Policy Shock	Firm-specific policy shock is the diffs-in-diff dummy estimator indicates a firm holds lands in the cities with "housing purchase restriction" policies at year after the policy is in Effect.
Treatment Group Firm	Treatment group firm is a dummy variable indicates that a firm holds lands in the cities with "housing purchase restriction" policies.

Appendix B. The List of 46 Cities That Adopted the Housing Purchase Restriction Policy with Dates of Announcing and Abolishing the Policy

City		City ID	Restriction Begin			Restriction End		
			Year	Month	Day	Year	Month	Day
北京市	Beijing	110000	2010	4	30			
天津市	Tianjin	120000	2010	10	13	2014	10	19
石家庄市	Shijiazhuang	130100	2011	2	20	2014	9	24
太原市	Taiyuan	140100	2011	1	14	2014	8	4
呼和浩特市	Huhehaote	150100	2011	4	14	2014	6	26
沈阳市	Shenyang	210100	2011	3	1	2014	9	12
大连市	Dalian	210200	2011	3	2	2014	9	3
长春市	Changchun	220100	2011	5	20	2015	6	4
哈尔滨市	Haerbin	230100	2011	2	28	2014	8	16
上海市	Shanghai	310000	2010	10	7			
南京市	Nanjing	320100	2010	10	13	2014	9	21
无锡市	Wuxi	320200	2011	2	24	2014	8	29
徐州市	Xuzhou	320300	2011	5	1	2014	8	1
苏州市	Suzhou	320500	2011	3	3	2014	9	26
杭州市	Hangzhou	330100	2010	10	11	2014	8	28
宁波市	Ningbo	330200	2010	10	9	2014	7	31
温州市	Wenzhou	330300	2011	3	11	2013	8	1
绍兴市	Shaoxing	330600	2011	8	25	2014	8	1
金华市	Jinhua	330700	2011	3	23	2014	8	1
衢州市	Quzhou	330800	2011	9	9	2014	7	23
舟山市	Zhoushan	330900	2011	8	2	2013	1	1
台州市	Taizhou	331000	2011	8	25	2014	8	19
合肥市	HeOLSi	340100	2011	1	25	2014	8	2
福州市	Fuzhou	350100	2010	10	11	2014	8	1
厦门市	Xiamen	350200	2010	10	1	2014	8	15
南昌市	Nanchang	360100	2011	2	20	2014	7	14
济南市	Jinan	370100	2011	1	21	2014	7	10
青岛市	Qinghai	370200	2011	1	30	2014	9	1
郑州市	Zhengzhou	410100	2011	1	6	2014	8	9
武汉市	Wuhan	420100	2011	1	15	2014	7	18
长沙市	Changsha	430100	2011	3	4	2014	8	6
广州市	Guangzhou	440100	2010	10	15			
深圳市	Shenzhen	440300	2010	9	30			
珠海市	Zhuhai	440400	2011	11	1	2016	3	16
佛山市	Foshan	440600	2011	3	18	2014	8	7
南宁市	Nanning	450100	2011	3	1	2014	10	1
海口市	Haikou	460100	2010	10	15	2014	7	23
三亚市	Sanya	460200	2010	10	12			
成都市	Chengdu	510100	2011	2	16	2015	1	21
贵阳市	Guiyang	520100	2011	2	18	2014	9	1
昆明市	Kunming	530100	2011	1	19	2014	8	11
西安市	Xi'an	610100	2011	3	1	2014	9	1
兰州市	Lanzhou	620100	2011	3	7	2014	7	28
西宁市	Xining	630100	2011	8	1	2014	9	9
银川市	Yinchuan	640100	2011	2	24	2014	8	26
乌鲁木齐市	Wulumuqi	650100	2011	3	9	2014	8	1