

# Real Estate Booms and Endogenous Productivity Growth\*

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## Abstract

This paper studies the inefficiency in capital reallocations following sectoral booms. I argue that imperfect financial market and external barriers to entry in the booming sector creates an inefficient reallocation of entrepreneurial talent and show that this argument applies to the recent Chinese real estate boom. Using matched firm-to-firm shareholding and balance sheet data from China, I document a significant pattern of capital reallocation within existing private businesses from the manufacturing sector to the real estate sector in the recent real estate boom. The capital reallocation, however, happened among the more productive private businesses. I then argue empirically that the real estate boom caused the capital reallocation, and that the particular pattern of reallocation is likely driven by more productive business owners being less financially constrained. To formalize the idea, I model the capital reallocation decision of private business owners assuming: 1) an imperfect financial market; 2) an entry barrier in the booming real estate sector; 3) a flexible comparative advantage structure. In my model, private business owners with higher absolute advantage in manufacturing accumulate more wealth through self-financing, and they are therefore less constrained by the cost of entering the real estate sector. Inefficient talent allocation arises if these business owners do not have a comparative advantage in real estate. Finally, I bring the model back data and structurally estimate the comparative advantage of private manufacturing business owners. My structural estimation confirms the existence of an inefficient reallocation of talent during the Chinese real estate boom.

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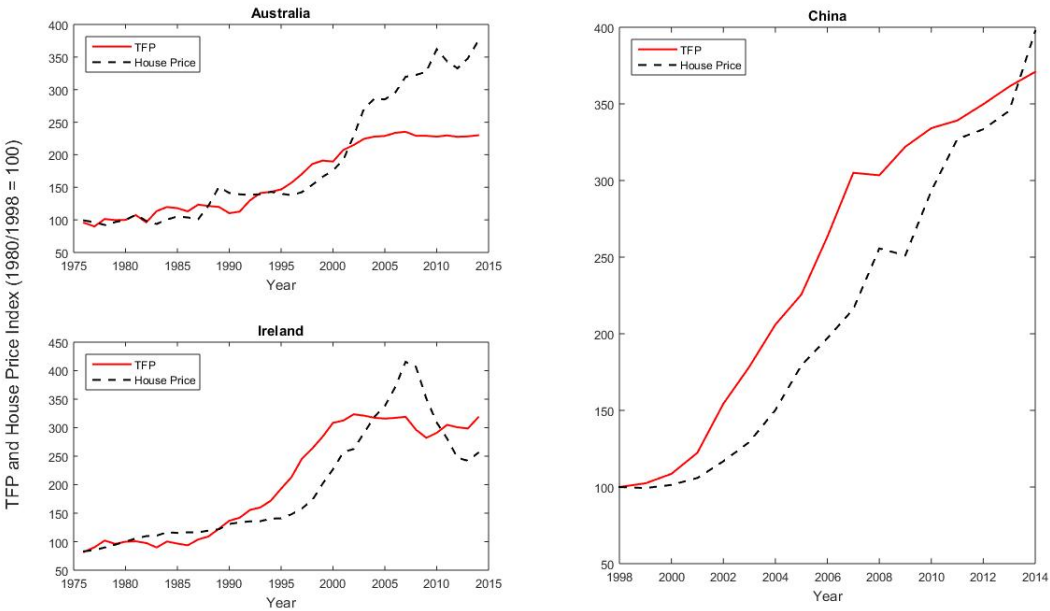
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# 1 Introduction

This paper studies the interaction of real estate prices and aggregate productivity. Figure 1<sup>1</sup> documents the relationship between real estate prices and total factor productivity (TFP) in real estate boom episodes in select countries. As the figure shows, in the real estate booms in Ireland, Australia, and China, productivity declined significantly while house prices were still rising, well before the peak of the boom-bust cycle. I consider the hypothesis that the real estate boom caused the loss in productivity growth, rather than both being caused by a third factor or causation running in the reverse direction. The recent literature emphasizes that rising real estate prices can cause increases in demand through the relaxation of collateral-based credit constraints (Chaney, Thesmar, and Sraer, 2012; Mian and Sufi, 2011; Kerr, Kerr, and Nanda, 2015), or that real estate becomes an asset with a rational pricing bubble (Martin and Ventura, 2012). In either situation, an increase in house prices increases the efficiency of the talent allocation by allowing unproductive agents to transfer wealth to the productive ones. Neither approach, therefore, is consistent with a slowdown of TFP during a real estate boom.

Figure 1: Real Estate Prices and Total Factor Productivity



I propose a novel channel through which a real estate boom can cause productivity losses in an

<sup>1</sup>Data sources: OECD, Penn World Table, St.Louis Fed, the Economist global house price database

economy with an imperfect financial market. During a real estate boom, high returns on the real estate market attract existing business owners from other sectors to reallocate resources to the real estate sector. Starting up real estate businesses, however, requires a significant investment up front for land purchases, thus creating an entry barrier. In the presence of an imperfect financial market, only successful business owners who have accumulated enough wealth can overcome such an entry barrier. But these business owners have been proven to have a high degree of talent in the non-real estate sector. It is then natural to believe that business owners with a comparative advantage outside the construction sector are those who enter it, leaving low-productivity business owners in the non-real estate sector and thus lowering aggregate productivity. In sum, the imperfect financial market can create a distortion in the allocation of entrepreneurial talents.

In this paper, I use the unique institutional features in China and rich, disaggregated data to identify this new channel. Since the late 1990s, the Chinese government has lifted a series of regulations to liberalize the housing market and to privatize the construction of residential housing. In 2002, urban land sales started to open to private real estate developers. During the same period, the urban population increased by 90% from 1995 to 2010, in contrast to a mere 10% increase in total population. The stimulus for both housing demand and housing supply led to a prolonged housing boom. The overall growth in house prices in the past decade was over 10% per annum on a compounded basis (Deng, Gyourko and Wu, 2015). Meanwhile, the overall growth in the quantity of residential housing was over 20% per annum<sup>2</sup>.

I first show that the raw patterns in the data are consistent with better-performing manufacturing firms reallocating capital to the real estate sector. In my sample, around 20% of the newly established real estate development businesses were held by existing companies in industries other than real estate or finance<sup>3</sup>. Companies that entered the real estate sector controlled 30% of the total fixed assets in the manufacturing sector and also exhibited higher investment rates, R&D intensities, and productivity levels prior to entry. In addition, I provide causal evidence that entering the real estate sector led to a significant decline in investment rate, R&D intensity, and productivity growth in these companies' original manufacturing businesses. This suggests that existing private business owners in the manufacturing sector redirected their limited resources of physical and human capital to the real estate sector.

However, the pattern of manufacturing business owners moving to real estate is prone to a critical endogeneity challenge: the likelihood of entering the real estate sector is correlated with an entrepreneur's manufacturing investment opportunities. I provide causal evidence that the declines in manufacturing investment rate, R&D intensity, and productivity growth are indeed driven by entry

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<sup>2</sup>The quantity growth is calculated by the author from an official National Bureau of Statistics publication.

<sup>3</sup>A large number of new entrants in the real estate sector also exists in other real estate booms. For example, Schmalz, Sraer and Thesmar (2015) document that when France experienced the first wave of their housing boom, over 18% of the newly created businesses in 1998 were construction companies. Similarly, Corradin and Popov (2015) find that during the great housing boom in the US, 15.5% of new business owners choose to operate in the construction industry. In contrast, the construction industry only accounts for 0.8% of establishments in the US.

into the real estate sector using two different identification strategies. The first strategy is an instrumental variable (IV) approach. I instrument entrepreneurs' decisions on entering the real estate sector with the interaction of city-specific land supply inelasticity, firm-specific potential connections with the local land bureau minister, and national real estate prices. The identifying assumption is that when real estate prices are appreciating, the potentially connected firms in a city with a flexible land supply do not necessarily gain more or less advantage in manufacturing compared to a similar firm in a city with an inflexible land supply. The land supply inelasticity, following Saiz (2010) and Mian and Sufi (2011), works as a proxy for house price appreciation. This variable is arguably uncorrelated with local income and output. It also has a negative correlation with quantity growth on the housing market, suggesting that land supply elasticity in China is unlikely to correlate with local housing demand shocks. The potential connections between entrepreneurs and local land bureau ministers serve as a proxy for individual ability to enter the land market. I construct this variable as an indicator of whether or not a firm executive shares the same birth county with his local regulators. This construction utilizes an implicit social network while eliminating the endogeneity concern in the formation of the network. I further control for the two-way interaction terms to capture any possible differences between politically connected firms and other firms that were not connected. For my second empirical strategy, I estimate the causal effect using a propensity score matching approach. In particular, I match manufacturing firms based on their size, profitability, and pre-entry investment activities to evaluate the effect of entering the real estate sector on manufacturing production. The estimates from both approaches are comparable in magnitude.

Second, I discuss a theoretical framework that rationalize the patterns in data. The theory also demonstrates how the social efficiency of the observed allocation of entrepreneurial talent depends on the comparative advantage of entrepreneurs. In a real estate boom, it is constrained inefficient to reallocate more talented manufacturing business owners to the real estate sector if they also have a comparative advantage in the manufacturing sector. The financial market imperfection is key to understanding this result. Prior to the real estate boom, the self-financing mechanism results in a positive correlation between wealth and entrepreneurial talent in the manufacturing sector. Then as the real estate boom starts, all private business owners face a higher return in the real estate sector while only the ones with enough wealth can overcome the entry barrier. When rich business owners enter the real estate market, they bid up land prices, making the entry barrier even higher. A social planner who is aware of the pecuniary externality would then incentivize wealthy and talented manufacturing business owners to stay in the manufacturing sector, so the land price and thus the entry barrier is lower.

Using the same framework, I analyze three policy tools that are potentially welfare-improving: liberalizing the financial market, reducing the entry barrier in the real estate sector, and taxing the returns from operating in the real estate sector. Liberalizing the financial market improves social welfare but also aggravates the social inefficiency. In a more liberalized financial market, the already

wealthy entrepreneurs can borrow more, which further increases land prices. As a result, more entrepreneurs with low wealth and the comparative advantages in the real estate sector are constrained by the entry barrier. Lowering the entry barrier in the real estate sector has an ambiguous impact on welfare. It creates more investment opportunities so generally untalented entrepreneurs continue operating their businesses, resulting in a decline in total credit supply. A taxation on real estate returns can improve both social welfare and efficiency. Using a calibrated model, I show the gains are economically significant: a 3% tax on real estate returns improve the overall social welfare by 0.5%.

Finally, I establish the inefficient allocation of entrepreneurial talent with a structural estimation. Using data that matches the real estate business and the manufacturing business of the same business owner, I estimate the structural correlation between the business owners' comparative advantage in the real estate sector and their absolute advantage (talent) in the manufacturing sector. Based on my model, comparing the return on capital in real estate and the manufacturing TFP of the whole population of entrepreneurs pins down the structural correlation. However, since the real estate return is not observable for non-moving business owners, I make additional structural assumptions for identification. I first divide business owners into groups based on their level of education and work experience. I then employ a Solow-residual type of estimate (Basu and Fernald, 1997) to estimate group-average manufacturing talent, using firm-level data prior to the land market reform in 2002. Finally, I regress the private businesses' returns on capital in the real estate sector on the estimated manufacturing talents to obtain the structural correlation. There are two problem with this structural estimation approach. First, the manufacturing talent of private business owners are estimated with errors, so there is attenuation bias. Second, selection bias exists because I do not observe the return on capital in real estate for the non-moving manufacturing businesses. To correct for the first bias, I impose an empirical Bayes adjustment on the estimates of business owners' manufacturing talent, which is commonly used in the literature when estimating the value added of teachers (Kane and Staiger, 2008; Meghir and Rivkin, 2011; Chetty, Friedman, and Rockoff, 2014). For the second bias, I proxy for the selection bias using a non-parametric function (Das, Newey, and Vella, 2003) of the entrepreneur-specific propensity score of entering the real estate sector. The estimates show that talented manufacturing business owners have both absolute advantage and comparative advantage in the manufacturing sector, so they should not have moved to real estate.

The new channel I propose and identify in this paper has two appealing theoretical features. First, it does not require a housing bubble to generate an inefficient allocation of entrepreneurial talents. The recent discussions on misallocations during housing booms focus on the bubble episodes (Charles, Hurst and Notowidigdo, 2015; Chen and When, 2014), and hence inefficiencies exist by definition. In my model, as long as housing construction has a high entry barrier and the financial market is imperfect, misallocation likely exists. This takes place even if the housing boom is driven by fundamental shocks such as urbanization. Second, the model can be used to study other booming sectors, as long as they also require a high capital expenditure up front. Another prominent example

is that countries typically are lacking of the ability to grow following a natural resource boom, as with the so-called “the Dutch disease” (Rajan and Subramanian, 1994; Torvik, 2001; Allcott and Keniston, 2014).

This paper is related to several strands of literature. It relates broadly to the literature on the relationship between house prices and the macroeconomy. Previous research outlines several channels through which housing can influence the economy. For example, Mian and Sufi (2011), Mian, Sufi and Rao (2013) and Chaney, Thesmar, and Sraer (2012) propose the household balance sheet channel and firm collateral channel. In linking real estate booms with productivity growth, Anzoategui et al. (2016) argues for an exogenous cycle of R&D activities. This paper proposes another channel through which real estate prices can endogenously affect aggregate productivity growth, namely through the decisions of entrepreneurs. I argue that when combined with an imperfect financial market, a significant and rapid price appreciation in the real estate market can result in inefficient entrepreneurial talent allocation across industries.

In addition, this paper complements the literature that studies the long-run impact of a housing boom from the perspective of entrepreneurs. One strand of the work in this area focuses on how house price appreciation promotes new businesses (Hurst and Lusardi, 2004; Schmalz, Sraer and Thesmar, 2015; Kerr, Kerr, and Nanda, 2015). They essentially explore the collateral value of real estate properties. The paper most similar in spirit to mine is Charles, Hurst, and Notowidigdo (2015). They argue that booming labor demand in the construction sector results in a decline in college attendance. This paper, by contrast, emphasizes the distortion on entrepreneurs’ occupation choice and its consequences to aggregate productivity.

This paper also relates closely to the discussion on the allocation of talent. Murphy, Shleifer, and Vishny (1991) propose that certain social reward structures may result in more talented people specializing in unproductive activities such as rent seeking, leading to stagnation. More related to my paper, Legros and Newman (2002) argue that certain financial imperfections can lead to the non-monotonic specialization of entrepreneurs, which corresponds to my empirical observations. I take their arguments one step further to show that in real estate booms, the misallocation of entrepreneurial talent inefficiently reduces productivity growth through rising land prices without assuming real estate production as a rent-seeking behavior. I also show that simple policy tools can be used to correct for such an inefficiency in entrepreneurial talent allocation.

Moreover, this paper makes a significant contribution to the literature on misallocation and economic growth. The majority of work has studied resource misallocation, which occurs when the most productive entrepreneurs do not acquire enough capital input for production, but does not touch directly on the misallocation of entrepreneurial talent (Hsieh and Klenow, 2009; Song et al. 2011; Buera and Shin, 2013). Other papers document that capital entry barriers prevent productive entrepreneurs from producing (Buera, Kaboski, and Shin, 2012; Midrigan and Xu, 2014). However, they do not explore the comparative advantage of the entrepreneurs, and thus miss an important channel via their

endogenous selection into different industries. This paper complements the literature by not only providing a theoretical framework, but also by offering substantial empirical evidence on talent misallocation and its impact on economic growth. The quantitative exercise of this paper builds on Song et al. (2011) to model the Chinese economy in transition to a balanced growth path. I extend their quantitative framework by adding a housing boom and heterogeneous entrepreneurs.

Last but not least, this paper fits into the growing literature studying the Chinese real estate market. Fang et al. (2014) and Deng, Gyourko, and Wu (2015) document a rapid real estate price appreciation and large variation in city-level real estate prices in China. Chen et al. (2015), Chen and Wen (2014), and Shi et al. (2016) discuss the misallocation of capital and labor in this real estate, under the hypothesis that the real estate boom is a bubble episode. Given that real estate prices in China are still going strong in the first-tier and second-tier cities, this paper suggests a framework that inefficiency exists without assuming a bubble episode. I also propose policy tools to reduce the inefficiency in entrepreneurial talent allocation.

The rest of the paper is organized as follows. Section 2 describes the institutional background of the real estate market reform and the housing boom in China. I also provide a comprehensive description of the Chinese data sets. Section 3 documents the empirical findings on the allocation of entrepreneurial talent in the recent Chinese real estate boom. In particular, I estimate the causal effect of entering the real estate sector on manufacturing firms' original businesses. Section 4 describes a two-period general equilibrium model for evaluating the social efficiency of the observed entrepreneurial talent allocation. I discuss several policy tools that can help with improving the social efficiency of the entrepreneurial talent allocation. Section 5 generalizes the model to an infinite horizon and structurally identifies the inefficient allocation of entrepreneurial talent during the housing boom. I also provide quantitative evaluation for the proposed policy tools. Section 6 concludes the paper.

## **2 Institutional Background and Data**

### **2.1 Institutional Background**

The recent real estate boom in China provides an ideal environment to examine the allocation of entrepreneurial talent in real estate booms for three reasons. First, the Chinese real estate boom was jointly driven by a country-wide urbanization and a series of privatization measures in the residential housing market. These structural changes led to the prolonged appreciation of house prices since 2003. The existing private business owners thus had sufficient time to react to the boom. Second, I have a complete record of entrepreneurs entering the real estate sector from the Enterprise Registration Database<sup>4</sup> (hereafter ERD) because the Chinese Registry Administration requires companies

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<sup>4</sup>A detailed description of the Enterprise Registration Database is provided in section 2.2.

that participate in land auctions to register and to acquire a license. Last but not least, there is a cash deposit requirement for companies to participate in land auctions. Therefore, credit market access is crucial in determining an entrepreneur's ability to enter the real estate sector.

In the past decade in China, the real estate property market and the land market went through a rapid liberalization. During the Maoist era and the early years of reform and opening up, land allocation and real estate construction have been entirely controlled by the state. The local state governments or state-owned enterprises (SOEs) allocated construction-completed apartments to workers following a priority system. There was neither a privatized market for real estate properties nor a market for land.

The reforms in the real estate sector began in the late 1990s. In the property market, housing demand increased as a result of a sequence of policy stimuli. The state-owned banks started issuing mortgage loans to households. Meanwhile, the local governments, SOEs, and private companies compensated workers on their house purchase out-of-pocket. These major policy changes contributed to buoyant housing demand, leading to a 10% annual <sup>5</sup> growth in both the number of houses and the prices of houses from 1999 to 2010.

In the land market, reform went hand-in-hand with the property market. Since 1986, the land administration in China has undergone significant modifications (Ding and Knapp, 2005). According to legislation, the state has complete ownership over all urban land. In the 1990's, private real estate developers and industrial companies were able to purchase the usage rights of land <sup>6</sup> from the state, but mostly through a hidden process. Only companies that had strong connections with local governments could acquire land use rights. In 2002, the central government banned the "negotiated sales" and started allocating land through public auctions, which marked the beginning of a fully privatized land market. The execution of this reform was completed in 2004. Land bureaus were established in cities between 2004 to 2006 to hold responsibility for city planning and all urban land sales.

Although the new policy was designed to establish a market mechanism, corruption persisted in the land market. On Nov 29, 2010, People's Daily, the official newspaper of the Chinese Communist Party, reported 28 out of 78 city land bureau officials in Guangdong received side benefits from the land market. Cai et al.(2013) studied all Chinese land auctions from 2003 to 2007 and found significant evidence of corruption by looking at the selection of land types into different auction types. Having a connection with the local land bureau would increase the benefit of a land purchase.

Entry to the land market oftentimes entails significant explicit and implicit fixed costs. Two key constraints make entering the real estate development market particularly difficult for capital-constrained private companies: required capital for obtaining property development licensing and a

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<sup>5</sup>The housing quantity is measured as total floor space sold in square meters. This is because house prices are measured as price per square meter of floor and because that the National Bureau of Statistics only reports the quantity as in total floor space sold but not in housing units.

<sup>6</sup>The length of owning the use rights is determined by the local government. Typically, land for industrial or commercial purposes rents for 40 or 50 years and land for residential purpose rents for 70 years.



cash deposit of at least 10% of the reservation land value.

Companies participating in land auctions are required to obtain a license for real estate development. Four types of licenses are issued to real estate development companies, from an A-class to D-class. The D-class license, if granted, allows for property development only in rural lands. Because I am primarily concerned with development in urban areas, I omit a discussion of the D-class license. The A-class license is granted by the national Ministry of Housing and Urban-Rural Development. It requires registered capital of more than 50 million RMB (7.38 million USD) and an employee count of more than 40 people. Upon obtaining the A-class license, real estate developers gain the right to participate in land auctions country-wide. The B-class and C-class licenses, issued by city ministries of housing development, only allow for land development within the city. The minimum requirement for B-class licenses is 20 million RMB (2.95 million USD) of registered capital and 20 professional employees. The C-class license requires 8 million RMB (1.18 million USD) of registered capital and 10 professional employees. The capital cutoffs in any license class are quite high, as an average manufacturing company in China made a median profit of 0.56 million RMB in 2005, a mere 7% of the required registered capital for a C-class license.

The second entry barrier in the land market is the cash deposit requirement. Real estate companies are required to pay local land bureaus a sizable deposit in cash prior to participating in any land auctions. No other sources of financing substitutes, either bank loans or equities, are allowed. During the initial years of land market reform, the government normally set the cash deposit requirement to be 10% of the reservation land value. From 2005 to 2009, the average cash deposit in the 10 first- and second-tier cities<sup>7</sup> reached 27.86 million RMB, amounting to 14.9% of the reservation land value on average. With rising land prices and a higher entry rate in the real estate sector, the average cash deposit in the 10 cities increased to 67.79 million RMB in 2012 and 113.25 million RMB in 2015. Again, given the median profit of 0.56 million RMB, the required cash deposit is an almost impossible hurdle for most Chinese manufacturing firms.

Together, the licensing and cash deposit requirement set a minimum capital requirement for entering the real estate sector, though they likely underestimate the actual capital required for starting any real estate projects. To get construction loans, for example, the developer needs a down payment of at least an extra 20% of the reservation value of land. Corrupt local officials imply additional upfront expenditures in the form of bribery.

To summarize, I intend to convey that:

1. The real estate market in China experienced massive liberalizations in a short period. Commercializing real estate properties led to a rapid increase in housing demand and a consequential boom in the real estate sector.
2. The land market reform resulted in local land bureaus having control over land sales. The cor-

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<sup>7</sup>Beijing, Shanghai, Shenzhen, Shijiazhuang, Zhengzhou, Sanya, Yinchuan, Ningbo, Nanjing, Chongqing.

rupt system suggests that having a connection with the local land bureau could help a company gain access to the land market.

3. The real estate sector faces a high entry barrier. Potential developers need to possess large amounts of capital and cash to enter the real estate sector.

Although the institutional setting is specific to China, these processes are applicable in multiple contexts. Financial innovations, capital flows, and immigration are prevalent factors for rapid housing booms seen around the world. In many countries, real estate development involves corruption, bribery, and intense lobbying. Last but not least, the entry barrier in the real estate sector is also high in many countries with less-developed financial markets.

## 2.2 Data

Firms are the key units of observation of my analysis. To map the business choices of firms to entrepreneurs, I focus on privately-owned firms with a single CEO or executive manager. Two firm-level data sets provide information on operation and investment activities: the Annual Industrial Survey (hereafter AIS) conducted by the National Bureau of Statistics (hereafter NBS), and the Enterprise Registration Database (hereafter ERD). The AIS is a panel survey of all SOEs and privately-owned enterprises with revenue of at least five million RMB<sup>8</sup> from 1995 to 2010<sup>9</sup>. It contains data on annual balance sheets, income statements, and cash flows of all manufacturing firms. The AIS is ideal for studying manufacturing firms because the firms sampled in the survey cover over 80% of total assets in the entire manufacturing industry. I drop SOEs, publicly-owned firms, and foreign branches from the sample so the focus of my analysis is on private entrepreneurs. The SOEs are also considered as less financially constrained and more inefficiently operated<sup>10</sup>, so they would not fit in my model. This leaves me with a sample of 105,298 firms and 1,368,897 firm-year observations.

I rely on the AIS to construct firm-level variables on R&D intensity, investment expenditure, and labor productivity. The investment expenditure measure is normalized by one-year lagged fixed asset values, which is equivalent to the “plants, property, and equipment” item in commonly-used corporate-level Compustat data. The R&D intensity is measured as the ratio of R&D expenditure to one-year lagged fixed asset values. In this paper, I consider R&D activities as a specific type of investment that creates new profit potential for firms. Therefore, I normalize R&D expenditure in the same way as capital expenditure. My later empirical results, however, are robust to alternative

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<sup>8</sup>Approximately 750 thousands USD.

<sup>9</sup>The survey is still ongoing, but the revenue threshold for reporting increased to 20 million since 2010. I therefore drop observations after 2010 for consistency's sake.

<sup>10</sup>Hsieh and Song (2015) compare SOEs and private firms using the AIS from 1998 to 2005. They found that the SOEs have a significantly lower capital productivity compared to private firms. Song et al. (2011) also document that SOEs do not appear to follow a profit maximizing objective.

normalizations for R&D intensity, including normalization by one-year lagged total output or one-year lagged total asset values. Labor productivity is measured as value added per worker.

Other accounting variables from the AIS are used to control for firm-level heterogeneity. A firm's debt dependence is proxied by the ratio of total debt outstanding to the lagged book value of total assets (the debt-to-asset ratio). The total cash holdings are measured as the summation of net cash inflows from operating, financing, and investment. The ROA (return on asset) is the ratio of operating income (after depreciation) to the lagged total asset value. I also include total asset value as a proxy for wealth and the total value of fixed assets to control for capital input. The age of a firm sums up the active years since its registration. Table 1 provides summary statistics of investment and productivity of privately-owned firms, as well as corporate financial variables used in the empirical analysis. The AIS also includes the location of each firm's headquarters. None of the firms in the sample moved their headquarters between 1995 to 2010. I utilize this property to explore the variation in local real estate markets in predicting entrepreneurs' incentives to enter the real estate sector.

I pair the AIS with my second dataset, the ERD, which contains the administrative information of all enterprises in China. I use the ERD to construct measures of manager characteristics and firm-specific investment activities. At the date of registration, all firms are required to disclose their legal representative, shareholders, board members, executives, and other basic information to the China State Administration for Industry and Commerce. Each firm then has a unique record in the ERD. I observe the entry of a manufacturing firm into the real estate sector when it becomes a shareholder of a newly established real estate company. As of 2010, 4.5% of privately-owned manufacturing firms in the AIS hold equity shares of at least one real estate company. The average shareholding of these manufacturing firms is 66.27% of the total amount outstanding, showing that they have absolute control of their real estate subsidiaries. I drop around 3% of the observations where the real estate firm has the same legal representative as its manufacturing shareholder to ensure that real estate activities do not appear on the manufacturing firms' balance sheets. I focus only on real estate developers that specialize in land acquisition, construction, and sales. Very few real estate developers are involved in the post-sale property management. Other companies in the real estate sector, including property agencies and management companies, are not of interest in this paper. For the remainder of this paper, "real estate sector" refers to the real estate development industry.

The information about firm executives is used to construct proxies for their potential political connections as well as their talent levels. This information includes the level of education, birth date, whether or not the executives are members of the Communist Party, the first six digits of their social identity number, gender, and race. For every Chinese resident, the first six digits of the social identity number indicates his or her residence county at the age of 16. There are a total of 2,854 counties in China, each with an average population of 610 thousand people<sup>11</sup>. There are also eight levels of education: graduate, undergraduate, post-high school, high school, vocational high school, middle

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<sup>11</sup>Based on the 2010 Population Census.

school, elementary, and not educated.

The AIS is matched to the ERD using the unique registered name of each company. The matching rate is over 80% for the entire data sample. The matching is unlikely to induce a non-random error to my empirical analysis. I further restrict the sample to firms active in 1997 to guarantee that pre-period controls exist. This leaves me with a sample of 25,513 firms and 382,695 firm-year observations.

[Table 1 about here]

There are several advantages of using the two data sets and the Chinese institutional background. First, the boundary of each firm in these two data sets is determined based on legal dependency. The corporate law in China requires each firm to have one legal representative responsible for all litigation against the firm. A firm or branch with a different legal representative is considered as a separate business. Thus, a manufacturing firm's performance in the real estate industry is reported separately from its main business as long as the two businesses are registered with different legal representatives. This appears to be a standard feature in the data. 97.1% of the manufacturing companies who entered the real estate sector registered their real estate subsidiaries as separate firms. This feature gives me the ability to look at the impact of real estate investment on manufacturing firms' main business.

Second, the shareholding data in the ERD provides a near complete documentation of investments from the manufacturing sector in the real estate sector. Chinese regulation requires that only real estate development firms with a development license can participate in the land auctions, with the exception that industrial companies can rent industrial land for factory buildings. Given that the positive demand shocks happened in the residential and commercial real estate market, and that industrial land prices did not increase during the housing boom<sup>12</sup>, I consider the entries observed in the ERD as capturing manufacturing companies' significant real estate investments<sup>13</sup>. Such investment is also isolated from the standard structure investment. In fact, I do not want to take into account the property or land holdings of manufacturing firms as they can be for manufacturing production purposes. As noted in Chaney, Thesmar, and Sraer (2012), cost-minimizing firms invest more in structures during real estate price run-ups. The entries into the real estate sector identified from the ERD are separated from the businesses in the manufacturing sector.

Finally, most real estate development firms in China are restricted to operating within their cities, with the exception of those operating under an A-class license. These A-class companies, which are less than 1.3% of the industry, are often stand-alone firms without a large institutional shareholder. I also observe from the ERD that over 90% of manufacturing firms invested in local real estate companies. Therefore, I can explore the variation in city house prices and land supply constraints to model the manufacturing firms' incentive to enter the real estate sector.

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<sup>12</sup>The average annual growth rate of industrial land price is 2.62%, which is higher than the average inflation rate by 0.15%.

<sup>13</sup>Gao (2014) matched the manufacturing companies to the final bidders of all land auctions using the 1998-2007 NBS Annual Industrial Survey and 1987-2012 land auction data. Less than 9 percentage points of the land transactions are associated with industrial firms purchasing commercial land.

I also collect city-level real estate data from China Real Estate Index System (CREIS), which is constructed and maintained by Soufun.com, the Chinese equivalent of Zillow. The cities are prefecture-level cities, which are based on Chinese administrative divisions. A prefecture-level city must meet the following three criteria<sup>14</sup>: an urban center with a non-rural population over 250,000; a total gross output value of over 200 million RMB (US\$32 million); and a tertiary industry output that contributes over 35% of the GDP, superseding that of primary industry. There are in total 333 prefecture-level cities in China, with an average geographical size comparable to the metropolitan statistical areas in the US. CREIS provides monthly data on the residential property market of 122 cities – including the total floor area and revenue of houses sold – and property-specific characteristics. I also use house price indices in Fang et al. (2014), which relies on mortgage data to construct quality-based house price indices for 120 Chinese cities. The CREIS also contains piece-by-piece land transaction information for the 145 cities since 2005. For each land transaction, the database records its location, total land area, desired floor space area, required cash deposit reservation land value, and final price. The 145 cities are officially divided into three tiers based on their economic activities. Table 2 provides a summary of the real estate data based on the regional location and three-tier divisions of the cities.

[Table 2 about here]

To control for local equilibrium outcomes, I supplement these data with city-level demographic data from city yearbooks. The yearbooks of the 145 cities are available from 1996 and 2013.

### 3 Empirical Evidence on the Allocation of Entrepreneurial Talent

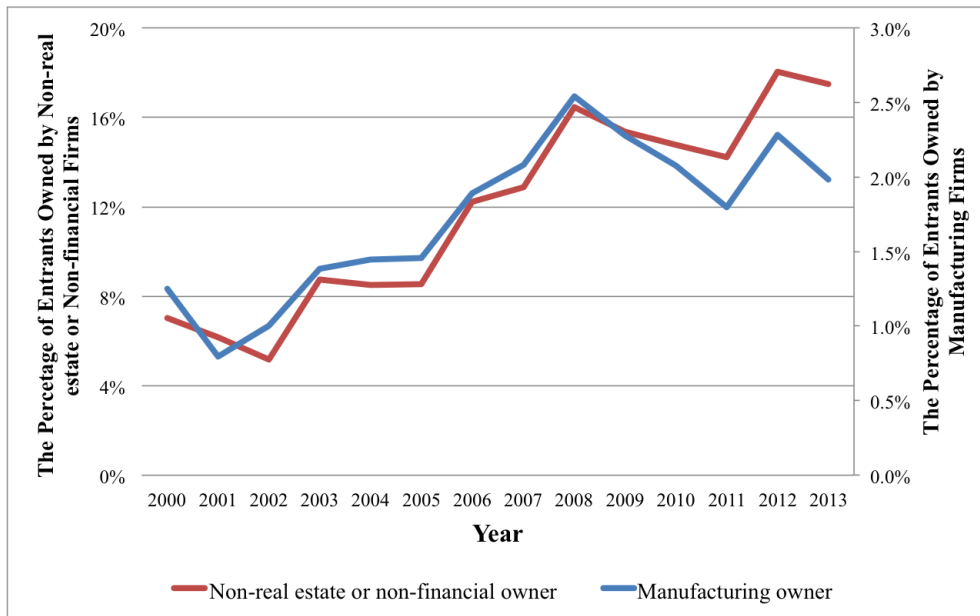
In this section, I present reduced-form evidence on existing private business owners reallocating capital to the real estate sector in the recent Chinese real estate boom. In the past decade, the residential house prices in China increased at an annual rate of 8% to 13% (Fang et al. 2014; Deng, Gyourko, and Wu, 2015). A large fraction of non-real estate and non-financial firms started up businesses in the real estate sector. Figure 2 presents the percentage of entrants<sup>15</sup> in the real estate sector run by non-real estate firms and non-financial firms, or by manufacturing firms only. This percentage increased over the years. I also observe in the AIS that 4.5% of manufacturing companies opened a new business in the real estate sector. These manufacturing companies owned 29.6% of the total fixed assets in the entire manufacturing industry.

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<sup>14</sup><http://www.china.org.cn/english/Political/28842.htm>

<sup>15</sup>Figure 2 uses the data from the ERD, which include a complete documentation of all registered companies in China. The numbers are slightly different from later analysis, when I only use observations from the AIS to study the impact of entering the real estate sector on manufacturing production. In addition, the ERD documents well the entry pattern, but not the exit pattern, thus some numbers do not match the cross-sectional summary statistics. This is due to the fact that the exit of a real estate development firm could happen in many forms, including M&A and revocation, which are not all observable in my data set.

Figure 2: The Entrants in the Real Estate Sector



Two main findings suggest that the aggregate productivity could be endogenously affected through a misallocation of entrepreneurial talent:

1. Firms that entered the real estate sector had substantially higher manufacturing productivity prior to entry. After firm-specific financing ability is controlled for<sup>16</sup>, I observed the reverse relationship — the probability of starting up real estate businesses is negatively correlated with manufacturing productivity.
2. Entering the real estate sector led to a sizable decline in investment, R&D expenditure, and productivity in manufacturing firms' original businesses. I employ two approaches to rule out the alternative hypothesis that the observed decline is driven by unobserved manufacturing investment opportunities: the propensity-score matching approach and the instrumental variable approach. Both estimation results suggest a negative causal effect of entry into the real estate on the entrants' original manufacturing production.

These two facts together indicate that productive manufacturing businesses owners moved to the real estate sector in the real estate boom, diverting their resources away from the manufacturing sector. The financial market imperfection is a key contributor to the observed pattern. Because real estate development is capital intensive (as mentioned in section 2)<sup>17</sup>, the productive manufacturing business

<sup>16</sup>I proxy firm-specific financing ability using pre-boom asset value and credit scores

<sup>17</sup>Based on the 2012 National Bureau of Statistics Input-Output Table, the labor share of the real estate development industry is roughly 15%, compared to an average labor share of 45% in the manufacturing sector.

owners exhaust resources that could have been otherwise used in the manufacturing sector, further decreasing their investment, R&D expenditures, and productivity in the manufacturing sector. As a result, the average productivity and innovation in the manufacturing sector drops.

The reduced-form analyses, however, are inconclusive on the efficiency of the private business owners' capital reallocation decision. It could also be efficient if these productive manufacturing business owners are even more productive in the real estate sector. In section 4, I develop a general equilibrium model to evaluate the social efficiency of the observed allocation of entrepreneurial talent.

### 3.1 The Decision to Entering the Real Estate Sector

Following the 1998 housing reform and the 2004 land market reform, the real estate sector in China entered a Golden era. There was a threefold increase in real estate development firms from 1998 to 2008. Figure 2 above illustrates that a large fraction of newly established real estate companies are held by privately-owned companies in other industries. Here, I directly investigate the properties of these entrants using the datasets described above.

Using firm-level accounting data from AIS, I examine the difference between companies that entered the real estate development industry and companies that did not. Table 3 summarizes their differences in productivity, investment, profit margin, size, and other characteristics between 1997 and 2002, when the land market was not fully liberalized. Prior to entry, real estate new entrants were 5.63 times larger in terms of total assets and twice as large in R&D expenditure and capital investment compared to firms that did not enter the real estate sector. They also enjoyed a 23.4% higher profit margin and have a significantly higher credit score. In addition, older firms with larger asset values and larger workforces were more likely to enter the real estate sector.

[Table 3 about here]

I then estimate a firm-specific propensity of entering the real estate sector using a probit specification. The panel data of real estate companies are compressed into a cross section, and all firm-level initial characteristics are measured using their average value between 1997 to 2002, before the land market was fully liberalized:

$$Prob(Enter_i) = \alpha_1 \Delta P_c + \alpha_2 \Delta w_c + \beta_1 LP_i + \beta_2 Inv_i + \beta_3 RD_i + controls_i$$

$Enter_i$  is a dummy variable indicating manufacturing companies' real estate entry after 2004;  $\Delta P_c$  is the average 3-year house price growth of city  $c$  (where the headquarter of firm  $i$  is located) from 2004 to 2010;  $\Delta w_c$  is the average annual local manufacturing wage growth after 2004, when the land market reform is finished;  $LP_i$  is firm  $i$ 's average labor productivity prior to 2002;  $Inv_i$  is the average

investment rate of firm  $i$  before 2002; and  $RD_i$  is the average R&D intensity of firm  $i$  before 2002<sup>18</sup>. Firm-level controls include pre-2002 average values of age, employment, and debt-to-asset ratios, as well as the initial exporting status and two-digit industry. I exclude all companies that invested in the real estate sector before the land market reform concluded in 2004. The results are summarized in column (1) of Table 4<sup>19</sup>. An average firm  $i$ 's probability of entering the real estate sector is positively correlated with average local real estate price appreciation and firm-specific labor productivity, investment rate, and R&D intensity. Column (2) reports the estimates when initial asset value in 1997 and credit scores are also controlled in the probit regression. The two controls serve as proxies for a firm's financing ability. All else equal, a company with a higher initial asset value and a higher credit score is more likely to have a larger borrowing capacity from the bank. While local house price appreciation still significantly predicts manufacturing firms entering the real estate sector, a firm with 1% higher pre-entry labor productivity has a 0.094% lower propensity to enter the real estate sector.

[Table 4 about here]

These results suggest that the financial constraint is an important determinant of private business owners' decisions to enter the real estate sector. As summarized in Table 3, existing business owners with a higher productivity in the manufacturing sector are larger and have higher credit scores. Therefore, the financial market imperfection increases the probability that more productive private manufacturing businesses moving to the real estate sector in a real estate boom. With firm-specific financing ability controlled for, the pattern is reversed: the more productive private manufacturing businesses are more likely to stay in the manufacturing sector.

### 3.2 The Causal Evidence on Capital Reallocation

This section establishes the causal evidence that the real estate boom lead to capital reallocation within private manufacturing businesses. I examine the relationship between entering the real estate sector and manufacturing activities as follows:

$$Y_{it} = \alpha_i + \delta_t + \beta \cdot POST_{it} + \sum_k \eta_{kt} X_k^i + controls_{it} + \epsilon_{it} \quad (1)$$

$Y_{it}$  is the outcome of interest, including the R&D intensity, investment rate, and labor productivity of the manufacturing business of firm  $i$  in year  $t$ .  $POST_{it} = 1$  if manufacturing firm  $i$  has entered the real estate sector in year  $t$ , and  $POST_{it} = 0$  otherwise.  $X_k^i$  are dummies indicating the initial conditions of firm  $i$ , including exporting status, size class, two-digit industry, and five quantiles of age at 1997. They are used to control for group-year fixed effects. Local wages and ROA are also added as controls

<sup>18</sup>Following the literature, I normalize R&D expenditure and investment by lagged fixed asset value on the firm balance sheet; labor productivity is computed as log value added per worker

<sup>19</sup>The total number of firms is smaller because I am only able to collect house prices in 96 cities.



in  $controls_{it}$ .  $\eta_{kt}$  is the group-year fixed effects, which control for average performance of initial control group  $k$  at year  $t$ .  $\beta$  is the key coefficient of interest, measuring the average change of firm  $i$ 's manufacturing production following its entry into the real estate sector. This sample includes the manufacturing firms in the AIS from 1997 to 2010. I identify  $POST_{it}$  through observing manufacturing firms holding shares of a newly established real estate development company in the ERD data<sup>20</sup>.

The OLS estimate  $\hat{\beta}$  suffers from two omitted variable biases: selection on manufacturing investment opportunities and selection on credit constraints. Unobserved investment opportunities induce a self-selection bias: firms losing good opportunities in the manufacturing industry are inclined to reduce manufacturing investments and R&D activities. At the same time, they may be more willing to participate in the real estate market during a housing boom. Thus, the OLS estimate would be biased downward. On the other hand, both investment and R&D in the manufacturing industry are sensitive to a firm's financing ability, like the firm's decision to enter the real estate sector. As is shown in Table 3, firms that entered into the real estate sector had a higher asset value, higher investment, more active R&D activities, and a higher credit score. Therefore, the heterogeneity in credit constraints is likely to induce an upward bias on the OLS estimates.

### The Matching Approach

To deal with the two omitted variable biases, I first select the sample using a semi-parametric matching procedure (Abadie and Imbens, 2006, 2012). I divide my sample into two groups: the treatment group and the control group. The treatment group includes companies that entered the real estate sector together with the comparison sets of all firms that did not enter. The control group includes companies that did not enter the real estate sector and the comparison sets of companies that entered. The exact matching procedure is as follows: for a given manufacturing firm  $i$  entered in the real estate development sector in year  $t$ , its matched comparison firms are restricted to operate in the same two-digit industry with the same exporting status,  $G_i(Ind, E)$ . The set of matched comparison firms is then selected as the closest four matches to firm  $i$  from  $G_i(Ind, E)$ :

$$\mathcal{J}_4(i) = \{l \in G_i(Ind, E) | W_l = 0, \|X - X_i\| \leq d_4(i)\}$$

$W_l$  and  $W_i$  are the treatment indicators of firm  $l$  and firm  $i$ , where  $W = 1$  indicates the firm entered the real estate in year  $t$ ;  $d_4(i)$  is the distance between firm  $i$  and its fourth closest match. The matching variables include registered capital, firm age, total asset value, fixed asset value, employment, debt-to-asset ratio, and profit margin at time  $t - 3$ . I drop observations whose fourth closest match has a distance larger than 20% of that to the origin.

<sup>20</sup>Unfortunately, the ERD only provides the most recent shareholding information. My sample excludes the manufacturing companies that modified the shareholdings of their real estate subsidiaries. This treatment on data does not affect the identification later, given that the validity of the instruments does not depend on the sample.

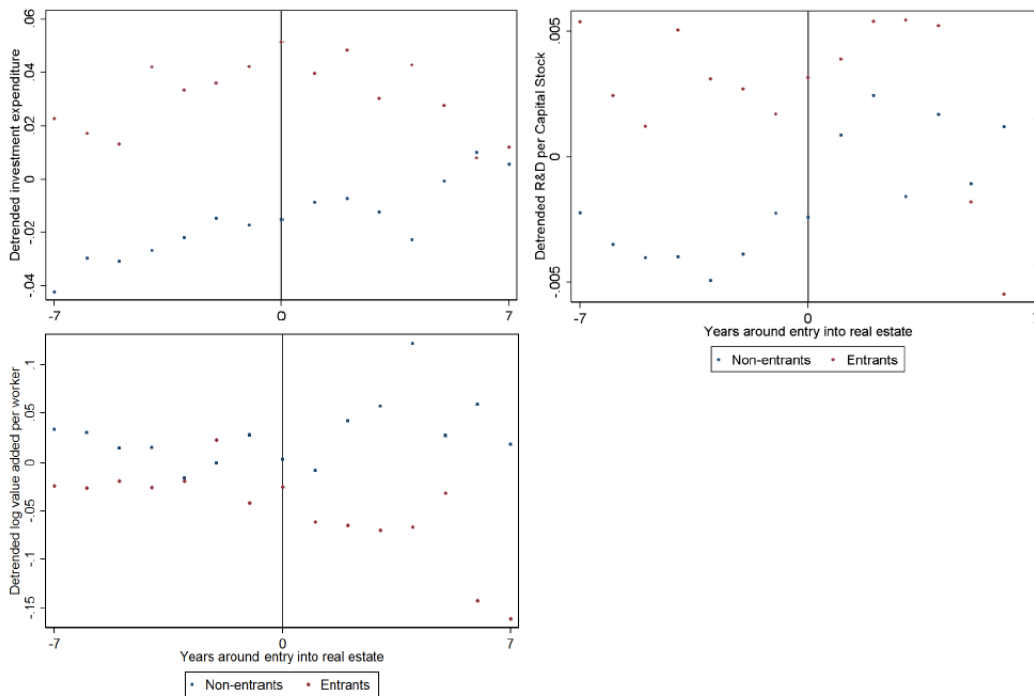
Firm  $i$ 's potential outcome in year  $t$  is computed as:

$$\hat{Y}_i(0) = \begin{cases} Y_i & \text{if } W_i = 0 \\ \frac{1}{4} \sum_{i \in \mathcal{J}_4(i)} Y_j & \text{if } W_i = 1 \end{cases}$$

$$\hat{Y}_i(1) = \begin{cases} \frac{1}{4} \sum_{i \in \mathcal{J}_4(i)} Y_j & \text{if } W_i = 0 \\ Y_i & \text{if } W_i = 1 \end{cases}$$

Figure 3 plots the average R&D intensity, investment rate, and labor productivity of the two groups around the time when firms in the treatment group entered the real estate development industry. Time trends are taken out by controlling for year-specific effects.

Figure 3: The Effects of Entering the Real Estate Sector



Prior to entering the real estate sector, the treatment and control groups have similar trends in R&D intensity, investment rate, and labor productivity. After treatment firms participated in real estate activities, I observe a sharp decline in production in their original manufacturing businesses.

I next apply an instrumental variable approach to provide additional and robust evidence about the causal effect of entering the real estate sector on manufacturing firms' original businesses.

### The Instrumental Variable Approach

I introduce an instrument for firms' decisions to enter the real estate sector by exploring city-level land supply elasticity and entrepreneurs' potential connections with the local land bureaus. The land supply elasticity is related to land appreciation during the construction period such that it predicts the return in the real estate sector in a given city. The entrepreneurs' potential connections with the local land bureaus exploit the institutional background in China, given corruptive behaviors in the land market.

I manually construct a land supply elasticity index<sup>21</sup> for 145 cities following Saiz (2010), who characterizes the supply-side response to housing demand shocks. A city with a land supply elasticity index of 1 implies that all areas within 30 kilometers of the city center can be developed into residential or commercial properties. Column (1) in Table 5 tests the correlation between residential home price appreciations and the land supply elasticity index. When national house prices appreciate by 100%, a city with 1% lower land supply elasticity would have a 0.78% faster three-year house price growth. The corresponding estimate with 2-year lagged land prices<sup>22</sup> being controlled for is 0.84%, which indicates that the land supply elasticity index can predict returns in the real estate sector. In addition, as discussed in section 2, most real estate companies are restricted to operating locally except for the less than 2% firms with an A-class license. Therefore, I consider the local real estate market return as a key determinant for manufacturing firms' decision to enter the real estate sector<sup>23</sup>.

[Table 5 about here]

The city land supply elasticity however has a low predictive power for individual firms' decisions to enter the real estate sector. The local land supply is in general constrained. From 2005 to 2015, an average of 6,713 pieces of land were sold per year, but there are a total of 83,913 real estate development companies on average<sup>24</sup>. Assuming a standard development period of two years, over 80% of the real estate companies could not always have a real estate project in development. To ensure a strong first stage in the IV analysis, it is necessary to find a firm-level variable that is correlated with the decision of entering the real estate sector.

The firm-level variable is the potential connection between the CEO and local land bureau ministers. I defined the potential connection between the CEO of a firm and the local land bureau minister

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<sup>21</sup>The index is normalized to a 0 to 1 scale.

<sup>22</sup>Deng, Gyourko, Wu (2015) documents that the average period of housing development is two years and that the construction costs in China remained almost constant during the housing boom.

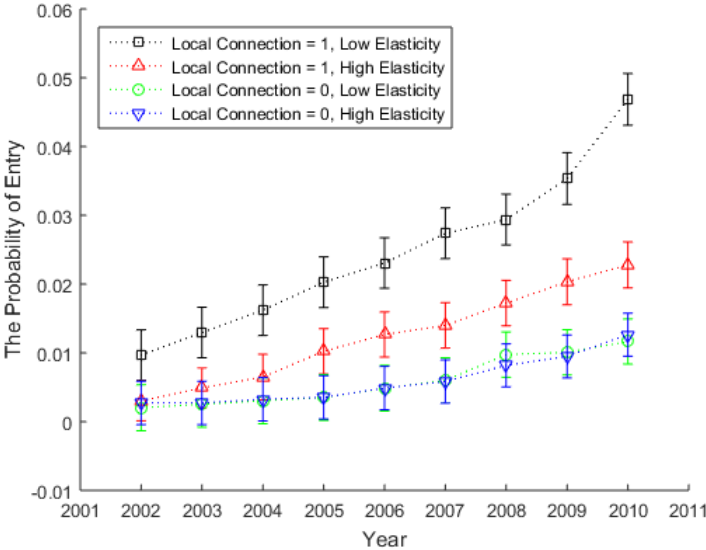
<sup>23</sup>In data, I also found almost no manufacturing companies starting a real estate firm in other cities.

<sup>24</sup>The numbers are calculated based on the CREIS statistics.

as whether or not they grew up in the same county. The ERD contains the first six digits of the national identification number of CEOs, which indicate their home county at the age of 16. The birthplaces of local land bureau ministers are collected manually based on their official resumes. This variable is inspired by the literature on the impact of social networks on investment (Shue, 2013; Haselmann et al., 2016), but avoids the endogeneity concern in the formation of social networks. Given that most land bureaus were established after 2004 and that a random sample from the ERD suggested that fewer than 0.5% firms changed their CEOs, the potential connection variable is arguably not affected by the investment opportunities of firms.

Figure 4 illustrates the significance of the land supply elasticity and the CEO’s potential connection with local land bureaus in predicting entry to the real estate sector. I divide the manufacturing firms into four groups based on their connections with the local land bureau and whether their home city has an elastic land supply. I then plot the fraction of firms that entered the real estate sector in each group. Over time, the group of firms with local connections and inelastic city-level land supply is significantly more likely to participate in real estate development, compared to all other three groups.

Figure 4: The Predictive Power of the Two Variables



In further examination, the land supply elasticity and the CEO’s potential connection with local land bureaus also significantly predict local land supply. I discuss related details in Appendix B.

## The Identification Strategy

In the baseline specification, I estimate the first stage with the following model:

$$POST_{it} = \alpha_i + \delta_t + \theta \cdot PolConnection_i \times (1 - LandElasticity_c) \times P_t + \kappa_1(1 - LandElasticity_c) \times P_t + \mu_1 PolConnection_i \times P_t + \sum_k \eta_{kt} X_k^i + controls_{it} + \epsilon_{it} \quad (2)$$

$PolConnection_i$  is a dummy variable, which is equal to 1 if firm  $i$ 's executive in 1997 ever shared the same birth county with the head of local land bureau in sample and is equal to 0 if no potential connection existed;  $1 - LandElasticity_c$  is the land supply inelasticity of city  $c$ , where the headquarters of manufacturing firm  $i$  is located<sup>25</sup>; and  $P_t$  is the 3-year house price growth at the national level. Firm fixed effects, year fixed effects and other controls are also included in the first stage. I do not explore the time series variation of the CEO's connection variable, due to the low frequency of turnover among local land bureau ministers<sup>26</sup>. Other controls are the same as in the OLS regression (1).

The instrumental variable is constructed by interacting the potential connection between the CEO of firm  $i$  with local land bureau ministers ( $PolConnection_i$ ) with the local land supply inelasticity<sup>27</sup> ( $1 - LandElasticity_c$ ) and a measure of the national housing cycle ( $P_t$ ). The core of this instrumental variable is difference-in-difference-in-differences. I control for the individual terms  $PolConnection_i$ ,  $LandElasticity_c$ ,  $P_t$ , and the two-way interaction terms in both the first stage and the second stage. The connection dummy interacted with local land supply inelasticity is absorbed by the firm fixed effects. The interaction term  $(1 - LandElasticity_c) \times P_t$  is essentially a proxy for the house price growth in city  $c$  in year  $t$ . The coefficient  $\theta$  is expected to be positive because entry is expected to be positively correlated with the CEO's connection with local land bureau ministers, the inelasticity of land supply, and the growth in house prices. Although the real interest rate is often used to instrument for a national housing cycle in the literature (Himmelberg, Mayer and Sinai, 2005; Mian and Sufi, 2011; Chaney, Thesmar and Saer, 2012), I found that the aggregate movements of house prices in China does not follow the fluctuations in real interest rates<sup>28</sup>. Given such a large difference, I consider national house price growth as a better proxy than real interest rate for house price cyclicalities.

My *identifying assumption* for using the DDD instrument is as follows: when real estate prices are appreciating, ex-ante connected firms located in cities with flexible land supply do not have higher

<sup>25</sup>The AIS shows that manufacturing firms in China almost never change the location of their headquarters.

<sup>26</sup>The average term of local land bureau is 4.6 years. Considering that the recent land reform started in 2004 and my sample ends in 2010, it is insufficient to explore the over-time variation of the political connection instrument.

<sup>27</sup>The inelasticity of city-level land supply is equal to 1 minus the land supply elasticity index, which is constructed following Mian and Sufi (2011).

<sup>28</sup>From 2002 to 2013, the average increase in the real interest rate was -0.33 percentage points, while real house prices increased by 7.9-13.1 percent annually in most cities (Fang et al. 2014).

advantage in the

manufacturing sector the connected firms in a city with a flexible land supply do not necessarily gain more or less advantage in manufacturing compares to a similar firm in a city with an inflexible land supply.

The second stage is similar to the OLS specification, except that the two-way interaction terms are controlled:

$$Y_{it} = \alpha_i + \delta_t + \beta \cdot POST_{it} + \kappa_2(1 - LandElasticity_c) \times P_t + \mu_2 PolConnection_i \times P_t + \sum_k \eta_{kt} X_k^i + controls_{it} + \epsilon_{it} \quad (3)$$

For the robustness of the IV estimates, I also estimate the first stage, allowing year-specific responses to the investment opportunity in the residential property market:

$$POST_{it} = \alpha_i + \delta_t + \theta_t \cdot PolConnection_i \times (-LandElasticity_c) + \kappa_{1t}(1 - LandElasticity_c) + \mu_{1t} PolConnection_i + \sum_k \eta_{kt} X_k^i + controls_{it} + \epsilon_{it}$$

This specification controls for the heterogeneous effect of entry on a year-to-year basis, which requires no modeling of the aggregate housing cycle. The corresponding second-stage regression is modified as:

$$Y_{it} = \alpha_i + \delta_t + \beta \cdot POST_{it} + \kappa_{2t}(1 - LandElasticity_c) + \mu_{2t} PolConnection_i + \sum_k \eta_{kt} X_k^i + controls_{it} + \epsilon_{it}$$

In addition to the two linear specifications, I estimate the first stage non-parametrically by including in the second-order fractional polynomials of the two instruments and their interaction terms. Because adding the polynomial controls is equivalent to imposing multiple instruments, I conduct the Hausman overidentification test.

### The Exclusion Restrictions

My key identification assumption is that when real estate prices are appreciating, the connected firms in a city with a flexible land supply do not necessarily gain more or less advantage in manufacturing compared to a similar firm in a city with an inflexible land supply. To test this exclusion restriction, I argue that the two instruments are uncorrelated with local economic trends, so that firms with

different exposures to them should not be subject to different aggregate shocks in the real estate business cycle.

The land availability of a city is pre-determined by geographical constraints. Given the large population in China and political considerations, cities are spread relatively evenly across the country<sup>29</sup>. Table 6 presents the economic activities and spatial distribution of cities in four quartiles of the land supply elasticity measure. The cities in the four quartiles are distributed almost evenly across economic regions and different city-tier divisions, except that the east region has more cities in the a lowest land supply elasticity category. The average rates of population growth, GDP per capita growth, and employment growth are also very similar in the different quartiles. Columns (4) to (6) in Table 5 show that the city-level land supply elasticity interacted with national house price growth cannot significantly predict the growth rate of population, wages, and overall employment at the city level<sup>30</sup>. Column (7) estimates the correlation between local export growth (measured as the ratio of the growth in total exports relative to total output) and land supply elasticity times the national house price growth. Controlling for city and industry fixed effects, the foreign demand for local manufacturing firms does not correlate with the instrumented local house price growth. Some inland cities, which are non-export intensive and experience less economic development than their coastal counterparts, also have a relatively inelastic supply of land due to geographical restrictions.

[Table 6 about here]

To show that local land supply elasticity does not correlate with housing demand, which might affect manufacturing demand via a substitution channel, I repeat the analysis in Davidoff (2016) by looking at how the elasticity index can predict the quantity growth of newly constructed residential properties. The results are summarized in Table 7: a 1% higher land supply elasticity is associated with a 6.49 percentage points increase in the total floor space purchased per year. These estimates stay statistically the same after controlling for local population growth and GDP per capita growth (in columns (2) and (3)), which implies that the land supply elasticity index does not correlate with shifts in the housing demand curve.

[Table 7 about here]

The potential connections between firm executives and local land bureau ministers are arguably exogenous to economic trends by construction. Table 8 compares the performance of manufacturing firms with and without a potential connection with the local land bureau between 1998-2002. Regardless of city-specific constraints in land supply, firms with and without future connections were similar in size, productivity, investment rate, profit margin, credit score, and age prior to the real estate boom.

<sup>29</sup>Figure A.1 in Appendix A provides an overview of the land supply elasticity index across China. Most cities that are short of land are located on the east coast or in the hilly areas in the west. The coastal region is considered the most economically active in China, while the western region has the least growth potential.

<sup>30</sup>The local economic variables are computed with both SOEs and private firms in all industries.

[Table 8 about here]

However, there is not a single sufficient test for the exclusion restriction, given that the firm-specific investment opportunities are not observable to econometricians. In particular, I cannot conclude that knowing the head of the local land bureau is completely independent from manufacturing investment opportunities. I argue that this possibility does not affect the validity of my proposed channel. First, the supply of industrial land has not been a significant constraint on manufacturing production in China<sup>31</sup>. Cai et al. (2013) discusses that corruption mostly happens among residential and commercial land auctions. Therefore, I consider the connection with local land bureaus as having little impact on manufacturing productivity. Second, knowing the head of the local land bureau is unlikely to be negatively correlated with the investment opportunities of firms. Therefore, my estimates at least indicate a lower bound of the causal effect. As a robustness check, I also control for firm-specific political connections with city mayors and vice-mayors, measured as whether or not they share the same home county.

### External Validity

The causal effects estimated using the instrumental variable approach are local average treatment effects (LATE). In a general framework, the relative return on real estate investment and the cost of entry are two key factors determining if a manufacturing entrepreneur would enter the real estate sector. Therefore, the estimation of average treatment effect would require a random entry assignment that is independent of these two factors. In other words, the LATE estimate of this paper is the effect of entry for firms with a connection with the local land bureau located in cities with constrained land supply. If such relationships appear in land markets with higher return and lower entry cost, the IV specification estimates the causal effect with more weights on these land markets.

### Main Results

Column (2) of Table 9 summarizes the OLS estimates using the sample of privately-owned firms that have been in operation since 1997. Following the establishment of a real estate development subsidiary, manufacturing firms on average reduce their R&D expenditure by 0.0056 per RMB of total assets; the average decline in capital spending is 0.042 per RMB of total assets; and labor productivity on average decreases by 6.4%. The effects on R&D intensity, investment rates, and labor productivity are equivalent to 7%, 25.4% and 5.2% of their respective standard deviation. Given that the accounting data of the manufacturing firms and their real estate subsidiaries are documented separately, the

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<sup>31</sup>Typically, the value of industrial land is 5%-10% of the value of a residential land



effect on labor productivity is unlikely to be driven only by the investment diversion into the real estate development industry.

Column (3) repeats the OLS analysis using firms that are selected using the nearest-neighbor matching estimator in Abadie and Imbens (2006, 2012). With the property development entrants matched to its similar non-entrants, the average effect of entry on labor productivity drops from 6.4% to 3.83% and the drop in R&D intensity becomes 0.0106, which is nearly twice as much as the full-sample estimates. The estimate of the coefficient of the investment rate changes the most. The average reduction of firm-level investment rate is 0.125, as opposed to 0.042 when estimating with the full sample. This is consistent with our previous conjecture: because labor productivity is more relevant to unobserved investment opportunity, the full-sample OLS estimates are likely to be downward biased. The bias in investment estimates depends on whether they are more sensitive to financial constraints or the unobserved labor productivity.

Column (4) presents my instrumental variable estimation. The entry decision of manufacturing firms is instrumented by local political connections to the land officials interacted with local land supply elasticity. The baseline IV estimates are close to the results in column (3): entry to the real estate development industry results in a reduction of manufacturing R&D by 0.012 and investment by 0.15 out of 1 RMB of total assets. This is equivalent to a 0.15 standard deviation drop in R&D intensity and a 0.95 standard deviation drop in the investment rate. In addition, average labor productivity of manufacturing firms also declines by 3.98% following entry. The first stage of the baseline specification is reported in column (1). For a manufacturing firm that has connections with the local land bureau, a 1% increase in instrumented local house price growth would lead to a 0.15% higher probability to enter into the property development business. Column (5) adds controls of the current political connection with city mayors and vice-mayors. The estimates are slightly larger than the ones using the baseline IV approach, but they are statistically indifferent.

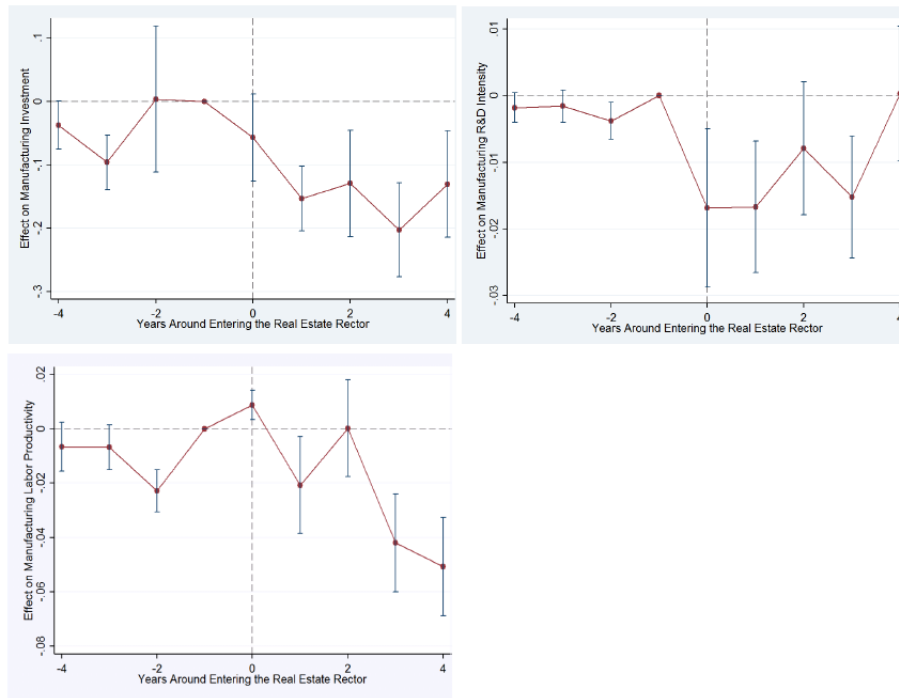
[Table 9 about here]

The IV estimates using nonlinear first-stage controls are reported in Table 10. Panel A of Table 10 reports the results of estimating heterogeneous year-specific responses to the real estate investment opportunity. The propensity of manufacturing firms to enter the real estate industry increases over time, except for 2008 when the Chinese economy underwent a severe slowdown. Panel B of Table 10 reports the results of adding non-parametric controls into the first stage regressions. The estimates are comparable with the baseline IV estimates, and the over-identification tests are not violated (with a p-value of 0.11). In the first stage, only the first- and second-order interaction terms are significant, so that the high-order controls do not impose many differences on the estimates.

[Table 10 about here]

Figure 5 provides the event study analyses on entering the real estate sector. No pre-trends are detected in either outcome variable of interest.

Figure 5: The Event Study Plots



## 4 The Social Efficiency of Entrepreneurial Talent Allocation

In the previous section, I provide solid empirical evidence about entrepreneurial talent allocation in a real estate boom: richer, more talented manufacturing entrepreneurs divert their resources from the manufacturing sector to the real estate sector. This section provides a tractable two-period model to rationalize the empirical findings and more importantly, to evaluate the efficiency of the observed entrepreneurial talent allocation in a real estate boom. The main purpose of this model is to assess whether private business owners enter the real estate sector following the criteria of a social planner.

There are three main features of the model: persistent and heterogeneous entrepreneurial talent, an imperfect financial market, and a minimum land requirement to enter the real estate sector. The persistence of entrepreneurial talent is crucial for the discussion of talent allocation. If different private business owners face idiosyncratic productivity shocks but have the same talent distribution a priori<sup>32</sup>, the allocation of entrepreneurial talent will not generate implications on efficiency ex ante.

<sup>32</sup>This condition also includes the case where the talent of all entrepreneurs follow the same Markov Process.

The imperfect financial market plays two important roles in this model: first, it governs the wealth accumulation of business owners with different talents; second, it partially determines the allocation of entrepreneurial talents in a real estate boom. Finally, the minimum land requirement in the real estate sector creates a friction in entrepreneurs' business choices. Only business owners who have accumulated enough wealth in the first period can overcome the entry barrier created by the minimum land requirement. The entry barrier arises because of the scarcity of land. The entry barrier of the real estate sector is therefore increasing with land price. In a growing economy, the cost of land use increases with total output. Therefore, industries using inflexible land as an input face a larger entry barrier compared to industries that use a flexible input (capital).

For tractability, I assume that there are only two sectors in the economy: manufacturing and real estate. For the rest of section 4 and section 5, I also label the private business owners as entrepreneurs, to match the notation in the literature. However, the results of the model can be generalized to an economy with multiple sectors and multiple periods. For the rest of this section, I refer to the real estate sector as the housing sector for notational purposes. A dynamic version of the model is discussed in Section 5.

## 4.1 Model Setup

The economy in the model consists of  $L$  workers and entrepreneurs with a measure of 1. Each entrepreneur is indexed by their talent in the manufacturing sector  $z^M \in [0, 1]$ , which is drawn from a cumulative distribution function  $F(z^M)$ .

### The First Period

In the first period, all entrepreneurs operate in the manufacturing sector. This is to model the period prior to the privatization of real estate construction<sup>33</sup>. Production in the manufacturing sector is constant returns to scale and uses capital and labor as inputs:

$$y(z^M, k, l) = (\exp(z^M)k)^{\alpha^M} l^{1-\alpha^M},$$

where  $1 - \alpha^M$  is the labor share in the manufacturing sector and  $k$  and  $l$  are the capital and labor input, respectively.

Each entrepreneur faces a *borrowing constraint*, which is modeled as a maximum leverage ratio of  $\lambda$ . Therefore, for a given level of wealth  $a$ , the maximum capital input has to satisfy:

$$k \leq \lambda a, \lambda \geq 1 \tag{4}$$

---

<sup>33</sup>In a more general setting, the model targets the entrepreneurs who operate in other industries prior to a real estate boom. Some of these entrepreneurs are reallocated into the real estate sector during the real estate boom. Therefore, it is reasonable to assume that they do not specialize in the real estate sector in the first stage.

The borrowing constraint assumption restricts the maximum of capital input of a firm to increase in entrepreneurs' wealth. This assumption implies a positive correlation between wealth and entrepreneurial talent, as shown in Table 3 and other work (Buera and Shin, 2013; Moll, 2014). It can be micro-founded by the limited enforcement of borrowing contracts between entrepreneurs and banks (Townsend, 1979; Holmstrom and Tirole, 1998). Such a constraint implies that self-financing is the primary mechanism for privately-owned firms to accumulate capital, which is well rooted in the literature. Song et al. (2011) and Hsieh and Klenow (2009) show that Chinese private firms rely heavily on self-financing and receive only limited funding from banks and insignificant equity funding. Moreover, a maximum leverage ratio that is independent of capital prices shuts down an additional inefficiency from capital prices fluctuations (Kiyotaki and Moore, 1997), so the discussion is more focused on the allocation of entrepreneurial talents. By varying  $\lambda$ , I can trace out all degrees of efficiency in the financial market:  $\lambda = \infty$  implies a perfect financial market, while  $\lambda = 1$  indicates that no firms can finance from external sources. The exact form of the borrowing constraint is not important here as long as the maximum investment is increasing in the entrepreneur's initial wealth  $a$  and non-decreasing in her talent  $z$ . I assume a constant  $\lambda$  across all groups for analytical convenience.

For simplicity, I further assume that all entrepreneurs have the same wealth  $a_0$  at the beginning of period 1. This assumption is to emphasize the importance of entrepreneurial talent on wealth accumulation<sup>34</sup>.

### The Second Period

In the second period, the economy experiences an unexpected real estate boom, and entrepreneurs have the option to enter the housing sector<sup>35</sup>. Production in the housing sector is also constant returns to scale. Due to the geographical constraint of land development, the total land supply in the economy is fixed at  $S$ .

Real estate developers use land and labor to produce housing:

$$h(z^H, s, l) = (\exp(z^H)s)^{\alpha^H} l^{1-\alpha^H},$$

where  $1 - \alpha^H$  is the labor share in the housing sector and  $s, l$  are the land and labor input, respectively.

The entrepreneurial talent in the housing sector is modeled as a reduced-form function of the entrepreneurial talent in the manufacturing sector:

$$z^H = c + bz^M \tag{5}$$

---

<sup>34</sup>In a more general setting, more talented entrepreneurs accumulate more wealth over time regardless of initial wealth distributions. I also present evidence in section 3 that more productive private firms in China on average own more assets. Therefore, the assumption is not crucial but simplifies the two-period model.

<sup>35</sup>The main reason for modeling an unexpected real estate boom is to derive closed-form solutions for policy discussions. The efficiency argument will hold when agents anticipate the real estate boom and adjust their savings for the cost barrier in the housing sector.

Equation (5) can be interpreted as the ex-ante correlation between entrepreneurs' comparative advantage and their absolute advantage. This is a key extension from the literature, where in expectation  $b$  is typically assumed to be 1 (Midrigan and Xu, 2014; Buera, Kaboski, and Shin, 2012). Letting  $b = 1$  is essentially assuming that all entrepreneurs have the same comparative advantage regardless of their talents in the manufacturing sector. Allowing  $b$  to differ from 1 generates heterogeneous comparative advantages of different entrepreneurs. I later show that when  $b$  is smaller than 1, entrepreneurs with higher talent in the manufacturing sector have both the absolute and the comparative advantage in producing in the manufacturing sector, and thus should not enter the housing sector in a real estate boom; when  $b$  is higher than 1, the talented entrepreneurs in manufacturing have the comparative advantage in the housing sector, although they are also more productive in the manufacturing sector.

Each entrepreneur is still subject to the maximum leverage ratio of  $\lambda$ , so the maximum capital and land input satisfy:

$$k + qs \leq \lambda a, \lambda \geq 1, \quad (6)$$

where  $q$  is the unit land price, which is taken as given for each entrepreneur.

In addition, there is a *minimum operating scale constraint* in the housing sector. If an entrepreneur were to operate in the housing sector, her land input has to be no lower than  $\underline{s}$ .

$$s \geq \underline{s} \text{ or } s = 0 \quad (7)$$

This assumption intends to model the inflexible land input and also plays a role for the imperfect financial market to influence the allocation of entrepreneurs across the two sectors<sup>36</sup>. If there is no such a constraint, i.e.  $\underline{s} \rightarrow 0$ , the borrowing constraint (5) only determines the land input of entrepreneurs at the intensive margin, i.e. the scale of investment in the housing sector, but not at the extensive margin.

### The Preference

Both the representative worker and entrepreneurs in the economy consume manufacturing goods only in the first period, and they consume both manufacturing goods and housing in the second period (after the real estate liberalization). Given that the real estate boom is unexpected, the agents maximize their utilities in the first period without incorporating the housing sector. Therefore, the utility criteria is:

$$U^1 = \log c_1 + \beta \log c_2,$$

---

<sup>36</sup>This assumption corresponds to the cash deposit requirement in the Chinese land market

where  $c_1$  is the consumption in the first period and  $c_2$  is the expected consumption in the second period.

In the second period, after the real estate liberalization starts, workers and entrepreneurs maximize total utility from consuming housing and manufacturing goods:

$$U^2 = \sigma \log c_2 + (1 - \sigma) \log h,$$

where  $h$  is consumption of housing and  $1 - \sigma$  is the housing consumption share in the second period. The elasticity of substitution between manufacturing goods and housing is assumed to be 1.

### Discussions of additional assumptions

In addition to the above assumptions, this model also assumes a constant-returns-to-scale production function in both the manufacturing and the housing sector. For each entrepreneur, the marginal ROA is independent from her total capital input. As a result, entrepreneurs will specialize either in the manufacturing sector or in the housing sector, except for the knife-edge case when an entrepreneur has the same marginal ROA in both sectors. In the empirical analysis in section 3, I argue that decreasing returns to scale is less likely to be the reason for more productive manufacturing firms to enter the real estate industry. The entrants do not have a declining internal investment rate or a significantly larger external investment rate. Besides, it is not intuitive to discuss the entrepreneurial talent allocation with a decreasing-returns-to-scale production function. Buera, Kaboski, and Shin (2012) relax the assumption of constant returns to scale, but they impose an additional assumption of a unique occupation for each entrepreneur. Therefore, I argue that the assumption of constant returns to scale provides a tractable framework to discuss the allocation of entrepreneurial talent without violating the empirical findings.

Last but not least, I do not model a per-period fixed cost in the manufacturing sector. This is not to propose that establishing a factory is less costly than building new homes. Instead, this assumption is motivated by the large differences in the value and depreciation rate of residential land and industrial land. The unit price of residential land is typically 7-10 times larger than the unit price of industrial land; as of 2012, the average fixed capital depreciation rate in the real estate sector is 50.04%, as opposed to the 12.68% capital depreciation rate in the manufacturing sector<sup>37</sup>. Once new houses are developed and sold to households, the real estate developers cannot re-use the lands to build more houses.

## 4.2 The Competitive Equilibrium

In the competitive equilibrium, there are four private markets in the economy: the labor market, the capital market, the land market, and the housing market. The first three markets are used to allocate

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<sup>37</sup>The statistics are from the 2012 China Input-Output Table of 122 3-digit industries.

production factors to entrepreneurs, and the housing market transfers wealth between entrepreneurs and workers. Each agent takes prices in the four markets as given to maximize their total utility. I next discuss the entrepreneurs' problems and the representative worker's problem in detail.

### The Entrepreneurs' Problems

In the first period, the entrepreneur with talent  $z^M$  makes decisions on consumption and savings in order to maximize her total utility in the two periods:

$$\begin{aligned} \max_{a_1(z^M)} U^1(z^M) &= \log c_1(z^M) + \beta \log c_2(z^M) \\ \text{s.t. } c_1(z^M) + a_1(z^M) &\leq \Gamma(\lambda, w_1, R_1, \exp(z^M)) \cdot a_0 \end{aligned} \quad (8)$$

$$c_2(z^M) \leq \Gamma(\lambda, w_2, R_2, \exp(z^M)) \cdot a_1(z^M), \quad (9)$$

where  $w_1$  and  $w_2$  are the real wage in the first and the second period, respectively; and  $R_1$  and  $R_2$  are the cost of capital in first and the second period. The two budget constraints (8) and (9) are obtained by solving the profit-maximization problem of entrepreneur  $z^M$ . In period  $t$  ( $t = 1, 2$ ), given initial wealth  $a_{t-1}(z^M)$ , entrepreneur  $z^M$  optimizes on labor and capital input subject to a borrowing constraint in the capital market:

$$\begin{aligned} \max_{k(z^M), l(z^M)} & [\exp(z^M)k(z^M)]^{\alpha^M} l(z^M)^{1-\alpha^M} - w_t l(z^M) - R_t [k(z^M) - a_{t-1}(z^M)] \\ \text{s.t. } & k(z^M) \leq \lambda a_{t-1}(z^M) \end{aligned}$$

#### Lemma 1:

*The entrepreneurs' wealth at the end of the first period,  $a_1(z^M)$ , is non-decreasing in  $z^M$ .*

(Proofs are provided in Appendix C). Lemma 1 is the result of the self-financing mechanism<sup>38</sup>: given the initial wealth, entrepreneurs with a higher talent in the manufacturing sector grow at a faster speed.

In the second period, when a real estate boom begins, the entrepreneur  $z^M$  faces the option to operate in the housing sector. Denoting  $p^H$  and  $q$  as the house price and land price in period 2, the profit-maximizing problem of entrepreneur  $z^M$  then becomes:

<sup>38</sup>The self-financing mechanism can be easily generalized into a model with infinite horizons: in a world without the financial frictions, only the most productive entrepreneur will participate in manufacturing production. However, when there is a maximum leverage ratio and the initial wealth of entrepreneurs is not too dispersed, firms with heterogeneous productivity would co-exist in the market. Although productive entrepreneurs can generate a higher return than unproductive entrepreneurs, its growth in each period is limited by the maximum borrowing constraint. Over time, the productive entrepreneurs occupy a larger and larger wealth share and eventually produce for all agents in the economy.

$$\begin{aligned}
& \max_{k(z^M), s(z^M), l_M(z^M), l_H(z^M)} [\exp(z^M)k(z^M)]^{\alpha^M} l_M(z^M)^{1-\alpha^M} + p^H [\exp(z^H)s(z^M)]^{\alpha^H} l_H(z^M)^{1-\alpha} \\
& \quad - w_2 [l_M(z^M) + l_H(z^M)] - R_2 [k(z^M) + qs(z^M) - a_1(z^M)] \\
& \text{s.t.} \quad k(z^M) + qs(z^M) \leq \lambda a_1(z^M) \\
& \quad \quad \quad s(z^M) \geq \underline{s} \quad \quad \quad \forall s(z^M) > 0,
\end{aligned}$$

where  $k(z^M)$  and  $l_M(z^M)$  refer to the capital and labor input of  $z^M$  in the manufacturing sector; and  $s(z^M)$  and  $l_H(z^M)$  refer to the land and labor input of  $z^M$  in the housing sector.

The utility-maximizing problem in the second period implies that each entrepreneur spends  $1 - \sigma$  of their total profit on housing and the rest  $\sigma$  of their total profit on purchasing manufacturing goods.

### The Worker's Problem

The representative worker in the economy has an endowment of  $e_0$  in the beginning of period 1. Like entrepreneurs, the representative worker consumes only the manufacturing goods in the first period without expecting the real estate boom in the second period. Therefore, the savings of the representative worker are determined by her utility maximization problem:

$$\begin{aligned}
& \max_{c_1^L, a_1^L} \log c_1^L + \beta \log c_2^L \\
& \text{s.t.} \quad c_1^L + a_1^L \leq R_1 e_0 + w_1 L \\
& \quad \quad c_2^L \leq R_2 a_1^L + w_2 L
\end{aligned}$$

In the second period, the workers spend a  $1 - \sigma$  fraction of their total income ( $R_2 a_1^L + w_2 L$ ) on housing and a  $\sigma$  fraction on purchasing manufacturing goods.

### The Competitive Equilibrium

The competitive equilibrium in this economy can be characterized with prices  $\{w_t, R_t, p^H, q\}$  ( $t = 1, 2$ ) such that the following conditions are satisfied:

1. Given prices  $\{w_t, R_t, p^H, q\}$ , entrepreneurs optimize on savings in the first period, factor inputs in the second period, and consumption of housing and manufacturing goods in the second period to maximize their total utility.
2. Given prices  $\{w_t, R_t, p^H, q\}$ , the representative worker optimizes on savings in the first period and consumption of housing and manufacturing goods in the second period to maximize her total utility.



3. The labor market clears in the both periods, such that the total labor input in the economy is equal to  $L$ .
4. The capital market clears in both periods. Savers in the capital market include workers and entrepreneurs who have a return on capital lower than  $R_t$ ; borrowers in the capital market are entrepreneurs who have a return on capital higher than  $R_t$ .
5. The land market clears in the second period. The total land used in production in the housing sector is equal to the exogenous land supply  $S$ .
6. The housing market clears in the second period. The total supply of housing is equal to the total housing demand of entrepreneurs and workers.

**Proposition 1:**

*There exists a unique competitive equilibrium in the economy. When the initial endowment of the representative worker is large enough, the allocation of entrepreneurial talent in the real estate boom can be characterized as follows:*

- a) *If  $b \geq 1$ , there exists two cutoffs  $\underline{z}^M$  and  $z_h^M$ , such that entrepreneurs with talent  $z^M \in (\underline{z}^M, z_h^M]$  operate in the manufacturing sector; entrepreneurs with talent  $z^M \in (z_h^M, 1]$  operate in the housing sector; and entrepreneurs with talent  $z^M \in [0, \underline{z}^M]$  exit and only save in the capital market.*
- b) *If  $b < 1$ , the allocation of entrepreneurial talents can be characterized with three cutoffs:  $\underline{z}^M$ ,  $z_l^M$  and  $z_h^M$ . Entrepreneurs with talent  $z^M \in (\underline{z}^M, z_l^M] \cup (z_h^M, 1]$  operate in the manufacturing sector; entrepreneurs with talent  $z^M \in (z_l^M, z_h^M]$  operate in the housing sector; and entrepreneurs with talent  $z^M \in [0, \underline{z}^M]$  exit and only save in the capital market.*

The structural parameter  $b$  pins down the structure of comparative advantage<sup>39</sup>. When  $b > 1$ , entrepreneurs' comparative advantages in the housing sector,  $z^H - z^M$ , are increasing in their manufacturing talents  $z^M$ . In other words, entrepreneurs with higher talents in the manufacturing sector have relatively higher returns to capital in the housing sector. Given prices, the talented manufacturing entrepreneurs should specialize in housing in the second period, leaving two cutoffs for characterizing the equilibrium:  $\underline{z}^M$  as determining whether or not to produce and  $z_h^M$  as determining the business choice. On the other hand, when  $b < 1$ , entrepreneurs' comparative advantages in the housing sector are decreasing in their manufacturing talents  $z^M$ . However given the entry barrier in the housing sector, entrepreneurs with low  $z^M$ 's are not able to accumulate enough wealth to enter the housing sector. As a result, entrepreneurs with talent  $z^M \in (\underline{z}^M, z_l^M]$  could not follow their comparative advantage in producing housing.

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<sup>39</sup>A detailed discussion of the comparative advantage will be provided in section 4.3.

### 4.3 The Social Planner's Problem

This section examines whether the entrepreneurial talent allocation in the competitive equilibrium is constrained efficient. In doing so, I assume that the social planner faces the same constraints as individual entrepreneurs: the individual borrowing constraint and the minimum operating scale constraint in the real estate sector. In other words, the social planner cannot arbitrarily assign production factors to entrepreneurs. Given that the real estate boom is unanticipated and that all agents in the economy have the same utility function, the social planner solves the first period as what entrepreneurs and workers achieve in a competitive equilibrium. This is a result implied by the second welfare theorem.

In the second period, I write the social planner's objective function following Gorman's Aggregation Theorem:

$$U = \chi \log C + \log H,$$

where  $C$  is the total consumption of entrepreneurs and workers and  $H$  is the total housing consumption in the economy.  $\chi = \frac{\sigma}{1-\sigma}$  is the Pareto weight that corresponds to the competitive equilibrium.

I first define the comparative advantage in the planner's problem. As discussed in Proposition 1, the entry barrier in the housing sector is the key constraint at the extensive margin. Entrepreneurs without enough wealth cannot achieve the minimum scale in the real estate sector. The comparative advantage is defined as the allocation criteria followed by a social planner, assuming that there is no constraint at the extensive margin.

#### **Definition of Comparative Advantage:**

*The comparative advantage of an entrepreneur is defined as the ratio of the marginal returns on capital in the two sectors. With a monotonic transformation, it is equivalent to  $z^H - z^M$ .*

The difference between the social planner's constrained optimization problem and a competitive equilibrium is that the social planner is aware that land prices are a function of the allocation of entrepreneurs. In the social planner's problem, there also exists the private markets for land, capital, labor, and housing. Solving the social planner's problem is thus equivalent to solving for the cutoffs described in Proposition 1.

In the first case, when  $b > 1$ , entrepreneurs with a higher talent in manufacturing have the comparative advantage in the housing sector. The social planner solves for the cutoff for producing,  $\underline{z}^M$ , and the cutoff for entering the housing sector  $z_h^M$ :

$$\begin{aligned} & \max_{\{\underline{z}^M, z_h^M, l(z^M)\}} && \chi \log C + \log H \\ \text{s.t.} & C = \int_{\underline{z}^M}^{z_h^M} [\exp(z^M)k(z^M)]^{\alpha^M} l(z^M)^{1-\alpha^M} dF(z^M) && (10) \\ & H = \int_{z_h^M}^1 [\exp(z^H)s(z^M)]^{\alpha^H} l(z^M)^{1-\alpha^H} dF(z^M) && (11) \\ & \lambda \int_{\underline{z}^M}^{z_h^M} a_1(z^M) dF(z^M) = \int_0^1 a_1(z^M) dF(z^M) + a_1^L && (12) \\ & \lambda a_1(z_h^M) \geq \frac{\lambda \int_{z_h^M}^1 a_1(z^M) dF(z^M)}{s} \underline{s} && (13) \\ & \int_{\underline{z}^M}^1 l(z^M) dF(z^M) = L && (14) \end{aligned}$$

In this problem, equations (10), (11), (12) and (14) refer to the resource constraints on the goods market, housing market, capital market, and labor market, respectively. The constraint (13) combines the resource constraint on the land market and the minimum operating scale constraint.  $\frac{\lambda \int_{z_h^M}^1 a_1(z^M) dF(z^M)}{s}$  is the effective land price in this social planner's problem.

In the second case, when  $b < 1$ , entrepreneurs with a lower talent in manufacturing have the comparative advantage in the housing sector. The social planner solves for three thresholds: one for producing,  $\underline{z}^M$ , and two for operating in the housing sector:  $z_l^M, z_h^M$ . The social planner's problem can be written as:

$$\begin{aligned} & \max_{\{\underline{z}^M, z_l^M, z_h^M, l(z^M)\}} && \chi \log C + \log H \\ \text{s.t.} & C = \int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} [\exp(z^M)k(z^M)]^{\alpha^M} l(z^M)^{1-\alpha^M} dF(z^M) && (15) \\ & H = \int_{z_l^M}^{z_h^M} [\exp(z^H)s(z^M)]^{\alpha^H} l(z^M)^{1-\alpha^H} dF(z^M) && (16) \\ & \lambda (\int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} a_1(z^M) dF(z^M)) = \int_0^1 a_1(z^M) dF(z^M) + a_1^L \quad (\mu_k) && (17) \\ & \lambda a_1(z_l^M) \geq \frac{\lambda \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)}{s} \underline{s} \quad (\mu_e) && (18) \\ & \int_{\underline{z}^M}^1 l(z^M) dF(z^M) = L \quad (\mu_l) && (19) \end{aligned}$$

Similar to the first case, equations (15), (16), (17) and (19) refer to the resource constraints on the goods market, housing market, capital market, and labor market, respectively. The constraint (18) combines the resource constraint on the land market and the minimum operating scale constraint.

**Proposition 2:**

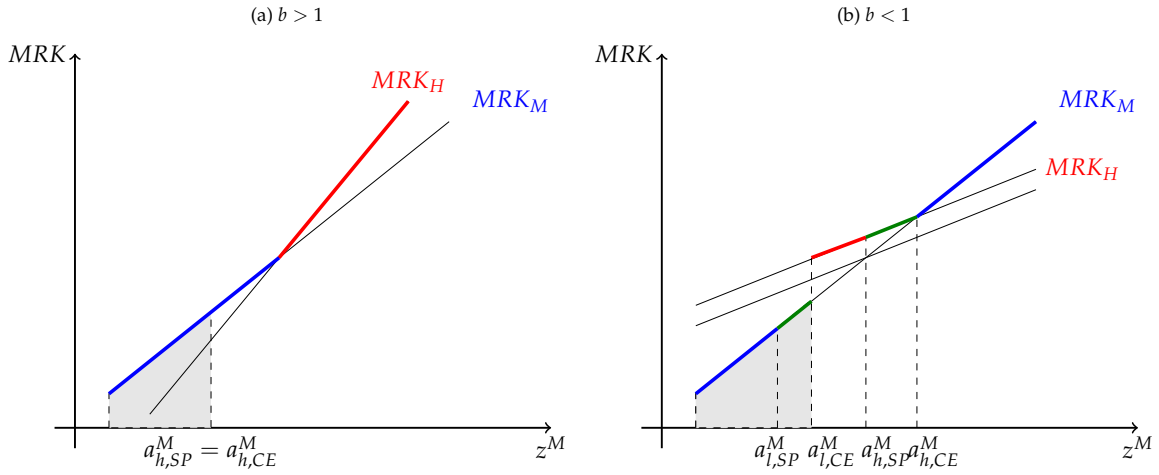
*When the least talented manufacturer  $z^M$  is constrained from entering the housing sector, the competitive equilibrium is constrained efficient if and only if  $b \geq 1$ . In the case when  $b < 1$ , both  $z_l^M$  and  $z_h^M$  are higher in the competitive equilibrium than in the social planner's problem.*

The socially optimal allocation of entrepreneurs should be determined by their comparative advantages in the housing and the manufacturing sectors. Whether or not a financial market friction can distort the entrepreneurs' choices at the extensive margin is then determined by the relationship between entrepreneurs' comparative advantages and their absolute advantages in the manufacturing sector. Panel (a) of Figure 6 illustrates an example of a positive correlation between the comparative advantage in the housing sector and the absolute advantage (talent) in the manufacturing sector, meaning that entrepreneurs with high  $z^M$ 's should switch to the housing sector in the optimal situation. In this case, the entry barrier in housing production does not impose additional distortions of the entrepreneurs' allocation. The productive manufacturing entrepreneurs would have accumulated enough wealth, so they are in fact unconstrained by the entry barrier in housing production.

Panel (b) of Figure 6 shows an opposite example, in which entrepreneurs with low  $z^M$ 's should operate in housing production in the optimal situation. The thresholds labeled with "CE" refer to the competitive equilibrium, and the thresholds labeled with "SP" refer to the solution to the social planner's problem. The entry barrier and financial market imperfection prevent these unproductive manufacturing entrepreneurs from entering the real estate sector. According to the empirical evidence provided in section 3, entrepreneurs entered the real estate sector have a higher talent in manufacturing. However, when entrepreneur-specific financing ability is controlled, the pattern no longer exists: unproductive manufacturing entrepreneurs are more likely to enter the real estate sector. This empirical evidence suggests that the entrepreneurs' comparative advantage is negatively correlated with their talent (absolute advantage) in the manufacturing sector, and that the financial market imperfection is distorting the allocation of entrepreneurs across sectors.

Two groups of entrepreneurs' choices at the extensive margin are distorted. First, the entry barrier results in a lack of competition in the land market, which extracts monopolistic rents to the land owners. The monopolistic rents attract entrepreneurs with talent in  $(z_{h,SP}^M, z_{h,CE}^M]$  to enter the housing sector. Given that the more talented manufacturing entrepreneurs also own more wealth, the land price is higher in the competitive equilibrium than in the planner's problem. Therefore, a larger fraction of entrepreneurs who have a higher comparative advantage in housing are constrained from entry. This group refers to entrepreneurs with talent in  $(z_{l,SP}^M, z_{l,CE}^M]$ . Endogenizing land prices allows the social planner to allocate entrepreneurs efficiently at the extensive margin. In section 5, I provide more evidence on the negative correlation between comparative advantage in housing and the absolute advantage in manufacturing.

Figure 6: The Entrepreneurs' Business Choices



#### 4.4 Discussion of Policy Tools

In this section, I focus on the case when  $b < 1$  and discuss three policy tools for improving social welfare: liberalizing the financial market, a more flexible schedule for land supply (or a reduced entry barrier), and taxation on the return on capital in the real estate sector.

The first two policy tools relax the borrowing constraint and the minimum operating scale constraint, respectively. These changes not only apply to the competitive equilibrium but also relax the constraints in the planner's problem. As a result, financial market liberalization and increasing land supply do not help with alleviating the inefficiency. The taxation on returns in the real estate sector, on the other hand, directly reduces the excess return due to the lack of entry, so that it partly solves for the inefficiency in the entrepreneurial talent allocation.

##### Financial market liberalization:

*A more liberalized financial market (a higher  $\lambda$ ) increases  $z^M$  and lowers  $z_l^M$  and  $z_h^M$ , resulting in higher social welfare but larger inefficiency at the extensive margin.*

In theory, a more liberalized financial market can be modeled as a marginal increase in the maximum leverage ratio  $\lambda$ . A higher  $\lambda$  is welfare-improving from two aspects. First, it directly reduces the resource misallocation in the economy, given that more productive entrepreneurs are allowed to borrow more. Second, the constrained entrepreneurs who have the comparative advantage in the housing sector are more capable of acquiring capital, so that they are more likely to overcome the entry barrier in the housing sector.

This result suggests that given existing constraints in the real estate sector, in a developed country

where the financial market is less imperfect, the social welfare is higher than in a developing economy. The finding is consistent with the literature, which argues that a more liberalized financial market improves resource misallocation. However, the inefficiency (the discrepancy between the competitive equilibrium and the planner's solution) at the extensive margin is exacerbated. The already wealthy entrepreneurs are now able to borrow more, which further increases the land prices. As a result, more entrepreneurs with low wealth (and therefore comparative advantages in the housing sector) are constrained by the entry barrier. A detailed proof is provided in Appendix C.

**A lower cost barrier to entry:**

*A smaller entry barrier in the real estate sector (a smaller  $\frac{s}{\bar{s}}$ ) lowers  $\underline{z}^M$ ,  $z_l^M$ ,  $z_h^M$ , and lowers inefficiency at the extensive margin. The welfare consequence is ambiguous.*

An increase in land supply in the model is equivalent to a decline in the minimum operating scale, which effectively lowers  $\frac{s}{\bar{s}}$ . This policy directly targets the origin of the social inefficiency, so that entrepreneurs are less constrained by the entry barrier in the real estate sector. In reality, the flexibility of land supply is often subject to geographical or political constraints. Lowering the entry barrier in the real estate market has an ambiguous impact on aggregate welfare. Despite the fact that the minimum operating scale in the real estate sector is lower, there are more entries in the real estate sector. Unproductive entrepreneurs, who might have become savers when the entry barrier is large, now produce actively. The aggregate productivity is thus lower.

**Taxation on the return from property sales (the stamp duty):**

*Taxing the returns from real estate development lowers  $\underline{z}^M$ ,  $z_l^M$  and  $z_h^M$ , resulting in a higher social welfare and a lower inefficiency at the extensive margin.*

This policy tool is equivalent to imposing a wedge on the returns from selling houses. Instead of obtaining  $p^H$  from selling one unit of housing, the real estate developers now get  $p^H(1 - \tau)$ . Taxing the returns on the real estate market do not change the planner's problem. It is also an effective policy because it lowers the return from producing in the real estate sector, so the more talented entrepreneurs in the manufacturing sector lose the incentive to enter. Due to the lack of entry of wealthy entrepreneurs, the land price is also lower so fewer entrepreneurs with a comparative advantage in housing are constrained from entry. In summary, this policy tool deals with both groups of entrepreneurs who were inefficiently allocated in the original competitive equilibrium by correcting their incentives.

## 5 Quantitative Evaluation

For the quantitative evaluation, I generalize the two-period model to a life-cycle model with overlapping generations. The economy consists of  $L$  workers and  $N$  groups of entrepreneurs. Each agent in

the economy works for 30 years and saves for 20 years after retiring<sup>40</sup>. While working, both workers and entrepreneurs can only save in the capital market. Young workers earn labor compensation, and young entrepreneurs earn manager compensation as a fraction of old entrepreneurs' investment return through managing their family firms. When agents retire, they can either save in the capital market or old entrepreneurs can invest in their family firms. The technology and preferences are the same as in the two-period model.

In each period, each old entrepreneur makes decisions on the capital investment into the family firm, while the young entrepreneur as the manager decides on the business choices of the company. Each family firm still faces the borrowing constraint and the minimum operating scale constraint in section 4. Therefore, both the entrepreneurial talent of the young manager and the firm-specific financing ability determines the business choice of each firm. I assume that there is no agency problem between the old entrepreneurs and the managers of their family firms. Allowing entrepreneurs to save in their family firms guarantees that entrepreneurs with different talent accumulate their wealth at different speeds. Therefore, the positive correlation between wealth and talent still holds in the life-cycle model.

I first focus on the structural estimation of  $b$  using data on the manufacturing performance and real estate performance of the same entrepreneur. From the discussions in section 4,  $b$  is the key parameter that governs the relationship between the comparative advantage and absolute advantage of entrepreneurs. The allocation of entrepreneurial talent is inefficient when  $b < 1$ , which implies productivity manufacturing entrepreneurs are not more productive in the housing sector. The identification of  $b$  then answers if the observed allocation of entrepreneurial talent is efficient or not in the Chinese real estate boom.

Next, I calibrate the life-cycle model with overlapping generations using aggregate moments from China. In the literature, the entry barriers in industries are often calibrated using the average firm size. In my model, however, both the entry barrier and the structural parameter  $b$  govern the selection into real estate. Therefore, they cannot be jointly identified using the average firm size in the real estate sector. I take the estimated parameter  $b$  as given and calibrate the entry barrier  $\underline{s}$  and other parameters of the model by matching empirical moments during 1997 to 2010, which corresponds to the coverage of my sample. Based on the calibration, I conduct policy counterfactuals that focus on the three policy tools discussed in section 4.

## 5.1 Structural Estimation

I structurally estimate the parameter  $b$ , which governs the correlation between the comparative advantage and the absolute advantage of entrepreneurs. In the data, entrepreneurs also face idiosyncratic productivity shocks. Estimating  $b$  at the firm level is not realistic and also subject to large

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<sup>40</sup>The parametrization follows Song et al. (2011)

measurement errors. I follow the literature of comparative advantage (Hurst et al. 2013; Adao, 2015) by estimating  $b$  at a higher level. I divide entrepreneurs into groups according to their levels of education and work experience. Because my data covers only the first six years of the real estate boom, I consider the education and work experience of each manager as stable and pre-determined within this period. Studying the behavior of entrepreneurs across groups further alleviates the concern about the constant-returns-to-scale assumption. In the model, although each entrepreneur only specializes in one sector, there is partial specialization at the group level, which matches the observation in the data.

The talent of a given entrepreneur  $i$  in group  $g$  is assumed to satisfy the following structure:

$$\begin{aligned} z_{it}^M &= \bar{z}_g^M + \zeta_t^M + \omega_{it} \\ z_{it}^H &= \bar{z}_g^H + \zeta_t^H + \epsilon_{it} \\ \bar{z}_g^H &= c + b\bar{z}_g^M \end{aligned}$$

$\bar{z}_g^M$  and  $\bar{z}_g^H$  are constant group-average productivity in the manufacturing sector and the housing sector;  $(\zeta_t^M, \zeta_t^H)$  are aggregate productivity shocks to these sectors; and  $\omega_{it}, \epsilon_{it}$  are idiosyncratic unexpected productivity shocks<sup>41</sup>, which do not depend on group  $g$ . This structure of entrepreneurial talents is designed to facilitate the identification of  $b$ , which is key to determining the efficiency of talent allocation as discussed in Proposition 2.

The structural parameter  $b$  governs the correlation between the group-specific comparative advantage and absolute advantage. When  $b > 1$ , the groups with an absolute advantage in the manufacturing sector should specialize more in the real estate sector in the event of a real estate boom; when  $b < 1$ , the groups with an absolute advantage in the manufacturing sector should stay in manufacturing.

I estimate the structural parameter  $b$  using a unique firm-level data set that matches manufacturing firms to their real estate subsidiaries. This is equivalent to matching the manufacturing business and the real estate business of the same entrepreneur. The key structural parameter  $b$  cannot be identified using a standard simulated method of moments approach, as usual macro moments (establishment scale) cannot distinguish  $b$  from the entry barrier  $\underline{s}$ . In other works on misallocation and growth in a multi-sector economy,  $b$  is typically assumed to be 1. As a result, the average size of entrants pins down the entry barrier parameter. However, if  $b$  is not fixed, the size of entrants is determined by both the entry barrier and the comparative advantage of the entrants. The micro-level data makes it

<sup>41</sup>In an economy with only idiosyncratic productivity shocks and with  $\bar{z}_g$  identical among entrepreneurs, there is also inefficient allocation of talent in the presence of an incomplete financial market and a cost barrier to entry (Burea, Kaboski and Shin, 2012). Adding the ex-ante heterogeneity of entrepreneurial talents, however, will likely to create a larger inefficiency ( $b < 1$ ) or a smaller inefficiency ( $b > 1$ ). The self-financing mechanism (as shown in Lemma 1) induces a positive correlation between wealth and entrepreneurial talent.



possible to jointly identify the comparative advantage of entrepreneurs and the entry barrier in the real estate sector.

## Data

The data used for the structural estimation are mainly from three sources: the AIS, the ERD, and the 2008 Economic Census. The AIS is used to estimate the manufacturing production function and group specific average productivity. The ERD contains the shareholding information of all registered businesses in China. Therefore, I can use the registration database to match manufacturing firms to their real estate development subsidiaries. A detailed introduction of the two data sets is provided in section 3.1.

Given that the AIS only covers industrial firms, I collect the operation information of the real estate firms using the National Economic Census. There have been three national economic censuses, which were carried out in 2004, 2008, and 2013 respectively. Given that the housing market reforms were not yet completed by 2004 and that the micro-level data of the 2013 census is still not available, I use the cross section of the 2008 national economic census to estimate the production of real estate development firms. The second national economic census in 2008 covered over 7,099,000 enterprises in China's secondary and tertiary industries, including data about production, management, investment, and corporate structure at the firm level. Table 1 provides a summary of the variables from the National Economic Census. In the Economic Census data, 1,299 real estate firms are found to be subsidiaries of manufacturing companies covered by the AIS.

The manager information is obtained from the ERD. I classified the managers into different groups according to their levels of education and work experience, which are pre-determined and not influenced by any firm-specific shocks between 1995 and 2010. There are 20 groups based on five levels of education and four quartiles of managers' work experience. The five education levels include graduate, undergraduate and post-high school, high school and vocational high school, middle school, and elementary school and below. The experience of managers varies from 1 to 48 years. I then divide the managers into four quartiles based on their managing experience

## Estimating the Structural Parameter

The structural estimation of  $b$  is equivalent to regressing the marginal return to capital in the real estate sector on the marginal return to capital in the manufacturing sector. As illustrated in Figure 2, the marginal return to capital in the real estate sector is labelled with red, and the marginal return to capital in the manufacturing sector is labelled with blue. The regression is derived from the following specification, which is directly implied by the model:

$$\log \frac{p_t^h h_{it}}{k_{it}} - \log \pi_t^H = c + b z_g^M + \zeta_t^H + \epsilon_{it}, \quad (20)$$

where  $\pi_t^H = \left(\frac{1-\alpha^H}{w_t}\right) \frac{1-\alpha^H}{\alpha^H} \frac{p_t^{1/\alpha^H}}{q_t}$  and  $\frac{p_t^h h_{it}}{k_{it}}$  is the average product of capital. I estimate the group-specific talent in the manufacturing sector,  $\bar{z}_g^M$ , with firm-level data prior to the real estate boom.

There are two key challenges for the estimation of  $b$ : first, the observed marginal return to capital in the manufacturing sector has measurement error, which creates attenuation bias; and second, I do not observe the real estate performance of entrepreneurs who did not enter the real estate sector, which induces selection bias. The selection bias leads to the error term  $(\epsilon_{it}|H_{g,t})$  not centering around 0:

$$E\left(\log \frac{p_t^h h_{it}}{k_{it}}\right) = \text{const} + b \bar{z}_g^M + E(\epsilon_{it} | (\epsilon_{it}, \omega_{it}) \in H_{g,t}), \quad (21)$$

where  $H_{g,t}$  indicates the group of entrepreneurs in group  $g$  that choose to enter the real estate sector in year  $t$ .

The measurement error problem biases the estimate of  $b$  towards 0. The selection bias results in the estimate of  $b$  being biased towards 1. When  $b > 1$ , more productive manufacturing entrepreneurs should specialize in the real estate sector. The probability of entry into the real estate sector is increasing in  $\bar{z}_g^M$ , so the correlation between  $E(\epsilon_{it} | (\epsilon_{it}, \omega_{it}) \in H_{g,t})$  and  $\bar{z}_g^M$  is negative. Therefore, the self-selection of entrepreneurs induce a downward bias. When  $b < 1$ , more productive manufacturing entrepreneurs should specialize more in the manufacturing sector, so that the probability of entry into the real estate sector is decreasing in  $\bar{z}_g^M$ . In this case, the correlation between  $E(\epsilon_{it} | (\epsilon_{it}, \omega_{it}) \in H_{g,t})$  and  $\bar{z}_g^M$  becomes positive and the self-selection introduces an upward bias. In summary, the selection bias would result in  $b$  to be biased towards 1.

I correct for the attenuation bias using the Empirical Bayes approach, which is often used in the literature for evaluating the value added from teachers (Kane and Staiger, 2008; Meghir and Rivkin, 2011; Chetty, Friedman and Rockoff, 2014). As with the selection bias, I employ the non-parametric bias correction approach following Das, Newey, Vella (2003). The approach is similar to the Heckman two-step correction but does not require a normality assumption. The main idea of this approach is to proxy for the selection bias with a non-parametric function of the firm-specific propensity score for entering the real estate sector.

I conduct the estimation of  $b$  following a three-step procedure. In the first step, I estimate the average talent of each group of entrepreneurs as the average Solow residual, using data prior to 2002. During this period, the manufacturing entrepreneurs have little incentive or ability to enter the real estate development industry, so the estimation is not subject to selection bias. Second, I estimate the entrepreneur-specific propensity score of entering the real estate industry. The city-specific land supply elasticity and the entrepreneur's potential connection with the local land minister are used as

instruments for correcting the selection bias. Finally, I plug in the Bayes-adjusted estimate of group-specific manufacturing talent to estimate equation (21). The selection bias,  $E(\epsilon_{it} | (\epsilon_{it}, \omega_{it}) \in H_{g,t})$ , is proxied with a non-parametric function of the propensity score of entry, as estimated in the second step.

Next I discuss the three-step identification procedure in detail.

**Step 1:** As discussed in section 2, the Chinese housing market was highly regulated on the demand side and the supply side in the 1990s. Prior to the 2002 land market reform, privately-owned manufacturing firms had neither the ability nor the incentive to enter into the property development industry. Therefore, manufacturing entrepreneurs focused only on manufacturing production during the pre-boom era. I estimate the entrepreneurs' talent in the manufacturing sector following Basu and Fernald (1997)<sup>42</sup> by estimating a residual from the production function:

$$\frac{1}{\alpha_{Ind_i}^M} \log y_{it} - \log k_{it} - \frac{1 - \alpha_{Ind_i}^M}{\alpha_{Ind_i}^M} \log l_{it} = \alpha_0 + \alpha_g + \delta_t + e_{it}, \quad (22)$$

where  $\alpha_{Ind_i}^M$  is the average capital share of the 4-digit industry to which entrepreneur  $i$  belongs and  $\hat{\alpha}_g$  is an estimate of the group specific manufacturing talent,  $\bar{z}_g^M$ . To correct for the attenuation bias induced by the measurement errors, I apply an empirical Bayes approach. The group-specific talent,  $\bar{z}_g^M$ , is assumed to be drawn from a higher-level distribution:

$$\bar{z}_g^M \sim G_0(z_0, \sigma_0^2),$$

where  $z_0$  and  $\sigma_0^2$  are the mean and variance of the higher-level distribution. The estimated group-specific talent,  $\hat{\alpha}_g$ , then follows a lower-level distribution that is centered around  $\bar{z}_g^M$ :

$$\hat{\alpha}_g \sim G_1(\bar{z}_g^M, \sigma_1^2),$$

where  $\sigma_1^2$  represents the measurement error. The empirical Bayes estimate of  $\bar{z}_g^M$  is thus:

$$\hat{\bar{z}}_g^M = \frac{\hat{\sigma}_1^2}{\hat{\sigma}_0^2 + \hat{\sigma}_1^2} \hat{z}_0 + \frac{\hat{\sigma}_0^2}{\hat{\sigma}_0^2 + \hat{\sigma}_1^2} \hat{\alpha}_g,$$

where  $\hat{z}_0$  is estimated as the constant  $\hat{\alpha}_0$  from regression (22);  $\hat{\sigma}_0^2 + \hat{\sigma}_1^2$  is estimated as the variance of  $\hat{\alpha}_g$ , and  $\hat{\sigma}_1^2$  is estimated as the average within-group variance of each  $\hat{\alpha}_g$ .

The estimation is conducted with the unbalanced sample of firms from 1997 to 2002.

<sup>42</sup>The estimation in this paper is a simplified version of Basu and Fernald (1997). First, I assume that the markets are perfectly competitive so the markups in both the manufacturing and housing sector are equal to 1. Second, I assume that entrepreneurs produce with only capital and labor so the factor shares for value added is the same as the factor shares for total output.

**Step 2:** The purpose of the second step is to estimate the propensity of entrepreneur  $i$  (firm  $i$ ) entering the real estate sector, i.e.  $P((\epsilon_{it}, \omega_{it}) \in H_{g,t})$ . Due to data availability, I could not observe a dynamic panel for the real estate development firms. Therefore, the propensity score is estimated as the probability of entering into the real estate industry between 2004 and 2008, using a semi-parametric specification:

$$\begin{aligned} Entry_{i,2008} = & \gamma_0 + \gamma_1 \log w_{c,2004} + \gamma_2 \log p_{c,2008} + \gamma_3 \log q_{c,2004} + F(\hat{z}_g^M, a_{i,2004}, CreditScore_{i,2004}) \\ & + \gamma_4 PolConnection_i + \gamma_5(1 - Elasticity_c) + \gamma_6 PolConnection_i(1 - Elasticity_c) \end{aligned}$$

, where  $F(\hat{z}_g^M, a_{i,2004}, CreditScore_{i,2004})$  is a fractional polynomial function of  $\hat{z}_g^M$ , firm  $i$ 's total asset value in 2004 -  $a_{i,2004}$ , firm  $i$ 's credit score in 2004, and their interaction terms. The fitted value  $Entry_{i,2008} \equiv \hat{P}_i$  is the estimated propensity score for entry.

**Step 3:** The last step estimates  $b$  and tests the structural relationship between  $b$  and 1. The identifying assumption is that conditional on  $\hat{z}_g^M$  and other factors used to estimate the propensity score of entry, the unobserved  $\epsilon_{it}$  is orthogonal to  $\hat{z}_g^M$ <sup>43</sup>:

$$E(\epsilon_{it} | (\epsilon_{it}, \omega_{it}) \in H_{g,t}, w_t, p_t, q_t, a_{it}, \hat{z}_g^M, \hat{P}_i) = 0$$

With the identifying assumption, the selection bias can be corrected with a non-parametric specification of the estimated propensity score<sup>44</sup>:

$$\log \frac{p_t^H h_i}{k_i} = \alpha_c + b(\hat{z}_g^M) + \Lambda(\hat{P}_i) + \epsilon_{it},$$

where  $t$  is the year of 2008;  $\alpha_c$  is city fixed effect to control for local prices in city  $c$ ;  $\Lambda(\hat{P}_i)$  is a fractional polynomial function of the estimated propensity score  $\hat{P}_i$ , which works as a proxy for the selection bias  $E(\epsilon_{it} | (\epsilon_{it}, \omega_{it}) \in H_{g,t})$ ; and  $\hat{b}$  is a consistent estimator of  $b$ , so the test of an efficient allocation of entrepreneurial talent is equivalent to testing the null hypothesis of  $H_0 : b > 1$ . Following the literature of control functions (Wooldridge, 2007), I conduct the statistical inference based on bootstrapping the sample at the manager level.

<sup>43</sup>The methodology would still work if we generalize  $z_i^H$  to be a time-varying Markov process:  $z_{it}^H = f(z_{i,t-1}^H) + \epsilon_{it}$ . In this case, the identifying assumption is valid as long as managers make their occupation choices for period  $t$  before  $z_{it}^H$  is realized. The non-parametric propensity score controls for the variation in  $z_{i,t-1}^H$  that can be explained by  $\hat{z}_g^M$ . The remaining component, together with unexpected shocks  $\epsilon_{it}$  and  $\epsilon_{it}$ , would still be orthogonal to  $\hat{z}_g^M$ .

<sup>44</sup>A proof and related discussion can be found in Das, Newey and Vella (2003).

**Main Results**

I first provide raw patterns from data that suggest  $b < 1$ , i.e. the entrepreneurs with the absolute advantage in the manufacturing sector do not also have a comparative advantage in the real estate sector. Figure 7<sup>45</sup> plots the average return to capital in the two sectors against the entrepreneurs' talent in manufacturing as estimated in step 1.

Figure 7: Average Return to Capital in Two Sectors

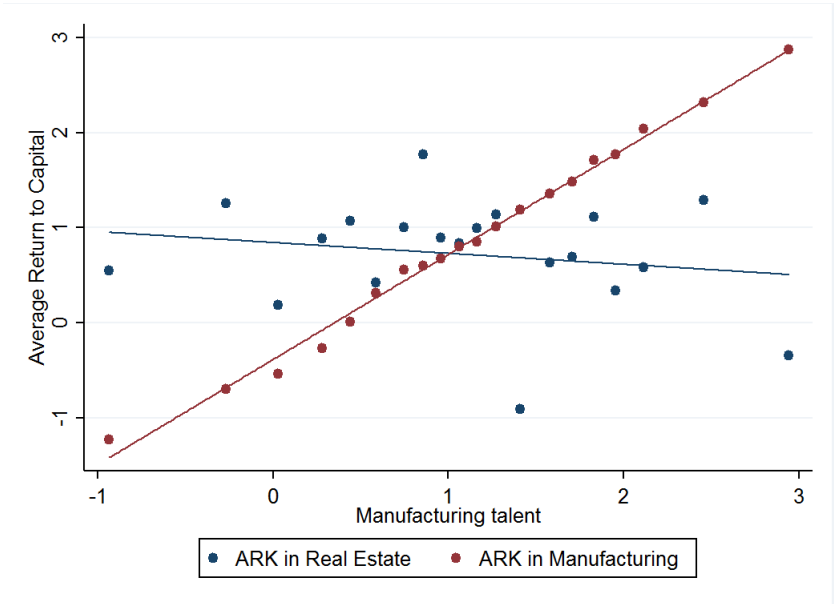


Table 11 summarizes the estimation results from the three-step approach. Columns (1) to (3) report the coefficients estimated with firm-specific talent, group-specific talent, and the group-level talent adjusted with the Empirical Bayes approach. Given the bias induced by the measurement errors, columns (1) and (2) are subject to attenuation bias. The null hypothesis of  $b \geq 1$  is rejected by all three estimations, indicating that there is likely a negative correlation between the comparative advantage in real estate and the absolute advantage in manufacturing. This supports the observation that allocation of entrepreneurial talent in the Chinese real estate boom is constrained inefficient.

[Table 11 about here]

<sup>45</sup>This figure is generated using the "binscatter" function in Stata.

## 5.2 Calibration and Counterfactual Policy Analyses

The calibration is based on the extended life-cycle model with overlapping generations. Given that a series of deregulations led to the real estate boom in China, I consider them as permanent shocks. My primary interest is to calibrate an economy transitioning to a new balanced growth path. The value function of each agent then depends on the entire path of prices, including wage, interest rate, house price, and land price. The set of state variables contain talent  $(z_{it}^M, z_{it}^H)$ , wealth, age, and year. To simplify the computation process, I calibrate the entrepreneurs' decisions at the group level and assume that  $(\epsilon_{it}, \omega_{it})$  are zero. In doing so, I replace the state variable  $(z_{it}^M, z_{it}^H)$  with exogenously fixed average productivity  $(\bar{z}_g^M, \bar{z}_g^H)$ . The talent distribution of group-specific talent,  $\bar{z}_g^M$ , follows a truncated Zeta distribution, which is a discrete approximate to the Pareto distribution. The probability density function of  $\bar{z}_g^M$  is:

$$\Pr(\bar{z}_g^M) = \frac{1/g^\zeta}{\sum_{i=1}^N 1/i^\zeta}, \zeta > 1$$

The total asset value available for each firm is determined by the old entrepreneurs' savings decisions. I further assume that the market for hiring young entrepreneurs as managers is competitive. Given that prior to the housing boom the group with a higher  $\bar{z}_g^M$  faces a larger return of capital, the manager compensation is increasing in  $g$ . The expected wage of each group  $m_{g,t}$  is determined such that the incentive compatibility constraint for each young entrepreneur is binding. The parameter determining the manager's compensation is assumed to be  $\psi$ , which is the minimum fraction of capital return that managers can steal. The size of  $\psi$  determines the overall growth rate of the economy. When  $\psi$  is higher, the income dispersion is larger in younger generations so the group of productive firms in manufacturing accumulate wealth at a faster speed.

To more closely model the Chinese economy, I add the SOEs in my quantitative analysis. Following Song et al. (2011), I assume that the SOEs are neither financially constrained nor managed by any entrepreneurs. Their role in the model is to clear the capital market in early years, when entrepreneurs have not accumulated enough wealth. The productivity of SOEs is assumed to be  $\kappa$  fraction of the average productivity of privately-owned firms.

There are two stages in the calibration. The first stage, the pre-boom stage, corresponds to the first period in section 4. The second stage models the real estate boom. I consider the real estate boom as driven by a permanent preference shock, such that agents increase the housing consumption share from 0 to  $\rho$ . I estimate parameters on manufacturing talent distribution, manager compensation, and initial wealth using in the first stage and parameters that determine average housing talent and entry barrier in the second stage. The rest of the parameters are set exogenously. Table 12 provides a description for the exogenously determined parameters.

Table 12: Exogenously Determined Parameters

Parameter	Description	Value	Source
$\beta$	The utility discount factor	0.99	Song et al. (2011)
$\lambda$	Maximum leverage ratio	1.35	Buera and Shin (2013)
$N$	Total groups of entrepreneurs	5	Education levels in data
$\alpha^M$	Capital input share in manufacturing	0.5	Bai, Hsieh, and Qian (2006), Song et al. (2011)
$\alpha^H$	Capital input share in housing	0.85	China input-output table
$b$	Comparative advantage parameter	-0.21	Point estimates from section 5.1
$\delta^M$	Capital depreciation rate in manufacturing	0.1	Song et al. (2011)
$\delta^H$	Land depreciation rate in housing	0.5	2-year construction period
$T_1$	Working age for workers and entrepreneurs	30	Song et al. (2011)
$T_2$	The number of year retiring	20	Song et al. (2011)

I assume that the first stage starts from 1992 (following the assumption in Song et al., 2011) and lasts for 10 years, until the 2002 land market liberalization. I calibrate the talent distribution using the estimated firm-level productivity between 1997 to 2002. Given the shape parameter  $\zeta = 2$ , the distance parameter is estimated to be  $d^M = 0.15$ . I set SOE productivity  $\kappa = 0.397$  to match the relative capital-to-output ratio of SOEs and private companies, 2.65. Last but not least, the initial wealth of workers and entrepreneurs is calibrated such that the average share of total fixed assets of private companies during 1997-2002 is close to 31.75% as in my data. The initial life-cycle distribution of wealth for entrepreneurs and workers is similar to a scaled-up version of the distribution of wealth over the life cycle in the balanced growth paths. Entrepreneurs with different talent groups are assumed to start with the same wealth level. The minimum fraction of capital return a manager can steal ( $\psi$ ) is estimated as 0.2, which matches the growth rate of the average share of total fixed assets owned by private companies. The model-based share in 1992 is 17.36%, which is close to 15.12% in the data.

In the second period, I take the wealth distribution in 2002 as the initial wealth and calibrate three parameters:  $\underline{s}$ ,  $c$ , and housing consumption share  $\rho$ . I calibrate the housing consumption share  $\rho = 0.4$ . Assuming an average worker works for 30 years, this yields a price-to-income ratio of 10.41, which matches the average price-to-income ratio of 10.2 in the data. Based on the proofs in appendix C, the entry decisions of entrepreneurs do not depend on the average productivity in real estate. Therefore, I calibrate the entry barrier using the average difference in log productivity between entrepreneurs who entered the real estate sector and others who did not. In the data, the average difference is estimated to be 0.25. This leaves me with an estimate of  $\underline{s} = 0.046$ . I interpret the estimate as follows: in an average city in China, the average startup cost for a real estate project is 4.6% of the

total value of land supplied in the city. The parameter  $c$  indicates the average log productivity in the housing sector. I estimate  $c$  to match the relative firm size in the manufacturing sector and the real estate sector. In the data, an average manufacturing firm hires 7.54 times more employees than an average real estate development firm. The average housing talent  $c$  is then estimated to be 0.31. Table 13 summarizes the calibrated parameters and corresponding moments in the data.

Table 13: Calibrated Parameters

Target Moments	Data	Model	Parameter	Description
Variance of group-level log productivity	0.022	0.022	$\zeta = 6.07$	Scale parameter for manufacturing talent
Relative $K/Y$ of SOEs and private firms	2.65	2.38	$\kappa = 0.397$	SOE productivity
Growth rate of private capital share	7.87%	8.89%	$\psi = 0.20$	Manager IC parameter
Share of capital held by private firms	31.75%	35.44%	Initial wealth	
House price to income ratio	10.2	10.41	$\rho = 0.40$	Housing consumption share
The difference in manufacturing productivity between real estate entrants and other firms	0.25	0.23	$\frac{s}{S} = 0.046$	Entry barrier in real estate
Relative scale in manufacturing and real estate	8.54	8.06	$c = 0.31$	Average housing productivity

Panels A-C of Figure 8 compare several macroeconomic outcomes of the model and data. The most important prediction of this model is on the relative growth rate of land prices to house prices. In early years of the real estate boom, the large preference shock induces a high return from operating in the real estate sector. The unproductive and poor manufacturing entrepreneurs, who have the comparative advantage in real estate, are initially constrained from participating in the land market. In order to attract the productive and talented manufacturing entrepreneurs, the land price must be low enough so their ROA in real estate is higher than their ROA in manufacturing. As entrepreneurs accumulate wealth at a different speed, over time real estate entrepreneurs with the highest manufacturing talents exit the real estate sector. This not only implies an decreasing relative ROA in the real estate sector, but also that land prices have to grow faster than house prices. I find a similar pattern in the data. In the first 3 years following the land market liberalization, the land price in China increased more than 20% per year compared to the increase in house price. After 2009, however, the annual growth rate of land price is mostly the same as the annual growth rate of house price.

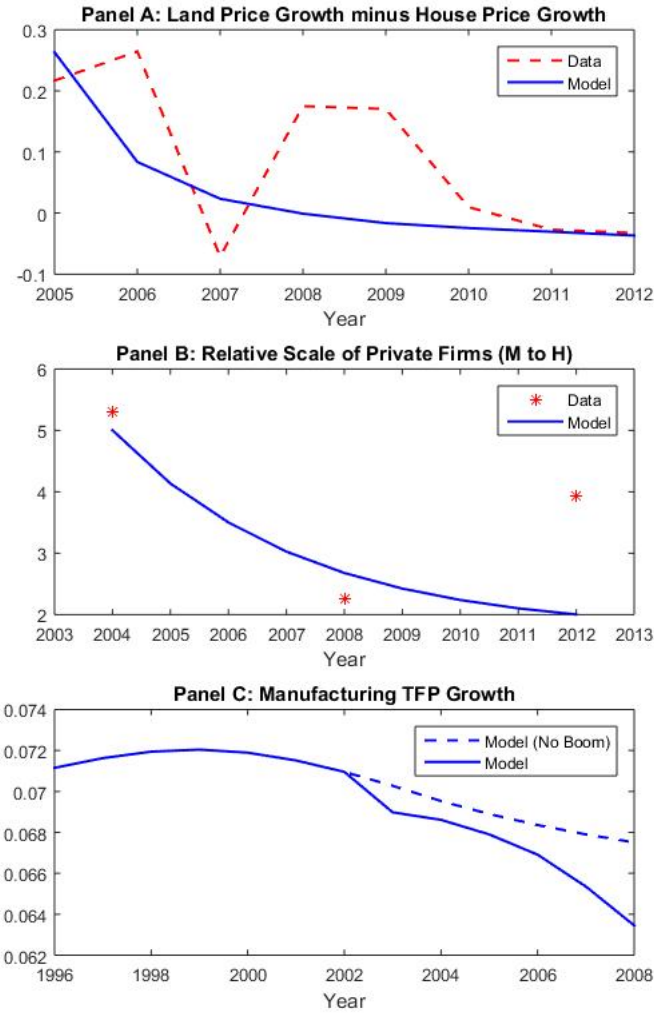
Panel B compares the average scale of private firms in the manufacturing sector relative to the real estate sector. Given that land prices increase faster than house prices (and thus total output), more unproductive and poor manufacturing entrepreneurs are constrained from entering the real estate sector. This leads to a larger average scale of real estate firms and a smaller average scale of manufacturing firms. Given data constraints, I am only able to recover the relative scale from the three



rounds of National Economic Census in 2004, 2008, and 2013. There is a rough pattern indicating that an average manufacturing firm is becoming smaller compared to an average real estate firm.

Panel C compares the manufacturing TFP growth with and without a real estate boom. An economy experiencing a real estate boom has a smaller TFP growth. This is due to the fact that land market liberalization changes the composition of entrepreneurs in the manufacturing sector, imposing a negative effect on the productivity growth in the manufacturing sector.

Figure 8: Calibration Results



## Policy Counterfactual Analyses

In analyzing the effects of the policy tools, I conduct three counterfactual analyses. The manufacturing TFP growth and land price in the model and the counterfactual cases are presented in Figure 9.

I first increase the maximum leverage ratio,  $\lambda$ , from 1.35 to 2 to understand the effect of liberalizing the financial market. A 48% larger borrowing constraint lead to a higher manufacturing TFP growth, as shown in panel A of Figure 9. This policy works indirectly through reallocating more resources to entrepreneurs with more talent in manufacturing, as also discussed in related works in the literature (Hsieh and Klenow, 2009; Buera and Shin, 2013). Given the composition of entrepreneurs in the manufacturing sector, the productivity growth is higher as productive entrepreneurs accumulate wealth at a faster speed. A more relaxed borrowing constraint, however, also increases land prices so more entrepreneurs are constrained from entering the real estate sector. The larger inefficiency in the allocation of entrepreneurial talent then dampens the effect of liberalizing the financial market.

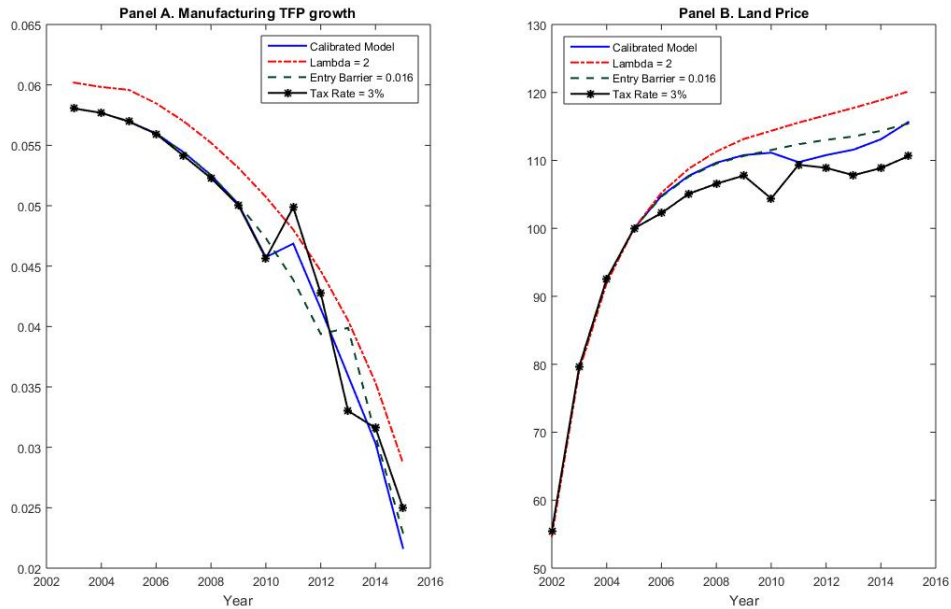
Second, I study the effect of a smaller entry barrier. In reality, a lower entry barrier can be achieved by increasing the total land supply or improving corporate laws so several entrepreneurs can jointly operate a real estate firm without additional principle-agent frictions. As discussed in section 4, the welfare consequences are ambiguous. Given prices, a lower entry barrier allows more unproductive entrepreneurs to enter the land market. However, more entries also increase the land price such that a larger fraction of entrepreneurs is needed to clear the land market. As shown in panel B of Figure 9, the land price with a lower entry barrier is strictly higher than the one in the calibrated model. This imposes an adverse effect on manufacturing productivity. Overall, the impact of reducing the entry barrier on manufacturing TFP growth is thus ambiguous.

My last policy counterfactual focuses on the effect of taxing the return from property sales. In many countries, it is implemented as the property stamp tax. When real estate developers sell houses, the buyer or the developers pay a 5% - 15% one-time stamp tax. This policy lowers the ROA from operating in the real estate sector without affecting land prices. Therefore, it prevents productive manufacturing entrepreneurs from operating in the real estate sector. Panel A in Figure 9 shows that a 3% property stamp tax increases manufacturing TFP growth in most years. The land price under this regulation is also always lower than the price in my calibrated model. Without changing the resource constraints, it improves social welfare by lowering land prices.

Regarding the welfare consequences, increasing  $\lambda$  from 1.35 to 2 results in a welfare increase of 6%, while a 3% property stamp tax increases the social welfare by 0.5%. The welfare is higher by less than 0.1% when the entry barrier is reduced from 0.046 to 0.016. Liberalizing the financial market is often costly and requires improving other related regulations. Collecting a property stamp tax, however, can be easily implemented as all properties on sale are already listed publicly. Policy makers then

need to take into account the welfare benefits of the policy tools and their costs.

Figure 9: Policy Counterfactuals



### 5.3 Limitations and Future Works

The quantitative evaluation in this section is mainly to evaluate the efficiency of entrepreneurial talent allocation in China and conduct policy analyses. The calibrated life-cycle model with overlapping generations matches the price dynamics on the land market, as well as the average scale in the manufacturing sector relative to the real estate sector. There are several aspects of this quantitative model that can be improved in future works.

First, a larger efficiency loss could occur if idiosyncratic productivity shocks are added back to the model. In this case, the wealth of entrepreneurs depends not only on their talent group but also on their productivity shocks in history. On the other hand, their comparative advantage only depends on the talent group and current productivity shocks. Therefore, adding back the idiosyncratic productivity shocks creates a larger gap between the incentive to entry (the comparative advantage) and the ability to entry (wealth). I am working on estimating a model that includes within-group mean-reverting productivity shocks for additional policy evaluations.

Second, the size and nature of the real estate boom also matter for my inefficiency argument. Imagine that China did not experience a large real estate boom following the deregulations. The

talented manufacturing entrepreneurs would not be incentivized to enter the real estate sector. The land price would also remain at a relatively low level, such that unproductive manufacturing entrepreneurs with the comparative advantage in real estate are not constrained from entry into the land market. However, if a real estate bubble exists in addition to the increasing demand for housing, the entry barrier in real estate creates a larger distortion on the allocation of entrepreneurial talent. Moreover, the growing investment in bubble assets yields an additional loss in social welfare, as these investments produce neither more housing nor more manufacturing goods.

Finally, I do not model the occupation choice of workers, so that the impact of real estate prices on entrepreneurship via the collateral channel is not considered here. Several empirical works (Hurst and Lusardi, 2004; Schmalz, Sraer and Thesmar, 2015; Kerr, Kerr, and Nanda, 2015) document that rising real estate prices may help alleviate the financial constraints of potential entrepreneurs. While my focus is on the business choices of existing entrepreneurs, I also argue that this is unlikely to matter for the Chinese real estate boom. Prior to the housing market reform, most households in China were not homeowners. Therefore, the increasing house prices do not help households in starting up new businesses. The effect of the collateral channel also depends on the correlation between homeownership and workers' comparative advantage in operating a firm. If the two factors are independent, the collateral channel should not have a sizable impact on welfare at the aggregate level.

## 6 Concluding Remarks

In this paper, I have proposed a new channel that links real estate booms and the aggregate productivity with a focus on the decisions of private business owners. I proved that an inefficient allocation of entrepreneurial talent could exist in a real estate boom using a neoclassical model that features ex-ante heterogeneity in entrepreneurial talent, an imperfect financial market, and a cost barrier in the real estate sector. The model is consistent with the new facts from the recent real estate boom in China: more productive manufacturing firms diverted their resources to the real estate sector, resulting in a decline in R&D, investment, and productivity growth in their manufacturing businesses. The positive correlation between manufacturing productivity and entering the real estate sector can be fully explained by more productive manufacturing businesses being wealthier. My data also suggests that more productive manufacturing business owners do not have the comparative advantage in the real estate sector. Therefore, the imperfect financial market, together with the entry barrier in real estate, create an inefficient allocation of entrepreneurial talent, resulting in an inefficient loss of aggregate productivity.

The new channel highlighted in my paper adds new insights on the role of real estate booms. I argue that productivity loss may exist even without a real estate bubble, which differs from related works (Charles, Hurst, and Notowidigdo, 2015; Chen and Wen, 2014; Mian, Sufi, and Rao, 2013). In

addition, the key feature of the real estate sector is that production of properties uses a scarce and inflexible factor: land. As an economy grows, the supply of capital is increasing while the supply of land is fixed. Eventually, the entry barrier only exists in the real estate sector. The real estate sector, however, is not the only sector that produces with scarce factors. The model can be used to study other booming sectors, as long as they also require a costly barrier to entry and that existing business owners reallocate from other sectors to the booming sectors. For instance, my model would help examine the natural resource booms (the “Dutch disease”) observed when countries with abundant natural resources experience a significant productivity slowdown following a positive shock to commodity prices.

I have also discussed three policy tools that may improve social welfare in real estate booms: financial market liberalization, reducing the entry barrier in real estate, and taxation on real estate returns. An ideal policy should provide subsidies to entrepreneurs constrained by the entry barrier in real estate and tax entrepreneurs with no comparative advantage in the real estate sector. Taxation on real estate returns appears to play a similar role to the ideal policy without the requirement in identifying the talent of individual entrepreneurs. Liberalizing the financial market is also welfare improving. However, it changes the planner’s problem without directly targeting the inefficient allocation of entrepreneurial talent. In fact, the financial market liberalization would result in a large efficiency loss. Reducing the entry barrier in the real estate sector yields an ambiguous welfare consequence. A calibrated version of the model has been provided to evaluate the TFP gains of the three policy tools.

## Tables:

Table 1: Firm-level Summary Statistics

	Mean	Median	Std. Dev	25th Percentile	75th Percentile	Observations
<i>Investment And Productivity:</i>						
R&D Intensity	0.025	0	0.080	0	0.011	355,562
Investment Rate	0.07	0	0.16	0	0.02	294,262
Log(Labor Productivity)	3.69	3.63	1.23	2.96	4.37	382,031
<i>Firm Accounting Data:</i>						
Age	12.63	12	6.28	8	17	358,241
Net Long-term Debt Outstanding	0.43	0.24	0.53	0.05	0.60	293,759
Net Debt Outstanding	0.67	0.66	0.41	0.41	0.09	379,507
Log (Total Asset Value)	9.05	9.01	1.28	8.27	9.81	382,369
Log (Total Fixed Assets)	7.85	7.86	1.57	6.88	8.82	382,693
Employment	403.98	195	905.2	99	400	382,690
Net Cash Inflows	40.23	0	889.09	0	3.04	102,005
Return on Asset	0.10	0.03	0.27	0.00	0.13	382,675
<i>Property Development Firm Data:</i>						
Operation Income	8.18	8.34	2.56	6.48	10.07	77,186
Employment	21.66	12	53.63	5	23	82,047
Log (Total Asset Value)	9.77	9.95	2.32	8.52	11.38	78,291
<i>Manager Data:</i>						
Schooling Years	9.91	9	5.76	6	15	19,432
Experience	25.53	25	10.49	18	29	12,867
Minority	38.94%					14,704
Male	86.12%					21,359
Communist Party Member	14.98%					12,243

*Notes:* This table summarizes the main variables used in the empirical exercises. The data are from the NBS Annual Industrial Survey, the Enterprise Registration Database, and the 2008 National Economic Census. The R&D intensity is measured as R&D expenses normalized by the lagged value of total fixed asset (including properties, plant and equipment), following OECD measurement on relative degree of investment in generating new knowledge. The labor productivity is defined as the logarithm of value added per worker, and the investment rate is capital investment normalized by total fixed assets in the previous year. The age of a firm is the number of years since registration. The debt issuance variable is computed as the ratio of outstanding debt to total asset value. The net cash inflows is defined as the net cash inflows from financing, operation, and investment, normalized by the lagged book value of total fixed asset. Return on asset is measured as operation income (after depreciation) of the total book value of assets. For variables in the manager data, minority, male, and Communist party member are three 0-1 dummy variables, so I only report their mean values.

Table 2: Summary Statistics of the Real Estate Data

	# of Cities	House Price			Land Price			Land Supply Elasticity Index		
		Mean	Median	Std. Dev	Mean	Median	Std. Dev	Mean	Median	Std. Dev
<i>City Tier:</i>										
First Tier	4	10.93	10.75	2.22	10.02	9.01	3.86	0.720	0.815	0.286
Second Tier	35	4.77	3.97	1.97	3.96	3.28	2.95	0.717	0.819	0.295
Third Tier	105	3.40	2.83	1.51	2.17	1.84	1.11	0.770	0.852	0.254
<i>Economic Region:</i>										
Northeast	10	3.31	2.98	1.01	1.68	1.52	1.01	0.810	0.925	0.334
Costal	70	5.03	4.23	2.50	4.79	3.58	3.65	0.661	0.753	0.309
Middle	45	2.73	2.67	0.70	2.37	2.07	0.77	0.847	0.880	0.134
West	18	3.14	3.10	0.58	2.25	2.12	1.20	0.853	0.899	0.161

Notes: This table summarizes the real estate data of the four economic regions and three tiers of cities in China. The house price, in thousands of Yuan, is the average price per square meter floor. The city-level average house price is computed by dividing total home value by the total floor area sold using National Bureau of Statistics (NBS) publication from 2003 to 2013. The land price, in thousands of Yuan, is the average price per square meters of land area. The land market data is obtained from China Real Estate Index System (CREIS). The land supply elasticity index is constructed manually by the author, following Saiz (2010). The range of the land supply elasticity is from 0 to 1 .

Table 3: Comparison Between Real Estate Entrants and Other Firms

	Real Estate Development Entrants			Others		
	Mean	Median	Std. Dev	Mean	Median	Std. Dev
R&D Intensity	0.011	0.000	0.047	0.006	0.000	0.040
Log (Labor Productivity)	3.62	3.65	1.23	3.49	3.42	1.53
Investment Rate	0.14	0.03	0.22	0.07	0.00	0.18
Profit Margin	0.19	0.17	0.15	0.16	0.13	0.14
Log (Total Fixed Assets)	10.29	10.22	1.84	8.36	8.32	1.69
Log (Total Asset Value)	11.43	11.30	1.78	9.51	9.39	1.37
Employment	1,198	495	2,496	376	190	781
Net Cash Inflow	29.76	0.00	421.48	5.35	0.00	500.51
Credit Score	634.02	641	590	575.98	583	522
Age	14.46	14	6	11.78	11	6.18
Fraction of Firms	5.24%			94.76%		
Fraction of Fixed Assets	29.96%			70.01%		
Fraction of Asset Value	22.19%			77.81%		

*Notes:* This table compares the manufacturing firms that entered the real estate development industry with firms that did not. The total fixed assets and asset value are in millions of Yuan. The fraction of firms is computed as a ratio of the total number of firms in sample. The fraction of fixed assets (asset value) are also computed as a ratio of the summation of the total fixed assets (total asset value) of all firms in sample.



Table 4: Determinants of Entering the Real Estate Development Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (Labor Productivity)	0.078*** (4.11)	-0.094*** (3.73)					0.066*** (3.41)	-0.097*** (3.81)
Investment Rate			1.21*** (13.67)	0.64*** (5.66)			1.17*** (13.08)	0.63** (5.54)
R&D Intensity					0.89** (2.25)	0.44 (1.06)	0.75** (2.25)	0.38 (0.85)
Log (Pre-period Total Asset Value)		0.25*** (9.12)		0.20*** (7.87)		0.21*** (8.51)		0.23*** (8.50)
Log (Credit Score)		1.60*** (9.94)		1.42*** (9.03)		1.47*** (9.36)		1.53*** (9.46)
Number of Firms	16,055	15,171	15,810	15,257	15,958	15,257	15,694	15,169
Pseudo R-squared	0.109	0.152	0.106	0.153	0.106	0.147	0.113	0.158
City FE	YES	YES	YES	YES	YES	YES	YES	YES
2-digit Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES

*Notes:* This table presents the determinants of entering the real estate development industry. Columns (1), (3), (5), (7) report the correlations between entry and investment and productivity without controlling for firm-specific financing ability. Columns (2), (4), (6) and (8) add the average pre-period total asset value and credit score as proxies for firm-specific financing ability. Control variables include five quantiles of employment, age, and exporting status. City fixed effects and 2-digit industry fixed effects are also included in all specifications. T-stats are reported in parentheses.

\*\*\* Significant at the 1 percent level

\*\* Significant at the 5 percent level

\* Significant at the 10 percent level

Table 5: The Validity of Instruments - Land Supply Elasticity and Local Economic Activities

Dependent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	House Price Growth			GDP per capita Growth	Wage Growth	Employment Growth	Export Intensity
Land Supply Elasticity *							
3-Year National House Price Growth	-0.776**	-0.843***	-0.548**	-0.057	-1.544	-0.643	0.009
	(0.440)	(0.313)	(0.247)	(0.604)	(1.961)	(0.546)	(0.011)
Land Price Growth		0.106***					
		(0.038)					
Observations	1,213	808	600	810	1,285	1,299	1,460
R-squared	0.194	0.425	0.380	0.014	0.033	0.035	0.0188
Number of Cities	138	87	86	125	137	137	146
Year FE	YES	YES	YES	YES	YES	YES	YES
City FE	YES	YES	YES	YES	YES	YES	YES

*Notes:* This table presents evidence that supports the validity of using the land supply elasticity index for IV analysis. Columns (4) - (7) examine whether cities with different land supply elasticities experience significantly different economic activities in the national housing cycle. The local economic conditions are obtained from China city statistical yearbooks (2002-2013). Columns (1) - (3) test if house prices in cities with lower land supply elasticities grow faster than house prices in other cities. Column (1) uses the average house price from the NBS; column (2) adds average land price as controls; column (3) uses the house price indices constructed by Fang et.al (2014). All specifications control for year and city fixed effects. Standard errors are reported in parentheses and are clustered at city level.

- \*\*\* Significant at the 1 percent level
- \*\* Significant at the 5 percent level
- \* Significant at the 10 percent level

Table 6: The Validity of Instruments - Land Supply Elasticity and Economic Activities, Cont'd

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
First Tier	2.7%	2.8%	5.6%	0.0%
Second Tier	24.3%	30.6%	27.8%	13.9%
Third Tier	73.0%	66.7%	66.7%	86.1%
Total	100%	100%	100%	100%
Northeast Region	2.7%	5.6%	8.6%	10.8%
Costal Region	78.4%	41.7%	34.3%	37.8%
Central Region	16.2%	36.1%	40.0%	35.1%
West Region	2.7%	16.7%	17.1%	16.2%
Total	100%	100%	100%	100%
Population Growth	1.26%	0.57%	1.02%	1.02%
GDP per capita Growth	13.72%	13.94%	14.01%	12.95%
Employment Growth	7.68%	7.04%	6.59%	6.06%

*Notes:* For this table, I divide cities into four quartiles according to their land supply elasticities and compare the geographical location and the economic activities of the four quartiles. The population, GDP, and employment data are from China city statistical yearbooks from 2002 to 2013.

Table 7: The Validity of Instruments - Land Supply Elasticity and Quantity Growth

	(1)	(2)	(3)
	The Growth Rate of Total Home Space		
Land Supply Elasticity	0.0649*** (0.023)	0.0620*** (0.024)	0.0668*** (0.024)
Population Growth		-0.132 (0.408)	0.279 (0.418)
GDP per capita Growth		0.16 (0.232)	0.137 (0.250)
Second Tier			0.124*** (0.038)
Third Tier			0.118*** (0.037)
Costal			-0.0572** (0.025)
Middle			-0.0686*** (0.025)
West			-0.0722** (0.028)
Number of Cities	138	138	138
R-squared	0.054	0.059	0.182

*Notes:* This table reports the correlation between the land supply elasticity of cities and the quantity growth in the housing market. The table replicates Table 6 in Davidoff (2016).

\*\*\* Significant at the 1 percent level

\*\* Significant at the 5 percent level

\* Significant at the 10 percent level

Table 8: The Validity of Instruments - Local Connection with Land Bureau

	With Potential Connections with Land Bureau			No Potential Connections with Bureau		
	Mean	Median	Std. Dev	Mean	Median	Std. Dev
R&D Intensity	0.006	0.000	0.034	0.007	0.000	0.040
Log (Labor Productivity)	3.53	3.49	1.08	3.53	3.48	1.01
Investment Rate	0.042	0.000	0.128	0.039	0.000	0.131
Profit Margin	0.175	0.150	0.150	0.181	0.157	0.183
Total Fixed Assets	20.56	5.22	12.84	22.79	5.91	9.55
Total Asset Value	113.35	20.66	862.46	138.23	27.60	662.64
Employment	732	487	1,126	803	540	1,254
Credit Score	576.37	583	103	578.93	590	108
Age	8.78	7.00	5.88	8.32	7.00	5.27
Fraction of Firms	25.83%			74.17%		

*Notes:* This table compares the firms with and without a potential connection with the local land bureau in my sample, depending on the value of the PolConnection dummy. The total asset value and the total fixed asset is in millions of Yuan.

Table 9: Real Estate Investment and Manufacturing Productivity, Investment

	First Stage	OLS		IV	
	(1)	(2)	(3)	(4)	(5)
		Full Sample	Matched Sample		
<i>Panel A: Dependent Variable: R&amp;D Intensity</i>					
Potential Connection with Local Land Bureau * (1-Land Supply Elasticity) * 3-year National House Price Growth	0.157*** (5.79)				
Post-entry Effect		-0.0056* (1.76)	-0.0107** (1.98)	-0.0119* (1.67)	-0.0234** (2.01)
F-Value	33.03				
<i>Panel B: Dependent Variable: Labor Productivity</i>					
Post-entry Effect		-0.064*** (3.87)	-0.0383* (1.80)	-0.0398** (2.36)	-0.0507* (1.90)
<i>Panel C: Dependent Variable: Investment Rate</i>					
Post-entry Effect		-0.042*** (7.63)	-0.1246*** (2.43)	-0.151** (2.04)	-0.177** (1.95)
Number of Observations		58,961	39,000	53,212	42,690
Current Linkage with Mayor	NO	NO	NO	NO	YES
Initial Controls * Year FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES

*Notes:* This table tests the effects of entering the real estate development industry on manufacturing production at the firm level. Columns (2) and (3) report the estimates with ordinary least squares, using the full sample and the sample selected by matching firms on observables, respectively. Column (4) reports the estimates using a three-way interaction instrument: local land inelasticity interacts with firm-specific potential connection with the local land bureau and the national house price growth. All two-way interactions are controlled in the regressions. The relevant first stage is reported in column (1). Column (5) adds firm-specific connection with city mayor as an additional control. All specifications control for age, local wage, year fixed effects, firm fixed effects, and firm-level initial conditions (exporter dummy, size classified according to employment, two-digit industry, economic region of location and credit rating) interacted with year fixed effects. T-stats are reported in parentheses with standard errors clustered at the firm level.

- \*\*\* Significant at the 1 percent level
- \*\* Significant at the 5 percent level
- \* Significant at the 10 percent level

Table 10: Real Estate Investment and Manufacturing Productivity, Investment - Robust Specifications

	(1)	(2)	(3)	(4)
	First Stage	R&D Intensity	Investment Rate	Log(Labor Productivity)
<i>Panel A: Heterogeneous Response to Real Estate Investment Opportunity</i>				
Past Local Land Bureau Connection *	0.0263***			
Land Supply Elasticity (2004)	(4.95)			
~ (2005)	0.0287***			
	(5.40)			
~ (2006)	0.0316***			
	(5.94)			
~ (2007)	0.0377***			
	(7.09)			
~ (2008)	0.0309***			
	(5.89)			
~ (2009)	0.0406***			
	(7.72)			
Average Post-entry Effect		-0.048**	-0.179*	-0.0563*
		(2.08)	(1.70)	(1.89)
First-stage F-Value	42.89			
Number of Observations		34,734	34,734	34,734
<i>Panel B: High-order Polynomial First-stage Specification</i>				
First-stage F-Value	27.34			
Post-entry Dummy		-0.0113**	-0.1104*	-0.0598**
		(1.96)	(1.84)	(2.10)
Hausman Test Statistic	2.49			
Number of Observations		38,598	38,598	38,598
Initial Controls * Year FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES

Notes: This table tests the relationship between entering the real estate development sector and manufacturing production using alternative IV specifications. Panel A instruments for the entry decision with year-specific responses to the real estate investment opportunity. Panel B employs a high-order polynomial (up to the second orders) to estimate the first-stage probability of entry. The F-values of the first stage and the Hausman Test statistic is reported in Column (1). All specifications control for age, local wage, firm fixed effects, year fixed effects, and firm-level initial conditions (exporter dummy, size classified according to employment, two-digit industry, economic region of location, and credit rating) interacted with year fixed effects. T-stats are reported in parentheses with standard errors clustered at the firm level.

- \*\*\* Significant at the 1 percent level
- \*\* Significant at the 5 percent level
- \* Significant at the 10 percent level

Table 11: Quantitative Evaluation - Comparative Advantage and Absolute Advantage

	(1)	(2)	(3)
	Firm-specific	Group-specific Estimation	Empirical Bayes-adjusted-specific Estimation
$b$	-0.163 (0.25)	-0.199 (0.68)	-0.214 (0.66)
P-Value ( $H_0 : b \geq 1$ )	<0.001	0.039	0.034

Notes: This table reports the structural estimators of  $b$  and the T-test statistics for the sufficient and necessary condition in proposition 2. Columns (1) to (3) report the coefficients estimated using the three-step approach. The entrepreneurial talent in the manufacturing sector is estimated at firm-level, group-level, and by applying an empirical Bayes adjustment at the group level, respectively.

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## Appendix

### *Appendix A: The Land Supply Elasticity of Chinese Cities*

Employing Geography Information System (GIS), we precisely calculated exogenously undevelopable land within 30 kilometer radii from central point of each city. Eliminating area lost to steep slope, ocean, inner water body, territory boundary and special district boundary which prohibits urban sprawl, we build a comprehensive measurement of urban land flexibility for all major China cities.

Steep slope significantly constrains residential development. Utilizing GIS software, we calculated area exhibits slope over 10% within 30km meter radii of city central point. Based on national contour lines map, we generated national-wide slope map at resolution of 1000 by 1000 meter. The data source of contour lines map is 1:1 Million Topographic map of China compiled by National Bureau of Surveying and Mapping (NBSM, PRC). Considering most residential construction projects take more than 1 square kilometer land and small pieces of flat land within mountain area are expensive for developing, we choose 1000-meter resolution as the grid size for calculating slope.

There are several classifications about slope and urban construction suitability and we set slope over 10% as unsuitable for urban housing development. The most popular standard for slope and urban construction suitability is set by Urban Planning Theory(the third edition), which is national text book for urban planning major. In this textbook, slope between 0.3% - 10% are considered to be suitable for residential land use. However, according to the Code for Vertical Planning on Urban Field published at 1999, the maximum slope allowed to be used for residential land use is 25%(P.6). The threshold is increased to cover most land in China<sup>46</sup>. Considering construction and maintenance cost will increase significantly for residential development on land with slope over 8%, and most China cities are built upon plain, we choose to use the general guideline of slope below 10% instead of the maximum limit of 25% as the threshold for land considered suitable for housing development.

Residential development is also constrained by water body, country territory boundary and special district administration boundary. For example, Shenzhen housing development cannot cross the border with Hong Kong. By intersecting the polygon of coastline, inner water body, country territory boundary and special district administration boundary with the 30 km radii circle of each city, we can eliminate all undevelopable area caused by these factors. Data for coastline, territory boundary and special district boundary comes from "Administrative Division Map of China" compiled by China Cartographic Publishing House and ESRI. Data for inner water body comes from hydrographic

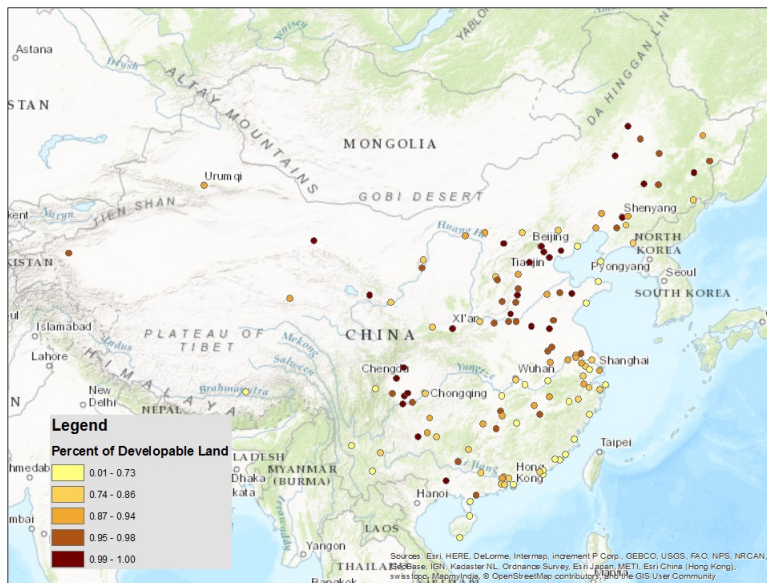
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<sup>46</sup>Code for Vertical Planning on Urban Field(CJJ 83-99): <http://wenku.baidu.com/view/504c9a10227916888486d79a.html>

map, 1:1 Million Topographic map of China compiled by National Bureau of Surveying and Mapping (NBSM, PRC).

Figure Appendix A.1 below illustrates the city-specific land supply elasticity index for 129 Chinese cities.

Figure A.1: The Land Supply Elasticity Index in China



## *Appendix B: Additional Empirical Analyses*

### *The Strength of Instrumental Variable*

Table B.1 shows the strength of the two variables by examining their correlations with local land supply. Column (1) and (2) report how reservation land value depends on local land supply elasticity and private firms' connections with the local land bureau. On average, a city with 1% higher land supply elasticity has a 0.72% lower reservation land value when normalized by the total land area, or a 0.89% lower reservation land value when normalized by the total floor area. The land reservation value is also positively correlated with the fraction of private companies that have a connection with the local land bureau. The land reservation value declines by 0.13% (normalized by total land area) or 0.4% (normalized by total floor area) when 1% more private firms are politically connected with the local land bureau. Column (3) and (4) present the correlation between the two instruments and the total area supplied on the land market. The total land area and total floor area can be significantly predicted by the local land supply elasticity. A city with 1% more developable land has a 0.5% more land supply in terms of the total land area, and a 0.55% more land supply in terms of the total floor area. The political connection variable is insignificant in predicting the quantity of land transaction. These results match the institutional features of the Chinese land market. Given that the urban land planning is conducted by an independent committee, the land supply relies more on the geographical constraints rather than the political constraints. On the other hand, the local land bureau involves in the land sales, so that both the geographical constraints and the political environment matter for land reservation values.

Table B.1: The Validity of Instruments - Government Land Supply

Dependent Variables:	(1) Unit Land Area Reservation Price	(2) Unit Floor Area Reservation Price	(3) Total Land Area Supplied	(4) Total Floor Area Supplied
Land Supply Elasticity	-0.723*** (4.00)	-0.887*** (4.84)	0.499** (0.04)	0.550*** (2.90)
Fraction of Firms with Political Connection	-0.126* (1.65)	-0.403* (1.77)	-0.24 (0.98)	-0.284 (0.12)
Observations	348	344	348	334
R-squared	0.25	0.45	0.39	0.45
Year FE	YES	YES	YES	YES

*Notes:* This table presents the correlation between local government land supply and the two instruments, land supply elasticity index and the political connection with the local land bureaus. The unit prices are computed by dividing the reservation land value by total land area and total desired floor area, respectively. All prices and quantities are analyzed in log terms. All specifications control for year fixed effects. Standard errors are reported in parentheses and standard errors are clustered at city level.

- \*\*\* Significant at the 1 percent level
- \*\* Significant at the 5 percent level
- \* Significant at the 10 percent level

### *Alternative Hypotheses*

The reduced-form estimates document that entering the real estate market will lead to a slowdown on R&D, investment and labor productivity growth. The empirical findings in this section seem to indicate that a real estate boom lead to the diversion of resources from productive entrepreneurs in the manufacturing sector. These productive entrepreneurs with large capital stocks allocate their capital to real estate development, therefore tightening capital constraints on their manufacturing business. As a result, the investment, R&D and productivity growth in their manufacturing segment experienced a reduction. Before proposing a dynamic framework to assess the inefficiencies associated with such behavior, I would first rule out several alternative hypotheses.

One alternative hypothesis is the reverse causality, which is the major threat of my empirical results. It stipulates that manufacturing firms enter the real estate industry because they lack opportunities in the manufacturing industry. More specifically, the future investment opportunities of already productive firms can be limited due to a mean reversion of productivity or these firms reaching to technological frontier. Their investment activities and productivity growth will slowdown irrespective of their entrance to the real estate market. Despite that there is no perfect way to control



for unobserved manufacturing investment opportunities, I dealt with the concern of reverse causality using the matching estimators and the instrumental variable estimator. The matching estimators imply that manufacturing firms that entered the real estate industry exhibit declines in investment, R&D and productivity, in comparison with their ex-ante similar comparison firms. The instrumental variable estimators show that, for two firms otherwise similar, a firm located in a city with less elastic land supply and simultaneously have closer connections with the local land bureaus are more likely to enter the real estate market. For these firms, their productivity and investment declines more during the housing boom. I argue that my two instruments, local land supply elasticity and firms' ex-ante potential connections with the local land bureaus, are uncorrelated with aggregate economic shocks. Therefore, firms with different loadings on the two instruments are unlikely to be differentially affected by the housing cycle. At the least, if the ex-ante potential connections of local land bureau would have an impact on manufacturing investment opportunities, such impact would by no means be a negative one. In other words, the IV approach estimate a lower bound of the negative impact of entering the real estate sector on the manufacturing companies' production in their original businesses.

A second alternative hypothesis is the bank-lending channel. The bank-lending channel implies that in regions with a booming real estate sector, the manufacturing borrowings could be crowded out by real estate borrowings, so that investment of manufacturing firms would decline. As a result, manufacturing firms in regions with inelastic land supply might have experienced a larger decline in investment. However, this channel will dampen my story only if the firms entered the real estate sector are more affected than neighboring firms that did not enter. Column (1) - (4) in Table B.2 compare the debt growth of the real estate entrants and others. Both OLS and IV estimates indicate that firms entered the real estate sector had a larger increase in long-term debt (normalized by total fixed asset), in comparison with other firms. These result suggest that the bank-lending channel is less of a concern for my empirical analysis.

Table B.2: Testing the Alternative Hypotheses - the Bank Lending Channel

	Long Term Debt-to-asset Ratio			
	OLS		IV	
	(1)	(2)	(3)	(4)
Post-entry Dummy	0.033*** (2.42)	0.015 (1.10)	0.110* (1.69)	0.090 (0.80)
Lagged Debt-to-asset	0.230 (1.13)	0.211 (1.04)	0.284 (0.78)	-0.390 (0.45)
Number of Firms	19,896	19,893	17,830	17,830
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
2-digit Industry * Year FE	NO	YES	NO	YES
Region * Year FE	NO	YES	NO	YES

*Notes:* This table presents the evidence that rules out the effect of local equilibrium feedback on manufacturing production. Column (1) - (4) provide evidence against the bank-lending channel, i.e. the decline in manufacturing innovation results from a decline in bank lending to the manufacturing industry. My estimates show that long-term debt-to-asset ratio does not decline after a manufacturing firm entered into real estate. Column (5) - (8) show that the employment at original establishments does not decline after a manufacturing firm entered into real estate. All specifications controlled for year and city fixed effects. Standard errors in parentheses are clustered at city level.

- \*\*\* Significant at the 1 percent level
- \*\* Significant at the 5 percent level
- \* Significant at the 10 percent level

Last but not least, I rule out the alternative hypothesis of decreasing return to scale. One may suspect that larger firms are more likely to invest in the real estate market as they suffer more from decreasing return to scale in their manufacturing businesses. I argue that decreasing return to scale could not solely explain my findings from the following two aspects: firstly, the firms that entered the real estate development industry on average have a higher investment rate, a higher R&D intensity, and also a higher profit-to-sales ratio than firms that did not. It is difficult to argue that firms with higher investment rates and R&D intensities are the ones reaching their optimal scales than firms with lower investment rates. Secondly, I look at the external investment of manufacturing firms using the Enterprise Registration Database. This data set records the shareholders of all registered firms in China, which can be transformed into firm-level investment portfolio. Burnstein (2015) argues that a more matured company is more likely to involve in mergers and acquisitions rather than internal investment activities. By this standard, we should observe firms entered the real estate development industry investing more in other companies, in order to argue these firms reaching or beyond their optimal operating scales. I do not find such evidence from the Enterprise Registration Database.

Table B.3 presents results from regressing the total external investment expenditure of each company on whether or not they entered the real estate industry. The estimates show that companies involved in real estate development do not spend more capital on external investment activities. Therefore, the decreasing return to scale should not be an explanation for my empirical findings.

Table B.3: Testing the Alternative Hypotheses - Decreasing Return to Scale

Dependent Variables:	(1) Total External Investment	(2) External Investment Rate
Entrants in the Real Estate	-2.889	-0.0415
Development Industry	(0.82)	(1.01)
Net Debt Issuance	0.475	0.003
	(1.61)	(1.49)
Credit Score	9.52*	0.314
	(1.65)	(1.39)
Observations	94,109	94,438
R-squared	0.0212	0.002
Size FE	YES	YES
Region FE	YES	YES

*Notes:* This table presents the evidence that rules out the decreasing return to scale hypotheses by looking at the external investment of manufacturing firms. The total external investment is measured as the total capital investment in other companies from the Enterprise Registration Database. The investment share is the external investment normalized by the lagged book value of total fixed assets. All specifications controlled for firm size and region fixed effects. Standard errors in parentheses are clustered at firm level.

\*\*\* Significant at the 1 percent level

\*\* Significant at the 5 percent level

\* Significant at the 10 percent level

## Appendix C: Proofs

### Proof of Lemma 1:

The entrepreneur with talent  $z^M$  solves for the following utility-maximizing problem in the first period:

$$\begin{aligned} \max_{a_1(z^M)} U^1(z^M) &= \log c_1(z^M) + \beta \log c_2(z^M) \\ \text{s.t. } c_1(z^M) + a_1(z^M) &\leq \Gamma(\lambda, w_1, R_1, \exp(z^M)) \cdot a_0 \end{aligned} \quad (23)$$

$$c_2(z^M) \leq \Gamma(\lambda, w_2, R_2, \exp(z^M)) \cdot a_1(z^M) \quad (24)$$

The first-order condition satisfies:

$$\begin{aligned} \frac{1}{c_1(z^M)} &= \frac{\beta \Gamma(\lambda, w_2, R_2, \exp(z^M))}{\Gamma(\lambda, w_2, R_2, \exp(z^M)) a_1(z^M)} \\ &= \frac{\beta \Gamma(\lambda, w_2, R_2, \exp(z^M))}{\Gamma(\lambda, w_2, R_2, \exp(z^M)) a_1(z^M)} = \frac{\beta}{a_1(z^M)} \end{aligned}$$

Therefore, we solve for  $a_1(z^M)$  as:

$$a_1(z^M) = \frac{\beta}{1 + \beta} \Gamma(\lambda, w_1, R_1, \exp(z^M)) \cdot a_0$$

Given that  $\Gamma(\lambda, w_1, R_1, \exp(z^M))$  is non-decreasing in  $z^M$ ,  $a_1(z^M)$  is non-decreasing in  $z^M$ .

### Proof of Proposition 1:

The competitive equilibrium in the second period is characterized by price  $\{w_2, p^h, q, R_2\}$  such that each entrepreneur  $z$  maximizes its total consumption:

$$\begin{aligned} \max_{k(z^M), s(z^M), l_M(z^M), l_H(z^M)} & [\exp(z^M)k(z^M)]^{\alpha^M} l_M(z^M)^{1-\alpha^M} + p^H [\exp(z^H)s(z^M)]^{\alpha^H} l_H(z^M)^{1-\alpha} \\ & - w_2 [l_M(z^M) + l_H(z^M)] - R_2 [k(z^M) + qs(z^M) - a_1(z^M)] \\ \text{s.t. } & k(z^M) + qs(z^M) \leq \lambda a_1(z^M) \quad (\eta(z^M)) \\ & s(z^M) \cdot [s(z^M) - \underline{s}] \geq 0 \quad (\delta(z^M)) \end{aligned}$$

where  $\eta(z^M)$ ,  $\delta(z^M)$  are the Lagrangian multipliers for the two constraints.

The first-order conditions of entrepreneur  $z^M$ 's problem are:

$$(1 - \alpha^M) \left[ \frac{\exp(z^M)k(z^M)}{l_M(z^M)} \right]^{\alpha^M} = w_2 \quad (25)$$

$$(1 - \alpha^H) p^h \left[ \frac{\exp(z^H)s(z^M)}{l_H(z^M)} \right]^{\alpha^H} = w_2 \quad (26)$$

$$\alpha^M \exp(\alpha^M z^M) \left[ \frac{l_M(z^M)}{k(z^M)} \right]^{1-\alpha^M} - R_2 = \eta(z^M) \quad (27)$$

$$\alpha^H p^h \exp(\alpha^H z^H) \left[ \frac{s(z^M)}{l_H(z^M)} \right]^{1-\alpha^H} - qR_2 - (2s(z^M) - \underline{s})\delta(z^M) = q\eta(z^M) \quad (28)$$

Combining with equation (25) and (26), equation (27) and (28) can be written as:

$$\begin{aligned} \alpha^M \exp(z^M) \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1-\alpha^M}{\alpha^M}} - R_2 &= \eta(z^M) \\ \alpha^H p^h \exp(z^H) \left( \frac{1 - \alpha^H}{w_2} \right)^{\frac{1-\alpha^H}{\alpha^H}} - qR_2 - (2s(z^M) - \underline{s})\delta(z^M) &= q\eta(z^M) \end{aligned}$$

$\eta(z^M)$ ,  $\delta(z^M)$  in equilibrium indicate the marginal return to capital and the marginal return to land of entrepreneur  $z^M$ , respectively. Therefore,  $\eta(z^M)$  is increasing in  $z^M$ . Although without the exact functional form of  $a_1(\cdot)$ , the closed-form of this new equation is not available, we can still prove the uniqueness of the equilibrium and derive policy implications. We discuss the solution to the competitive equilibrium in the two cases,  $b > 1$  and  $b < 1$ . Recall that  $b$  governs the relationship between the comparative advantage in housing,  $z^H - z^M$ , and the absolute advantage in manufacturing  $z^M$ .

**Case 1:  $b \geq 1$ :**

When  $b \geq 1$ , the entrepreneurs with high talent in the manufacturing sector should specialize in real estate. Therefore, there are two cutoffs that characterize the entrepreneurs' business choices:  $\underline{z}^M$  decides if an entrepreneur produces or saves in the capital market;  $z_h^M$  decides if an entrepreneur operates in the real estate sector or in the manufacturing sector. The lower cutoff  $\underline{z}^M$  is pinned down by the free-entry condition:

$$\alpha^M \exp(\underline{z}^M) \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1-\alpha^M}{\alpha^M}} - R_2 = 0$$

The higher cutoff  $z_h^M$  should satisfy the following two inequalities:

$$\alpha^M \exp(z_h^M) \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1 - \alpha^M}{\alpha^M}} \leq \alpha^H \frac{p^H}{q} \exp(z_h^H) \left( \frac{p^H(1 - \alpha^H)}{w_2} \right)^{\frac{1 - \alpha^H}{\alpha^H}} \quad (29)$$

$$\lambda a_1(z_h^M) \geq q \underline{s} \quad (30)$$

The land price in equilibrium is determined by the land market clearing condition:

$$\lambda \int_{z_h^M}^1 a_1(z^M) dF(z^M) = qS$$

The capital market clearing condition indicates that:

$$\lambda \int_{z_h^M}^{z_h^M} a_1(z^M) dF(z^M) = \int_0^1 a_1(z^M) dF(z^M) + a_1^L \quad (31)$$

The goods market clearing conditions further imply the relationship between wage, house prices on the total output of the two sectors:

$$p^H = \frac{\sigma}{1 - \sigma} \cdot \frac{C}{H} \quad (32)$$

$$w_2 = (1 - \alpha^M + (1 - \alpha^H) \frac{\sigma}{1 - \sigma}) \cdot \frac{C}{L} \quad (33)$$

The total output in the manufacturing sector and the real estate sector can be further written as:

$$C = \lambda \int_{z_h^M}^{z_h^M} \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1 - \alpha^M}{\alpha^M}} \exp(z^M) a_1(z^M) dF(z^M)$$

$$H = \lambda \int_{z_h^M}^1 \frac{1}{q} \left( \frac{p^H(1 - \alpha^H)}{w_2} \right)^{\frac{1 - \alpha^H}{\alpha^H}} \exp(z^H) a_1(z^M) dF(z^M)$$

Plugging the above two equations and (32) into (29), we get that

$$\text{const} \cdot \exp(z_h^M) \int_{z_h^M}^1 \exp(z^H) a_1(z^M) dF(z^M) \leq \cdot \exp(z_h^H) \int_{z_h^M}^{z_h^M} \exp(z^M) a_1(z^M) dF(z^M)$$

Assuming this equation (29) holds with equality, and defining  $I$  as the LHS minus the RHS, we can derive the following first-order derivative using the Implicit Function Theorem:

$$\begin{aligned}
\frac{\partial z_h^M}{\partial \underline{z}^M} &= - \frac{\partial I / \partial \underline{z}^M}{\partial I / \partial z_h^M} \\
&= \frac{\exp(c + bz_h^M) \exp(\underline{z}^M) a_1(\underline{z}^M) f(\underline{z}^M)}{(1 + \text{const}) \exp(c + bz_h^M) \exp(z_h^M) a_1(z_h^M) f(z_h^M) + (b - 1) \exp(z_h^H - z_h^M) \int_{\underline{z}^M}^{z_h^M} \exp(z^M) a_1(z^M) dF(z^M)} \\
&< \frac{a_1(\underline{z}^M) f(\underline{z}^M)}{a_1(z_h^M) f(z_h^M)}
\end{aligned}$$

If instead equation (30) holds with equality, given that  $\underline{z}^M$  is not part of the constraint, we know that:

$$\frac{\partial z_h^M}{\partial \underline{z}^M} = 0$$

Given that the slope  $\frac{\partial z_h^M}{\partial \underline{z}^M}$  from either (29) or (30) is flatter than from (31), the competitive equilibrium is unique upon existence.

**Case 2:  $b < 1$ :**

In the case of  $b < 1$ , when the representative worker's endowment is large so that all entrepreneurs produce in the first period, there are three cutoffs  $\underline{z}^M$ ,  $z_l^M$  and  $z_h^M$ .  $\delta(z^M) > 0$  for all  $z \leq z_l^M$ , so that:

$$\lambda a_1(z_l^M) = qS \quad (34)$$

Two free entry conditions determine the other two cutoffs  $\underline{z}^M$ ,  $z_h^M$ :

$$\alpha^M \exp(\underline{z}^M) \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1 - \alpha^M}{\alpha^M}} = R \quad (35)$$

$$\alpha^M \exp(z_h^M) \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1 - \alpha^M}{\alpha^M}} = \alpha^H \exp(z_h^H) \frac{p^H}{q} \left( \frac{p^H (1 - \alpha^H)}{w_2} \right)^{\frac{1 - \alpha^H}{\alpha^H}} \quad (36)$$

$\underline{z}^M$  is the entrepreneur indifferent from saving and producing, and  $z_h^M$  is the entrepreneur indifferent from producing in the real estate sector and producing in the manufacturing sector.

The land market clearing condition implies that:

$$\lambda \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M) = qS \quad (37)$$

Combining equation (34) and (37), the least talented entrepreneur and the most talented entrepreneur in the real estate sector follow:

$$\frac{S}{\underline{S}} \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M) = a_1(z_l^M) \quad (38)$$

The capital market clearing condition implies that all capital used for manufacturing production should be the same as the total wealth of the economy. So that:

$$\begin{aligned} \lambda \left[ \int_{\underline{z}^M}^{z_l^M} a_1(z^M) dF(z^M) + \int_{z_h^M}^1 a_1(z^M) dF(z^M) \right] &= \int_0^1 a_1(z^M) dF(z^M) + a_1^L \\ \Rightarrow \lambda \left[ \int_{\underline{z}^M}^1 a_1(z^M) dF(z^M) - \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M) \right] &= \int_0^1 a_1(z^M) dF(z^M) + a_1^L \\ \Rightarrow \lambda \left[ \int_{\underline{z}^M}^1 a_1(z^M) dF(z^M) - \frac{S}{\underline{S}} a_1(z_l^M) \right] &= \int_0^1 a_1(z^M) dF(z^M) + a_1^L \end{aligned} \quad (39)$$

Since the left hand side of the equation is increasing in both  $\underline{z}^M$  and  $z_l^M$ , (39) indicates that  $z_l^M$  is decreasing in  $\underline{z}^M$ .

The housing market clearing condition imply that

$$\begin{aligned} p^h H &= \frac{\sigma}{1-\sigma} C \\ \Rightarrow w_2 L &= (1-\alpha^M)Y + (1-\alpha^H)p^H H = (1-\alpha^M + (1-\alpha^H)\frac{\sigma}{1-\sigma})C \end{aligned}$$

Where  $\rho$  is the housing consumption share of workers. Therefore, we can re-write the prices  $w$  and  $p^h$  as functions of manufacturing output  $Y$  and housing output  $H$ :

$$p^H = \frac{\sigma}{1-\sigma} \cdot \frac{C}{H} \quad (40)$$

$$w_2 = (1-\alpha^M + (1-\alpha^H)\frac{\sigma}{1-\sigma}) \cdot \frac{C}{L} \quad (41)$$

The free-entry condition of equation (36) can then be written as:

$$\begin{aligned} \alpha^M \exp(z_h^M) \left( \frac{1-\alpha^M}{w_2} \right)^{\frac{1-\alpha^M}{\alpha^M}} &= \alpha^H \exp(c + bz_h^M) \frac{p^H}{q} \left( \frac{p^H(1-\alpha^H)}{w_2} \right)^{\frac{1-\alpha^H}{\alpha^H}} \\ &= \alpha^H \exp(c + bz_h^M) \frac{1}{q} \cdot \frac{\sigma}{1-\sigma} \cdot \frac{Y}{H} \left( \frac{p^H(1-\alpha^H)}{w_2} \right)^{\frac{1-\alpha^H}{\alpha^H}} \end{aligned}$$

Re-writing the total output in manufacturing and housing sector, we get:



$$\begin{aligned}
C &= \int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} \exp(z^M) \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1 - \alpha^M}{\alpha^M}} k_1(z^M) dF(z^M) \\
\Rightarrow C \cdot \left( \frac{w_2}{1 - \alpha^M} \right)^{\frac{1 - \alpha^M}{\alpha^M}} &= \lambda \int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} \exp(z^M) a_1(z^M) dF(z^M)
\end{aligned} \tag{42}$$

$$\begin{aligned}
p^H H &= \int_{z_l^M}^{z_h^M} \exp(c + bz_h^M) p^H \left( \frac{p^H (1 - \alpha^H)}{w_2} \right)^{\frac{1 - \alpha^H}{\alpha^H}} s(z) dF(z) \\
\Rightarrow qH \cdot \left( \frac{w_2}{p^H (1 - \alpha^H)} \right)^{\frac{1 - \alpha^H}{\alpha^H}} &= \lambda \int_{z_l^M}^{z_h^M} \exp(c + bz^M) a_1(z^M) dF(z^M)
\end{aligned} \tag{43}$$

Plugging the two equations back to (36), we can further derive the free entry condition as:

$$\begin{aligned}
\frac{1 - \sigma}{\sigma} \cdot \frac{\alpha^M \exp(z_h^M)}{\lambda \int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} \exp(z^M) a_1(z^M) dF(z^M)} &= \frac{\alpha^H \exp(c + bz_h^M)}{\lambda \int_{z_l^M}^{z_h^M} \exp(c + bz^M) a_1(z^M) dF(z^M)} \\
\int_{z_l^M}^{z_h^M} \left[ \frac{1 - \sigma}{\sigma} \cdot \frac{\alpha^M}{\alpha^H} \cdot e^{(1-b)z_h^M} \exp(bz^M) + \exp(z^M) \right] a_1(z^M) dF(z^M) &= \int_{\underline{z}^M}^1 \exp(z^M) a_1(z^M) dF(z^M)
\end{aligned} \tag{44}$$

Recall that equation (38) specifies  $z_h^M$  as a function of  $z_l^M$ :

$$\frac{\S}{\S} \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M) = a_1(z_l^M)$$

From the above equation above, it's easy to see that  $z_h^M$  is increasing in  $z_l^M$ . In addition, using the Implicit Function Theorem, we can calculate the derivative of  $\partial z_h^M / \partial z_l^M$ :

$$\begin{aligned}
\frac{\partial z_h^M}{\partial z_l^M} &= - \frac{\partial I_1 / \partial z_l^M}{\partial I_1 / \partial z_h^M} \\
&= \frac{a_1(z_l^M) f(z_l^M) + \frac{\S}{\S} a_1'(z_l^M)}{a_1(z_h^M) f(z_h^M)}
\end{aligned}$$

where  $I_1 = \frac{\S}{\S} \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M) - a_1(z_l^M) = 0$  is the corresponding implicit function. Plugging the above relationship between  $z_h^M$  and  $z_l^M$  into equation (44), we can derive another equation between  $\underline{z}^M$  and  $z_l^M$ . Writing the implicit function between  $\underline{z}^M$  and  $z_l^M$  as:

$$\begin{aligned}
I_2 &= \int_{z_l^M}^{z_h^M} \left[ \frac{1-\sigma}{\sigma} \cdot \frac{\alpha^M}{\alpha^H} \cdot e^{(1-b)z_h^M} \exp(bz^M) + \exp(z^M) \right] a_1(z^M) dF(z^M) - \int_{\underline{z}^M}^1 \exp(z^M) a_1(z^M) dF(z^M) \\
&\equiv \int_{z_l^M}^{z_h^M} \left[ \chi \cdot \frac{\alpha^M}{\alpha^H} \cdot e^{(1-b)z_h^M} \exp(bz^M) + \exp(z^M) \right] a_1(z^M) dF(z^M) - \int_{\underline{z}^M}^1 \exp(z^M) a_1(z^M) dF(z^M)
\end{aligned}$$

The derivate of  $\partial z_l^M / \partial \underline{z}^M$  can be obtained using again the Implicit Function Theorem:

$$\begin{aligned}
\frac{\partial z_l^M}{\partial \underline{z}^M} &= - \frac{\partial I_2 / \partial \underline{z}^M}{\partial I_2 / \partial z_l^M} \\
&= - \frac{\exp(\underline{z}^M) a_1(\underline{z}^M) f(\underline{z}^M)}{\frac{\partial I_2}{\partial z_h^M} \cdot \frac{\partial z_h^M}{\partial z_l^M} + \frac{\partial I_2}{\partial z_l^M}}
\end{aligned}$$

The denominator of this equation can be expressed as:

$$\begin{aligned}
\frac{\partial I_2}{\partial z_h^M} \cdot \frac{\partial z_h^M}{\partial z_l^M} + \frac{\partial I_2}{\partial z_l^M} &= \left[ \chi \frac{\alpha^M}{\alpha^H} \cdot (1-b) \int_{z_l^M}^{z_h^M} \exp(bz^M) a_1(z^M) dF(z^M) + \left( \chi \frac{\alpha^M}{\alpha^H} + 1 \right) \exp(z_h^M) a_1(z_h^M) f(z_h^M) \right] \cdot \frac{\partial z_h^M}{\partial z_l^M} \\
&\quad - \chi \frac{\alpha^M}{\alpha^H} e^{(1-b)z_h^M + bz_l^M} a_1(z_l^M) f(z_l^M) - \exp(z_l^M) a_1(z_h^M) f(z_h^M) \\
&= \chi \frac{\alpha^M}{\alpha^H} \cdot (1-b) \int_{z_l^M}^{z_h^M} \exp(bz^M) a_1(z^M) dF(z^M) \frac{\partial z_h^M}{\partial z_l^M} + \left( \chi \frac{\alpha^M}{\alpha^H} + 1 \right) \exp(z_h^M) [a(z_l^M) f(z_l^M) + \frac{S}{\underline{z}} a'_1(z_l^M)] \\
&\quad - \chi \frac{\alpha^M}{\alpha^H} e^{(1-b)z_h^M + bz_l^M} a_1(z_l^M) f(z_l^M) - \exp(z_l^M) a_1(z_h^M) f(z_h^M) \\
&> \chi \frac{\alpha^M}{\alpha^H} \cdot (1-b) \int_{z_l^M}^{z_h^M} \exp(bz^M) a_1(z^M) dF(z^M) \frac{\partial z_h^M}{\partial z_l^M} + \exp(z_h^M) \frac{S}{\underline{z}} a'_1(z_l^M) > 0
\end{aligned}$$

The last inequality utilizes the assumption that  $z_h^M > z_l^M > \underline{z}^M$ . Given the last line is strictly higher than 0, equation (44) specifies also  $z_l^M$  as decreasing in  $\underline{z}^M$ .

Next we show that upon the existence of an competitive equilibrium, the equilibrium must be unique. From equation (39),

$$\lambda \left[ \int_{\underline{z}^M}^1 a_1(z^M) dF(z^M) - \frac{S}{\underline{z}} a_1(z_l^M) \right] = \int_0^1 a_1(z^M) dF(z^M) + a_1^L$$

By the Implicit Function Theorem,

$$\frac{\partial z_l^M}{\partial \underline{z}^M} = - \frac{a_1(\underline{z}^M) f(\underline{z}^M)}{\frac{S}{\underline{z}} a'_1(z_l^M)} \tag{45}$$

The slope is strictly increasing in  $\underline{z}^M$  and decreasing in  $z_l^M$ .

For a given  $(z_l^M, \underline{z}^M)$ , the slope  $\frac{\partial z_l^M}{\partial \underline{z}^M}$  from equation (44) can be computed as:

$$\begin{aligned} \frac{\partial z_l^M}{\partial \underline{z}^M} &= - \frac{\exp(\underline{z}^M) a(\underline{z}^{cp}) f(\underline{z}^{cp})}{\frac{\partial I_2}{\partial z_h^M} \cdot \frac{\partial z_h^M}{\partial \underline{z}^M} + \frac{\partial I_2}{\partial z_l^M}} \\ &> - \frac{\exp(\underline{z}^M) a(\underline{z}^{cp}) f(\underline{z}^{cp})}{\exp(z_h^M) \frac{\underline{s}}{\underline{s}} a_1'(z_l^M)} > - \frac{a_1(\underline{z}^M) f(\underline{z}^M)}{\frac{\underline{s}}{\underline{s}} a_1'(z_l^M)} \end{aligned}$$

Therefore,  $z_l^M$  as a function of  $\underline{z}^M$  specified from (39) is strictly flatter than the function specified from (44), which guarantees the uniqueness of the equilibrium upon existence.

The rest of the equilibrium can be solved as follows:

- The third cutoff  $z_l^M$  can be solved by plugging in  $z_h^M$  into equation (38).
- The land price  $q$  is determined by the land market clearing condition:  $\lambda \int_{z_l^M}^{z_h^M} a_1(\underline{z}^M) dF(\underline{z}^M) = qS$
- The equilibrium wage  $w_2$  and output  $Y$  are jointly determined by (41) and (42)
- The equilibrium interest rate  $R_2$  is pinned down by equation (35)
- The equilibrium house price  $p^H$  and housing output  $H$  are jointly determined by (40) and (43).

### Proof of Definition 1:

The comparative advantage is defined through solving the planner's problem without the constraint at the extensive margin. Among the two firm-level constraints in production, the minimum operating scale constraint creates frictions at the extensive margin. Therefore, no matter  $b > 1$  or  $b < 1$ , the solution to the planner's problem can be characterized with two thresholds. One is determined by the free-entry condition in producing, and the other is determined by the free-entry condition in switching between the real estate sector and the manufacturing sector. Here we walk through the case when  $b > 1$ , the proof to the other case follows the same logic.

When  $b > 1$ , there are two cutoffs that characterize the entrepreneurs' business choices:  $\underline{z}^M$  decides if an entrepreneur produces or saves in the capital market;  $z_h^M$  decides if an entrepreneur operates in the real estate sector or in the manufacturing sector. The planner's problem without the minimum operating scale constraint can be written as:

$$\begin{aligned}
& \max_{\{z^M, z_h^M, l(z^M), k(z^M), s(z^M)\}} && \chi \log C + \log H \\
& \text{s.t.} && C = \int_{z^M}^{z_h^M} [e^{z^M} k(z^M)]^{\alpha^M} l(z^M)^{1-\alpha^M} dF(z^M) \\
& && H = \int_{z_h^M}^1 [e^{z^H} s(z^M)]^{\alpha^H} l(z^M)^{1-\alpha^H} dF(z^M) \\
& && \int_{z^M}^{z_h^M} k(z^M) dF(z^M) = \int_0^1 a_1(z^M) dF(z^M) + a_1^L \quad (\mu_k) \quad (46) \\
& && \int_{z^M}^1 l(z^M) dF(z^M) = L \quad (\mu_l) \quad (47) \\
& && \int_{z_h^M}^1 s(z^M) dF(z^M) = S \quad (\mu_s) \quad (48)
\end{aligned}$$

The  $\mu$ 's in the parenthesis are the Lagrangian multipliers for the three factor market clearing conditions. The first-order condition with respect to  $z_h^M$  implies that:

$$\frac{\chi}{C} [\exp(z_h^M) k(z_h^M)]^{\alpha^M} l(z_h^M)^{1-\alpha^M} - \frac{1}{H} [\exp(z_h^M) s(z_h^M)]^{\alpha^H} l(z_h^M)^{1-\alpha^H} + \mu_k k(z_h^M) - \mu_s s(z_h^M) = 0$$

It is easy to show<sup>47</sup> that  $[\exp(z_h^M) k(z_h^M)]^{\alpha^M} l(z_h^M)^{1-\alpha^M}$ ,  $k(z_h^M) \propto \exp(z_h^M) a_1(z_h^M)$  and that  $[\exp(z_h^M) s(z_h^M)]^{\alpha^H} l(z_h^M)^{1-\alpha^H}$ ,  $\exp(z_h^H) a_1(z_h^M)$ . Therefore, the above equation can be re-written as:

$$const_1 \exp z_h^M - const_2 \exp z_h^H = 0$$

where  $const_1, const_2$  are three constant numbers that depend on the exogenous parameters and the Lagrangian multipliers.

The social planner allocates entrepreneurs into different sectors according to the difference between  $const_1 \exp z_h^M$  and  $const_2 \exp z_h^H$ . When  $const_1 \exp z_h^M - const_2 \exp z_h^H > 0$ , the entrepreneur  $z^M$  is allocated to the manufacturing sector; when  $const_1 \exp z_h^M - const_2 \exp z_h^H < 0$ , the entrepreneur  $z^M$  is allocated to the real estate sector.

$$\begin{aligned}
const_1 \exp z_h^M - const_2 \exp z_h^H &< 0 \\
\Leftrightarrow const_1 \exp z_h^M &< const_2 \exp z_h^H \\
\Leftrightarrow \exp(z_h^H - z_h^M) &> const_1 / const_2
\end{aligned}$$

With a monotonic transformation, we define an entrepreneur's comparative advantage in the real estate sector as:

<sup>47</sup>The detailed derivation can be found in the proof of Proposition 1.

$$z^H - z^M$$

**Proof of Proposition 2:** The social planner assign inputs (labor, land, capital) to entrepreneurs to maximize a weighted average of the entrepreneurs' utilities and the workers' utilities:

$$\max_{k(z^M), l(z^M), s(z^M)} \chi \log C + \log H$$

In proving Proposition 2, we discuss the two scenarios that specify different correlation between the entrepreneurs' comparative advantages and the absolute advantages separately.

**Case 1:**  $b \geq 1$ :

In this case, the comparative advantage of entrepreneurs in the real estate sector is increasing in their absolute advantage in the manufacturing sector,  $z^M$ . The social planner solves for the two cutoffs as in the competitive equilibrium. Thus the social planner's problem can be written as:

$$\max_{\{z^M, z_h^M, l(z^M)\}} \chi \log C + \log H$$

$$s.t. \quad Y = \int_{z^M}^{z_h^M} [e^{z^M} k(z^M)]^{\alpha^M} l(z^M)^{1-\alpha^M} dF(z^M) \quad (49)$$

$$H = \int_{z^M}^1 [e^{z^H} s(z^M)]^{\alpha^H} l(z^M)^{1-\alpha^H} dF(z^M) \quad (50)$$

$$\lambda \int_{z^M}^{z_h^M} a_1(z^M) dF(z^M) = \int_0^1 a_1(z^M) dF(z^M) + a_1^L \quad (\mu_k) \quad (51)$$

$$\lambda a_1(z_h^M) \geq \frac{\lambda \int_{z_h^M}^1 a_1(z^M) dF(z^M)}{S} \underline{s} \quad (\mu_e) \quad (52)$$

$$\int_{z^M}^1 l(z^M) dF(z^M) = L \quad (\mu_l) \quad (53)$$

Given the imperfect financial market, each entrepreneur participating in production would exhaust its borrowing capacity:

$$\begin{aligned} k(z^M) &= \lambda a_1(z^M) \quad \forall z \in [z^M, z_h^M] \\ s(z^M) &= \frac{\lambda a_1(z^M)}{\lambda \int_{z_h^M}^1 a_1(z^M) dF(z^M)} S \quad \forall z \in (z_h^M, 1] \end{aligned}$$

If the entry barrier in the real estate sector is binding for  $z_h^M$ ,  $z_h^M$  is determined by the pre-period wealth  $a_1(\cdot)$ , and that the social planner cannot increase or decrease  $z_h^M$ . If (52) is not binding, endo-

genizing the land price  $q = \frac{\lambda \int_{z_h^M}^1 a_1(z^M) dF(z^M)}{s}$  does not generate different first-order conditions from the competitive equilibrium.

As a result, the solution to the planner's problem is the same as the competitive equilibrium. So that the equilibrium allocation of entrepreneurial talent under  $b > 1$  is constrained efficient.

**Case 2:  $b < 1$ :**

The social planner assign inputs (labor, land, capital) to entrepreneurs to maximize a weighted average of the entrepreneurs' utilities and the workers' utilities:

$$\max_{k(z^M), l(z^M), s(z^M)} \chi \log C + \log H$$

Solving for the planner's problem is equivalent to solve for the allocation of entrepreneurs. From the competitive equilibrium, we know that there exists three cutoffs:  $\underline{z}^M, z_l^M, z_h^M$ .  $\underline{z}^M$  is the threshold where entrepreneurs are indifferent from saving or producing;  $z_l^M$  is the threshold where the entrepreneurs are unconstrained from entering the real estate sector;  $z_h^M$  is the threshold such that entrepreneurs are indifferent from producing in the housing and the real estate sector. As a result, the planner's problem can be written as:

$$\max_{\{\underline{z}^M, z_l^M, z_h^M, l(z^M)\}} \chi \log C + \log H$$

$$s.t. \quad Y = \int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} [\exp(z^M) k(z^M)]^{\alpha^M} l(z^M)^{1-\alpha^M} dF(z^M) \quad (54)$$

$$H = \int_{z_l^M}^{z_h^M} [\exp(c + bz^M) s(z^M)]^{\alpha^H} l(z^M)^{1-\alpha^H} dF(z^M) \quad (55)$$

$$\lambda \left( \int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} a_1(z^M) dF(z^M) \right) \leq \int_0^1 a_1(z^M) dF(z^M) + a_1^L \quad (\mu_k) \quad (56)$$

$$\lambda a_1(z_l^M) \geq \frac{\lambda \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)}{s} \underline{s} \quad (\mu_e) \quad (57)$$

$$\int_{\underline{z}^M}^1 l(z^M) dF(z^M) = L \quad (\mu_l) \quad (58)$$

Given the imperfect financial market, each entrepreneur participating in production would exhaust its borrowing capacity:

$$k(z^M) = \lambda a_1(z^M) \quad \forall z^M \in [\underline{z}^M, z_l^M) \cup (z_h^M, 1]$$

$$s(z^M) = \frac{\lambda a_1(z^M)}{\lambda \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} \underline{s} \quad \forall z^M \in [z_l^M, z_h^M]$$

The Lagrangian equation of the planner's problem can be written as:

$$\begin{aligned}\mathcal{L} = & \chi \log C + \log H - \mu_k \left( \int_0^1 a_1(z^M) dF(z^M) + a_1^L - \lambda \left( \int_{[z^M, z_l^M] \cup (z_h^M, 1]} a_1(z^M) dF(z^M) \right) \right) \\ & + \mu_e \left( \lambda a(z_l^M) - \frac{\lambda \int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)}{S} \right) + \mu_l \left( L - \int_{z^M}^1 l(z^M) dF(z^M) \right)\end{aligned}$$

The first-order conditions of the planner's problem are:

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial z^M} &= -\frac{\chi}{C} (\lambda \exp(z^M) a_1(z^M))^{\alpha^M} l(z^M)^{1-\alpha^M} - \mu_k \lambda a_1(z^M) + \mu_l l(z^M) = 0 \\ \frac{\partial \mathcal{L}}{\partial z_l^M} &= \frac{\chi}{C} (\lambda \exp(z_l^M) a_1(z_l^M))^{\alpha^M} l(z_l^M)^{1-\alpha^M} - \frac{1}{H} \left( \frac{\exp(c + dz_l^M) a_1(z_l^M) S}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} \right)^{\alpha^H} l(z_l^M)^{1-\alpha^H} - \mu_k \lambda a_1(z_l^M) \\ &\quad + \underbrace{\mu_e \lambda a_1'(z_l^M) + \frac{(1-\chi)\alpha^H}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} a_1(z_l^M) + \mu_e \lambda a_1(z_l^M) \frac{S}{S}}_{\text{general equilibrium feedback}} = 0 \\ \frac{\partial \mathcal{L}}{\partial z_h^M} &= -\frac{\chi}{C} (\lambda \exp(z_h^M) a_1(z_h^M))^{\alpha^M} l(z_h^M)^{1-\alpha^M} + \frac{1}{H} \left( \frac{\exp(c + dz_h^M) a_1(z_h^M) S}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} \right)^{\alpha^H} l(z_h^M)^{1-\alpha^H} \\ &\quad + \underbrace{\mu_k \lambda a_1(z_h^M) - \frac{(1-\chi)\alpha^H}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} a_1(z_h^M) - \mu_e \lambda a(z_h^M) \frac{S}{S}}_{\text{general equilibrium feedback}} = 0 \\ \frac{\partial \mathcal{L}}{\partial l(z^M)} &= \frac{\chi}{C} (1 - \alpha^M) \left( \frac{\lambda \exp(z^M) a(z^M)}{l(z^M)} \right)^{\alpha^M} - \mu_l = 0 \quad \forall z^M \in [z^M, z_l^M] \cup (z_h^M, 1] \\ \frac{\partial \mathcal{L}}{\partial l(z_h^M)} &= \frac{1}{H} (1 - \alpha^M) \left( \frac{\exp(c + bz^M) a(z^M) S}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M) l(z)} \right)^{\alpha^H} - \mu_l = 0 \quad \forall z^M \in [z_l^M, z_h^M]\end{aligned}$$

In an environment with  $b < 1$ , the difference between the social product of capital in  $H$  and  $C$  is increasing as  $z_l^M \downarrow$ , and the difference between the social product of capital in  $C$  and  $H$  is increasing as  $z_h^M \uparrow$ . Therefore, the general equilibrium feedbacks result in lower  $z_l^M$  and  $z_h^M$  in the planner's problem:

$$\begin{aligned}
& \frac{1}{H} \left( \frac{\exp(c + dz_l^M) a_1(z_l^M) S}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} \right)^{\alpha^H} I(z_l^M)^{1-\alpha^H} - \frac{\chi}{C} (\lambda \exp(z_l^M) a_1(z_l^M))^{\alpha^M} I(z_l^M)^{1-\alpha^M} \\
= & \mu_e \lambda a_1'(z_l^M) - \mu_k \lambda a_1(z_l^M) + \frac{(1-\chi)\alpha^H}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} a_1(z_l^M) + \underbrace{\mu_e \lambda a_1(z_l^M) \frac{\xi}{S}}_{\text{Externality}} \\
> & \mu_e \lambda a_1'(z_l^M) - \mu_k \lambda a_1(z_l^M) + \frac{(1-\chi)\alpha^H}{\int_{z_l^M}^{z_h^M} a_1(z^M) dF(z^M)} a_1(z_l^M) \tag{59}
\end{aligned}$$

$$\begin{aligned}
& \frac{\chi}{C} (\lambda \exp(z_h^M) a_1(z_h^M))^{\alpha^M} I(z_h^M)^{1-\alpha^M} - \frac{1}{H} \left( \frac{\exp(c + dz_h^M) a_1(z_h^M) S}{\int_{z_h^M}^{z_l^M} a_1(z^M) dF(z^M)} \right)^{\alpha^H} I(z_h^M)^{1-\alpha^H} \\
= & \mu_k \lambda a_1(z_h^M) - \frac{(1-\chi)\alpha^H}{\int_{z_h^M}^{z_l^M} a_1(z^M) dF(z^M)} a_1(z_h^M) - \underbrace{\mu_e \lambda a_1(z_h^M) \frac{\xi}{S}}_{\text{Externality}} \\
< & \mu_k \lambda a_1(z_h^M) - \frac{(1-\chi)\alpha^H}{\int_{z_h^M}^{z_l^M} a_1(z^M) dF(z^M)} a_1(z_h^M) \tag{60}
\end{aligned}$$

The competitive equilibrium inefficiently allocated more talented and wealthy entrepreneurs into the real estate sector, resulting a higher land price and a lower total welfare.

Combining the two cases, we show that the competitive equilibrium is constrained efficient if and only if  $b \geq 1$ .

**Proof of Policy Discussions - Financial Market Liberalization:** Liberalizing the financial market is equivalent to increasing  $\lambda$ , therefore we compute the following comparative statics:

$$\frac{\partial(\chi \log C + \log H)}{\partial \lambda}$$

Holding the initial wealth distribution  $a_1(\cdot)$  as fixed, the marginal increase in  $\lambda$  does not affect equation (44). Intuitively, equation (44) captures the business choice of unconstrained entrepreneurs, which depends on the marginal product of capital in both the real estate and the manufacturing sector but not on the marginal entrepreneurs' wealth. The capital market clearing condition indicates that (39) is shifted to the right.

Given that equation (44) specifies a downward-sloping relationship between  $z_l^M$  and  $z_h^M$ , the shift leads to a higher  $z_h^M$  and a lower  $z_l^M$ .

The manufacturing output follows (42) and (41):



$$C^{\frac{1}{\alpha^M}} \propto \lambda \int_{[\underline{z}^M, z_l^M) \cup (z_h^M, 1]} \exp(z^M) a_1(z^M) dF(z^M) \equiv \lambda \tilde{C} \quad (61)$$

Similarly, the housing output follows (43), (41) and (32):

$$qH^{\frac{1}{\alpha^H}} \propto \lambda \int_{z_l^M}^{z_h^M} \exp(c + bz^M) a_1(z^M) dF(z^M) \equiv \lambda \tilde{H} \quad (62)$$

Thus the comparative statics can be computed in two parts:

$$\begin{aligned} \frac{\partial \log C}{\partial \lambda} &= \frac{\alpha^M}{\lambda} + \frac{\alpha^M}{\tilde{C}} \cdot \left[ -\exp(z_h^M) a_1(z_h^M) f(z_h^M) \frac{\partial z_h^M}{\partial z_l^M} \frac{\partial z_l^M}{\partial \lambda} + \exp(z_l^M) a_1(z_l^M) f(z_l^M) \frac{\partial z_l^M}{\partial \lambda} \right. \\ &\quad \left. - \exp(\underline{z}^M) a_1(\underline{z}^M) f(\underline{z}^M) \frac{\partial \underline{z}^M}{\partial \lambda} \right] \end{aligned}$$

$$\begin{aligned} \frac{\partial \log H}{\partial \lambda} &= \frac{\alpha^H}{\lambda} + \frac{\alpha^H}{\tilde{H}} \cdot \left[ \exp(c + bz_h^M) a_1(z_h^M) f(z_h^M) \frac{\partial z_h^M}{\partial z_l^M} \frac{\partial z_l^M}{\partial \lambda} - \exp(c + bz_l^M) a_1(z_l^M) f(z_l^M) \frac{\partial z_l^M}{\partial \lambda} \right] \\ &\quad - \frac{a_1'(z_l^M)}{a_1(z_l^M)} \frac{\partial z_l^M}{\partial \lambda} \end{aligned}$$

The optimization conditions in the competitive equilibrium imply that  $z_h^M$  has the same marginal return to capital in both sectors, so that:

$$\frac{\alpha^H}{\tilde{H}} \cdot \exp(c + bz_h^M) a_1(z_h^M) f(z_h^M) = \frac{\alpha^M}{\tilde{C}} \cdot \exp(z_h^M) a_1(z_h^M) f(z_h^M)$$

Given that the  $z_l^M$  is the marginal entrepreneur who is constrained from entering the housing sector,

$$\frac{\alpha^H}{\tilde{H}} \cdot \exp(c + bz_l^M) a_1(z_l^M) f(z_l^M) > \frac{\alpha^M}{\tilde{C}} \cdot \exp(z_l^M) a_1(z_l^M) f(z_l^M)$$

In addition, condition (39) implies that

$$\begin{aligned}
\frac{\partial z_l^M}{\partial \underline{z}^M} &> -\frac{a_1(\underline{z}^M)f(\underline{z}^M)}{\frac{S}{\underline{s}}a_1'(z_l^M)} \\
\Rightarrow a_1(\underline{z}^M)f(\underline{z}^M)\frac{\partial \underline{z}^M}{\partial \lambda} &= a_1(\underline{z}^M)f(\underline{z}^M)\frac{\partial z_l^M/\partial \lambda}{\partial z_l^M/\partial \underline{z}^M} \\
&> -\frac{S}{\underline{s}}a_1'(z_l^M)\frac{\partial z_l^M}{\partial \lambda} = -a_1'(z_l^M)\frac{\int_{z_l^M}^{z_h^M} a_1(z^M)dF(z^M)}{a_1(z_l^M)}\frac{\partial z_l^M}{\partial \lambda}
\end{aligned}$$

Taking into account that  $\underline{z}^M$  is also constrained from entering the real estate sector, and that  $\frac{\partial \underline{z}^M}{\partial \lambda} > 0$ ,

$$\begin{aligned}
-\frac{\alpha^M}{\tilde{C}}\exp(\underline{z}^M)a_1(\underline{z}^M)f(\underline{z}^M)\frac{\partial \underline{z}^M}{\partial \lambda} &> \frac{\alpha^H}{\tilde{H}}\exp(c + b\underline{z}^M)a_1(\underline{z}^M)f(\underline{z}^M)\frac{\partial \underline{z}^M}{\partial \lambda} \\
&> \frac{\alpha^H}{\tilde{H}}\exp(c + b\underline{z}^M)\frac{\int_{z_l^M}^{z_h^M} a_1(z^M)dF(z^M)}{a_1(z_l^M)}\frac{\partial z_l^M}{\partial \lambda} \\
&> \frac{a_1'(z_l^M)}{a_1(z_l^M)}\frac{\partial z_l^M}{\partial \lambda}
\end{aligned}$$

Therefore, the first-order derivative  $\frac{\partial(\chi \log C + \log H)}{\partial \lambda}$  is strictly higher than 0. As a result, the social welfare is increasing in  $\lambda$ .

The discrepancy between the marginal return to increasing  $z_l^M$ ,  $z_h^M$  are  $\mu_e \lambda a_1(z_l^M) \frac{S}{\underline{s}}$  and  $\mu_e \lambda a_1(z_h^M) \frac{S}{\underline{s}}$ , respectively. Therefore, the inefficiency is worse off when  $\lambda$  is higher.

**Proof of Policy Discussions - Reducing the Entry Barrier in the Real Estate Sector:** Reducing the entry barrier is equivalent to reducing the ratio of  $\underline{s}$  to  $S$ . For given  $\underline{z}$ , both equation (39) and equation (44) requires a lower  $z_1$ , so that the two curves between  $\underline{z}$  and  $z_1$  are shifted to the left. In addition, for both curves,  $\frac{\partial z_1}{\partial \underline{z}} < 1$  so that the shifts lead to a lower  $\underline{z}$  and also a lower  $z_1$ . It is also easy to see that  $z_2$  increases as  $\frac{S}{\underline{s}}$  decreases, otherwise the land price will be strictly lower and that the market clearing conditions will not hold.

Similar to our discussions in financial market liberalization, the policy impact can be written as:

$$\chi \frac{\partial \log C}{\partial (\frac{S}{\underline{s}})} + \frac{\partial \log H}{\partial (\frac{S}{\underline{s}})}$$

Looking at the manufacturing sector and the real estate sector separately,

$$\frac{\partial \log C}{\partial (\frac{s}{S})} = \frac{\alpha^M}{\bar{C}} \cdot [-\exp(z_h^M) a_1(z_h^M) f(z_h^M) \frac{\partial z_h^M}{\partial (\frac{s}{S})} + \exp(z_l^M) a_1(z_l^M) f(z_l^M) \frac{\partial z_l^M}{\partial (\frac{s}{S})} - \exp(\underline{z}^M) a_1(\underline{z}^M) f(\underline{z}^M) \frac{\partial \underline{z}^M}{\partial (\frac{s}{S})}]$$

$$\begin{aligned} \frac{\partial \log H}{\partial (\frac{s}{S})} &= \frac{1}{\bar{H}} [\exp(c + bz_h^M) a_1(z_h^M) f(z_h^M) \frac{\partial z_h^M}{\partial (\frac{s}{S})} - \exp(c + bz_l^M) a_1(z_l^M) f(z_l^M) \frac{\partial z_l^M}{\partial (\frac{s}{S})}] \\ &\quad - \frac{a'(z_l^M)}{a(z_l^M)} \frac{\partial z_l^M}{\partial (\frac{s}{S})} + \frac{S}{\underline{s}} \end{aligned}$$

Similar to our discussions for the previous policy,

$$\frac{\alpha^H}{\bar{H}} \cdot \exp(c + bz_h^M) a_1(z_h^M) f(z_h^M) = \frac{\alpha^M}{\bar{C}} \cdot \exp(z_h^M) a_1(z_h^M) f(z_h^M)$$

$$\frac{\alpha^H}{\bar{H}} \cdot \exp(c + bz_l^M) a_1(z_l^M) f(z_l^M) > \frac{\alpha^M}{\bar{C}} \cdot \exp(z_l^M) a_1(z_l^M) f(z_l^M)$$

Given that  $\frac{\partial z_l^M}{\partial (\frac{s}{S})} > 0$  and  $\frac{\partial z_h^M}{\partial (\frac{s}{S})} > 0$ , the welfare implication of reducing the entry barrier is ambiguous. If  $\underline{s} \rightarrow 0$ , it is welfare-improving to increase the entry barrier in the real estate sector.

In considering the differences between the planner's solution and the competitive equilibrium, both  $\mu_e \lambda a_1(z_l^M) \frac{s}{S}$  and  $\mu_e \lambda a_1(z_h^M) \frac{s}{S}$  are decreasing in  $\frac{s}{S}$ . Therefore, the inefficiency is better off when the entry barrier is lower.

**Proof of Policy Discussions - Taxation on Real Estate Returns:** When the social planner imposes a tax  $\tau$  on the return from operating in the real estate sector, the profit-maximizing problem of entrepreneur with talent  $z^M$  becomes:

$$\begin{aligned} \max_{k(z^M), s(z^M), l_M(z^M), l_H(z^M)} & [\exp(z^M) k(z^M)]^{\alpha^M} l_M(z^M)^{1-\alpha^M} + p^H (1-\tau) [\exp(z^H) s(z^M)]^{\alpha^H} l_H(z^M)^{1-\alpha^H} \\ & - w_2 [l_M(z^M) + l_H(z^M)] - R_2 [k(z^M) + qs(z^M) - a_1(z^M)] \\ \text{s.t.} & k(z^M) + qs(z^M) \leq \lambda a_1(z^M) \\ & s(z^M) \geq \underline{s} \qquad \qquad \qquad \forall s(z^M) > 0 \end{aligned}$$

Thus the first-order conditions implies that for  $z_h^M$  who is indifferent from operating in the real estate or the manufacturing sector,

$$\alpha^M \exp(z_h^M) \left( \frac{1 - \alpha^M}{w_2} \right)^{\frac{1 - \alpha^M}{\alpha^M}} = \alpha^H \exp(z_h^H) \frac{p^H (1 - \tau)}{q} \left( \frac{p^H (1 - \alpha^H)}{w_2} \right)^{\frac{1 - \alpha^H}{\alpha^H}}$$

With a small  $\tau$ , both  $z_l^M$  and  $z_h^M$  become smaller so that the inefficiency is improved in the competitive equilibrium.