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Beyond the collateral channel: Real estate prices and manufacturing firm investment in China

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ABSTRACT

Recent studies show that real estate price appreciation raises firms' debt capacity and therefore investment. However, appreciation of real estate prices may also push up production costs and thus discourage investment incentives. Using a large panel data set of Chinese manufacturing firms, we document that local real estate price appreciation had significant and robust negative effects on firm investment. The size of the negative effect is economically large, with a one standard deviation change in real estate prices explaining 17% of the variation in firm investment. Further exploration reveals that such negative effects of real estate prices on investment are stronger for firms in labor intensive sectors.

1. Introduction

The rise and fall of real estate prices can trigger large fluctuations in the real economy. To understand why the economy is so volatile to the real estate market, previous studies have paid considerable attention to the collateral function of real estate. In this view, the swings in real estate market affect the collateral values of firm owned real estate, while the values of pledgeable assets, in the absence of contract completeness, are positively associated with the access to credits (Barro, 1976; Hart & Moore, 1994). As a result, firm debt capacity and investment will increase on the upside of the real estate cycle but decrease on its downside, yielding a co-movement between real estate prices and the business cycle (e.g., Chaney et al., 2012; Gan, 2007a, 2007b).

However, a growing body of research provides mixed results on how real estate prices affect firm investment. In contrast to the collateral effect, recent research suggests that higher returns in the real estate sector lead firms and banks to increase their financial investments in real estate-related areas. This shift results in reduced credit access and fewer investments in sectors unrelated to real estate. In addition to these findings, our study argues that rising real estate prices can also restrict firm investment by increasing the local cost of labor. This occurs as higher real estate prices push up housing rents, prompting workers to demand higher wages to offset the increased cost of living (Roback, 1982; Liang et al., 2016), or to migrate out of cities (Meng et al., 2023).

The aim of this study is therefore to examine the effects of real estate prices on investment, while identifying and differentiating the effects of different channels. The data we use are from China. We match the city-level real estate prices data with the Annual Survey of Industrial Firms (ASIF) data from the National Bureau of Statistics of China (NBS). Previous studies have mainly used the data for publicly listed firms. Few studies have explored the data for manufacturing firms. In addition, we include a complete set of more than

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200 cities at the prefecture level and above. Previous studies tend to focus on the 35 major cities. According to our dataset, real estate prices in most cities have experienced rapid and sustained growth since the 2000s. In first-tier cities such as Beijing, Shanghai, Shenzhen, and Guangzhou, real estate prices have increased by an average of 24 percent per year (Meng et al., 2023).

One main challenge of our empirical analysis is to address the endogeneity issues related to real estate prices. Following the previous studies, we employ two instrumental variables. The first and primary instrumental variable is the share of unsuitable land for real estate construction, interacted with the national movement in the interest rate. The logic is that cities with less developable land would witness larger changes in real estate prices, given the magnitude of demand shocks caused by changes in the national interest rate (e.g., Chen & Kung, 2016). The second instrumental variable we use is the amount of urban land supplied by local governments (adjusted by lagged GDP), which is encouraged by the fact that the supply of land in China is governed by the construction land use quotas system as illustrated in the work of Liang et al. (2016).

Our analysis proceeds in three stages. First, we estimate a standard firm investment equation with the city-level real estate prices as an explanatory variable. Our results consistently suggest that there are significant negative effects of real estate prices on manufacturing investment in China. The magnitude of the impact is also economically large – a one standard deviation change in the real estate prices can explain as high as 17% of the variations in firm investment in our preferred specification using two instruments.

Second, we investigate to what extent these findings can be accounted for by different channels such as the labor cost effect and the collateral effect. To test the labor cost effect, we add the interaction term between real estate prices and a set of labor intensity quintile dummies at industrial levels. The coefficient estimates for such interaction terms will then capture the heterogeneous effects of real estate price changes for industries with high and low labor intensities (within a city). The corresponding results indicate that the higher is the labor intensity of an industry, the more investment is reduced. These results thus provide support for our argument that the growth of real estate prices hampers firm investment by driving up the local labor costs. Besides, we verify the existence of the collateral channel by adding interaction terms between real estate prices and the conventional firm-level proxies of credit constraints. We find that the appreciation of local real estate prices does allow small firms to invest more, but the amount is not significant in terms of economic importance. Yet we find that the state-owned firms – commonly considered as credit unconstrained – invest more than the non-state-owned firms. These findings contradict the prediction of the collateral channel and may suggest that the growth of local real estate prices has caused over-investment among the state-owned firms, e.g., speculating in the real estate markets.

Finally, we test whether the above findings exist in the long run. To do so, we run the first-difference regressions using data at the starting and ending years (i.e., from 2003 to 2007). We show that the main findings documented with the annual panel data exist in the long run too. Additionally, we document that the adverse impact of real estate prices on manufacturing investment is more pronounced among the older firms, while the younger firms can partially adapt to the impacts of the growth of real estate prices. Overall, we provide evidence that the appreciation of local real estate prices can push up the cost of labor and make investment nonprofitable; the rising labor costs will lower the returns of investment and therefore discourage firm investment. By contrast, we find there is little evidence that the credit constrained firms have benefited from the collateral effect of real estate.

Our contribution to the literature is three-fold. First, we propose and test a less-discussed mechanism that real estate prices changes may impact firm investment. Previous studies have predominantly focused on the collateral effect of real estate. In the contexts of Japan and the US, studies have demonstrated a positive relationship between real estate prices and firms' debt capacity and their investment (e.g., Chaney et al., 2012; Gan, 2007a, 2007b). Conversely, in China, Chen et al. (2017) have noted that rising real estate prices encourage firms to speculate in land and real estate itself, which adversely affects their investments in non-real estate areas such as innovation and production facilities (Rong et al., 2016; Miao & Wang, 2014; Chen & Wen, 2017). In the financial sector, a robust real estate market encourages banks to redirect credit supply toward mortgage lending, consequently reducing loan availability for businesses (Chakraborty et al., 2018). In addition to these studies, we demonstrate that real estate price appreciation can have positive effects on labor costs. Due to these effects, rising real estate prices can hamper firm investment by lowering investment returns. Our evidence shows that increases in real estate prices have raised labor costs and discouraged firm investment. Second, to address endogeneity concerns, we employ two instrumental variables: the proportion of land unsuitable for real estate construction (interacted with changes in the national interest rate) and the supply of urban land (adjusted by local GDP). The use of these instrumental variables enables us to explore the causal effects of real estate price appreciations and to conduct statistical tests to verify the validity of our identifications. Last, our focus on manufacturing companies is also noteworthy. Manufacturing is often seen as the long-term driving force of economic growth. Morevoer, Stroebel and Vavra (2019) and Mian et al. (2020) find that the price and demand for services (e.g., retail, banks, hotels) can be impacted by real estate prices. Yet real estate prices, as suggested by the collateral effect or the cost effect, can also impact service firms from the supply side (i.e., through their effects on investment or wages). Therefore, the non-manufacturing firms absorb complicated impacts from both the supply side and the demand side. By contrast, manufacturing products are traded regionally and internationally, and focusing on manufacturing firms then helps purge the local demand effects associated with real estate price changes.

2. Literature and hypotheses

Previous studies have distinguished different channels through which real estate prices can impact firms' investment decisions. This section discusses these channels and related empirical evidence. Based on the discussion, we present our hypotheses.

2.1. Financial friction and the collateral channel

Loans are often secured by collateral assets, such as real estate. Earlier studies on collateralized loans indicate that the asset values of debtors are positively correlated with financial capacity (Barro, 1976; Hart & Moore, 1994). The mechanism is that high value of debtors' assets reduces the agency costs of financing real capital investments. Because of this positive relationship between collateral values and debt capacity, shocks to collateral assets can initiate (and cause large) investment cycles (Bernanke & Gertler, 1989; Kiyotaki & Moore, 1997; Liu et al., 2013; Wang et al., 2023; Zhang et al., 2023).

Using the shock of the land market collapse in Japan, Gan (2007a) shows empirical evidence that losses in collateral value in the land market dramatically reduced corporate investments in the real economy. However, the burst of the Japanese real estate bubble in the late 1980s was largely an extreme event. Chaney et al. (2012) exploit the period of real estate price appreciation in the United States between 1993 and 2007 – relatively normal real estate market conditions – and find that the higher values of firms holding real estate, caused by the real estate market boom, contributed to the growth in investment of U.S. public corporations. Specifically, a US$ 1 increase in collateral value led the representative U.S. public corporation to increase its investment by US$ 0.06.

However, Wu et al. (2015) find no significant correlation between real estate price appreciation and firm investment in recent China. They argue that this is because real estate assets play a limited role in determining firms' debt capacity in China. Many firms are still state-owned and usually not credit constrained (see also Chen et al., 2015). For the credit-constrained private firms, their main creditors – the four large and state-supported banks – often charge very high defaulting costs beyond the value of the collateral assets. The financial market in China thus does not feature the occurrence of meaningful collateral channel effects.

2.2. *Real estate speculation and the crowding-out channel*

Focusing on real estate price appreciation, a few studies note that a real estate price boom could draw investment excessively into the real estate sector and therefore may have negative effects on firms' investment in other sectors. Miao and Wang (2014) build a two-sector model and show that the crowding-out channel (capital reallocation effect) coexists with the collateral effect (credit-easing effect) following an asset price bubble. Similarly, a study by Chen and Wen (2017) suggests that a real estate bubble crowds out productive capital investment because investments flood into the real estate market.

Recent studies have provided micro-level evidence on the crowding-out effect of real estate boom. For instance, Rong et al. (2016) investigate the effect of local real estate prices on a firm's innovation. They find that increases in local real estate prices reduced firms' propensity to innovate and incentivized firms to reallocate resources to real estate development. Chen et al. (2017) document that real estate market booms encourage firms to speculate in real estate per se, while discouraging their investments in production activities.

Most recently, Chakraborty et al. (2018) argue that the increased demand and profitability that resulted from a strong real estate market can drive up mortgage lending. The growth of mortgage lending crowds out commercial loans and firm investment, as bank credit and firms' alternative financial sources are often limited. Their empirical analysis, using data for the United States from 1988 to 2006, shows the supportive evidence of the bank lending crowding-out effect. To understand the relative importance of the collateral and crowding-out channels, Chakraborty et al. (2018) compare the magnitude of these two effects. They find that the impact of the crowding-out effect is even larger than the collateral effect, implying a net negative effect of real estate prices on aggregate investment (excluding construction and financial activities).

2.3. *Hypotheses: real estate prices and production costs*

Studies have also found evidence that the growth of real estate prices could drive up production costs (Chen & Lee, 2020). For instance, Fougère et al. (2019) note that the increase in real estate prices suggests that the cost of land and buildings will go up; the rising cost of land and buildings could have direct negative effects on the firm's investment incentives. Moreover, Chakraborty et al. (2018) find that the rise of mortgage loans, resulting from local real estate booms, will reduce the supply of commercial loans. Access to credits may become more difficult and more expensive following the banks supply more mortgage loans.

In addition, the appreciation of real estate prices may have large impacts on local labor costs. The logic is that the rising real estate prices will drive up the housing rents. To maintain the living standards, workers will in turn ask for higher wages to compensate for the disutility of increasing housing rents (Roback, 1982; Liang et al., 2016). In line with this prediction, Liang et al. (2016), using recent city-level data from China, provide evidence that real estate prices have pushed up local wages.

Inspired by these discussions, we formulate the hypotheses of this study as follows.

Hypothesis 1. Appreciation of real estate prices has positive effects on labor cost and therefore discourages firm investment by lowering investment returns.

Manufacturing industries in China are typically labor-intensive. Investment returns will decrease significantly if real estate prices drive up the local labor cost. Theoretically, real estate prices may have positive effects on land cost too. However, local governments in China have been using low industrial land prices to attract manufacturing investment; the industrial land prices thus did not increase much over the past decades (Chen et al., 2017). The role of the land cost will not be considered in this study.

Hypothesis 2. Appreciation of real estate prices has positive effects on finance costs and therefore discourages firm investment by lowering investment returns.

The rising demand from mortgage lending caused by real estate price booms will reduce the supply of commercial loans, which will then drive up interest rates.

It is worth noting that the production cost effects of real esatate prices can coexist with the collateral effect and the speculation and crowding-out effect (Fig. 1). The net effect of real estate prices on firm investment will depend on the magnitudes of the effects from three channels.

3. Data

3.1. Data sources

The China Statistical Yearbook for Regional Economy publishes city-level data for the sold area and sales of newly built real estate since 2001. The data are available for more than 200 cities throughout China. The statistics are aggregated sales and sold area for the residential buildings, offices, and commercial real estate (e.g., shopping malls) together. For most of the years, the yearbook also publishes the same statistics for newly built residential buildings, which accounted for more than 70% of total sales in the real estate market during the study period.

We calculate real estate prices for each city-year as the ratio of aggregated sales of all types of real estate to the sold area. Similarly, we also calculate the average selling prices of residential buildings. The correlation coefficient between the two series is larger than 0.90 and is significant at 1% level. In our empirical analysis, we focus on the average selling price for all types of real estate, and results are highly consistent if we use the average selling price of residential buildings alternatively.

One concern about the real estate prices we use is that the data are not adjusted for building qualities. Zheng and Kahn (2013) have shown that the average selling prices of newly built real estate are highly correlated with a quality-controlled hedonic price index for 35 major cities, constructed by Wu et al. (2014). Moreover, Deng et al. (2012) suggest that the quality-adjusted real estate price indexes for 70 large and medium-size cities lack variation over time and are severely downward biased. As China's real estate market started in the early 2000s and was thus dominated by newly built buildings, we use the average selling price for newly built real estate as our proxy for city-level real estate prices.

The firm-level data we use come from the Annual Survey of Industrial Firms (ASIF) conducted by the National Bureau of Statistics of China (NBS). The data provide detailed information of all SOEs and non-SOEs with annual sales of over 5 million RMB, including industry affiliation, location, and all operation and performance items from the accounting statements (e.g., output, intermediate materials, employment, and book value and the net value of fixed assets). We focus on the manufacturing firms and exclude firms in the sectors such as resource exploitation and public utilities (for more details about the data, see Brandt et al., 2012; Brandt et al., 2014).

The study period we choose is from 2003 to 2007. On the one hand, firm data are more reliable for the period 1998–2007. Firm identifiers only became consistent from 1998 onward and the data after 2007 contain missing or unreliable information (Brandt et al., 2014; Feenstra et al., 2013). On the other hand, the land for real estate development before 2003 was often obtained by 'negotiation' between developers and government officials, while after 2003 the land for real estate development had to be acquired through public auctions following the ban of 'negotiation' by the Ministry of National Land and Resources in 2002 (Cai et al., 2013). To refrain from the inconsistency in the land cost of real estate development, we consider only the period after 2003.

3.2. Data cleaning and matching

We first cleaned the ASIF data by following the procedure suggested by Jefferson et al. (2008). This involves discarding observations with the following criteria: (1) key variables such as total industrial output, industrial added value, fixed assets, and employees have negative values; (2) the ratio of value added to sales is less than 0 or greater than 1; and (3) the number of employees is fewer than 8, as most of the improbable values are associated with smaller firms that usually have less reliable accounting systems. This procedure reduces the size of raw data by 4%–6%.

We then matched the firm data with city real estate price data, using the firm location identifier in the ASIF data. One concern is how to identify the locations of multi-plant firms. Since more than 95% of firms have only one establishment in the ASIF data (see also Brandt et al., 2012), we thus confine our sample to the single-establishment firms operating in one city. After data cleaning and matching, we have annual observations between 140,000 and 248,000 firms, including those only appear once during 2003–07.

To better control for firm fixed effects, our empirical analyses focus on subsamples with at least three to five consecutive years of observations during 2003–07. The last three columns of Table 1 show the corresponding numbers of firms for these subsamples.

Table 2 shows the evolution of real estate prices. The mean value of the nominal real estate prices was 1532 RMB, approximately US $185, per square meter in 2003, while it reached 2679 RMB (or US$352) in 2007. The average annual growth rate was 10%, with the fastest growth rate observed in 2005 (14%). Yet there were substantial differences in the growth rates between cities. From 2003 to 2007, the growth rate was 102% for the cities at the 90th percentile and only less than 61% for those at the 50th and lower percentiles. The disparity in real estate prices, as also shown by the standard deviations or the coefficients of variation of real estate prices, has thus increased a lot between 2003 and 2007.

Micro Channels

Real estate price	Collateral channel	(+)	**Firm investment**
	Crowding-out channel	(-)	
	Cost channel	(-)	

Fig. 1. Conceptual Framework. Notes: (+) indicates positive effect; (−) indicates negative effects.

Table 1
Number of firms in the ASIF data.

Year	(1) Raw data	(2) Cleaned	(3) Matched			
			All firms	Age composition of firms (years)		
				≥3	≥4	≥5
2003	181,186	169,924	140,077	70,708	61,803	48,909
2004	256,999	242,382	181,007	87,585	79,023	64,640
2005	249,030	237,218	195,921	158,189	130,174	64,639
2006	279,282	266,971	224,083	171,242	131,467	64,639
2007	313,046	300,829	248,322	160,674	125,198	64,640

Note: Data cleaning followed the procedure suggested by Jefferson et al. (2008).
Data source: ASIF data, 2003–07.

Table 2
Real estate prices and their rates of change: Average across cities.

Year	Cities	Average real estate prices (RMB/square meter, Nominal)								ΔlnRE (Real)
		Mean	SD	cv	p10	p25	p50	p75	p90	Mean
2003	217	1532	784	0.51	878	1042	1303	1792	2429	–
2004	217	1703	919	0.54	934	1181	1455	2056	2676	7.2%
2005	217	2027	1115	0.55	1118	1344	1647	2354	3683	14.0%
2006	217	2345	1646	0.70	1241	1489	1861	2614	4221	9.4%
2007	217	2679	1724	0.64	1417	1681	2101	3053	4903	9.6%
03-07(Δ)	217	75%	120%	25%	61%	61%	61%	70%	102%	10.1%

Note: 1) The final sample comprises 217 cities, fewer than the 286 cities recorded in the China City Statistical Yearbooks. The cities not included are predominantly in the ethnic minority areas of Tibet, Xinjiang, Inner Mongolia, Yunnan, Hainan, and Qinghai. These regions are characterized by underdeveloped real estate markets and limited data availability of the manufacturing sectors documented in the ASIF dataset during the study period. 2) The last column (ΔlnRE) reports the rate of change in real estate prices (deflated by the consumer price index), the simple average across cities.

4. Empirical strategy

4.1. Baseline specifications

We specify the following model to estimate the net effects of local real estate prices on the investment of local firms,

$$Investment_{i,j,c,t} = \alpha + \beta_1 \, ln(RE_{c,t}) + \beta_2 FirmVars_{i,t} + \beta_3 IndVars_{j,t} + \beta_4 FirmVars_{i,t0} \times ln(RE_{c,t}) + \mu_i + \sigma_t + \varepsilon_{i,j,c,t}, \tag{1}$$

where i stands for firm, j for sector, c for city, and t for year; μ_i and σ_t capture firm and year fixed effects, respectively; and $\varepsilon_{i,j,c,t}$ is an error term.

The outcome variable, $Investment_{i,j,c,t}$, measures firm investment normalized by total fixed assets (see detailed definitions of the variables in Table 3). We use book values of fixed assets and assume a constant depreciation rate of 5% to calculate firm investment by following Song and Wu (2012) and Liu and Lu (2015).

On the right-hand side of the equation, $ln(RE_{c,t})$ reflects the log of real estate prices in the city where the firm is located. Real estate prices are calculated as the ratio of the total real estate sales to the total sold area, deflated with the corresponding provincial consumer price index (as the city-level consumer price index is not available). The deflated real estate prices are also normalized using the year 2003 as the base year (i.e., 2003 = 100). The coefficient on the variable $ln(RE_{c,t})$, β_1, thus captures how the changes in local real estate prices affect firm investment, and it is the parameter of our key interest.

We control for two standard determinants of firm investment in the equation, i.e., return on assets (calculated as the ratio of earnings before tax and interest to total assets, i.e., ROA) and cash flow (calculated as the ratio of cash flow to total assets, i.e., CASH).[1] The previous literature suggests that the ex ante firm characteristics prior to a real estate price shock are also responsible for the ex post differences in firm investment. We thus further add in the equations the interaction terms between the initial values of time-varying firm-level variables (i.e., ROA and CASH) and real estate prices, i.e., $FirmVars_{i,t0} \times ln(RE_{c,t})$.

Last, we control for a few industry-level variables (at the three-digit level of China Industry Classification). For instance, we include the degree of industrial agglomeration (using city as the spatial unit when measuring agglomeration, see Ellison & Glaeser, 1997; Lu et al., 2012, for details). For other industry-level heterogeneities, we use the median values of ROA and CASH for each three-digit industry as proxies.

[1] The former is calculated as the sum of the following four items – total profits, sales tax, value-added tax, and interest at the end of each year – divided by total assets at the beginning of each year; the latter is calculated as the ratio of cash (current assets minus current debt) to total assets.

Table 3
Variable definitions and summary statistics.

Variable	Definition	Obs.	Mean	SD	P25	Median	P75
Firm level							
Investment	Net change in investment on fixed assets normalized by the value at the beginning of the year (%)	307,467	16.48	18.18	4.67	9.05	21.84
Labor	Wage and welfare expenditure divided by value added (%)	307,467	37.57	38.26	14.63	28.36	48.14
Finance	Interest and other finance costs divided by income (%)	307,467	1.12	1.66	0.05	0.56	1.54
ROA	Earnings before interest and taxes depreciation and amortization normalized by firm assets at the beginning of the year (%)	307,467	14.67	18.42	4.56	9.78	18.48
CASH	(Current assets- current debt)/total assets (%)	307,467	7.94	28.59	−9.22	7.88	26.13
Industry level							
Industrial median ROA	Median value of ROA at the 3-digit industry level each year	749	10.45	4.89	8.51	9.88	11.38
Industrial median CASH	Median value of CASH at the 3-digit industry level each year	749	7.74	5.51	4.84	8.06	10.90
EG index	Agglomeration index (at the 3-digit industry level), calculated using city as the spatial unit, following the method developed by Ellison and Glaeser (1997)	749	0.02	0.02	0.01	0.01	0.03
City level							
Ln (RE)	Log of average selling prices of newly built real estate (2003 = 100)	1085	4.80	0.23	4.61	4.77	4.96
Instruments							
Interest rate	Long-term interest rate (>5 years, %)	5	6.30	0.64	5.82	6.12	6.46
Unsuitable land share	(Area with slope greater than 15° + bodies of water) divided by jurisdictional size	217	0.22	0.17	0.09	0.20	0.33
Ln (land_GDP)	Log of (land granting area/previous year GDP)	1085	−0.08	0.77	−0.58	−0.02	0.43

Data sources: Firm- and industry-level data are from the Annual Survey of Industrial Firms. City-level data are from the China Statistical Yearbook for Regional Economy.

4.2. The cost channel

To investigate our hypothesis of the labor cost effect, we add the interaction terms between local real estate prices and the proxy for industrial-level labor intensity to the baseline specification. Specifically, we estimate the following equation:

$$Investment_{i,j,c,t} = \alpha + \gamma_1 \ ln\left(RE_{c,t}\right) + \sum_{k=2}^{5} \gamma_k QuintileL\_K_j^k \times ln\left(RE_{c,t}\right) + \gamma_6 FirmVars_{i,t} + \gamma_7 IndVars_{j,t} + \gamma_8 FirmVars_{i,t0} \times ln\left(RE_{c,t}\right) + \mu_i + \sigma_t + \varepsilon_{i,j,c,t}, \tag{2}$$

where $\sum_{k=2}^{5}\gamma_k QuintileL\_K_j^k \times ln\left(HP_{c,t}\right)$ represents the interaction term between the dummies of for the second to fifth industrial labor intensity quintiles and local real estate prices. To quantify labor intensity, we use the median value of the firm labor-to-capital ratio (log) within each industry for the whole period studied. If the labor cost effect we hypothesized is at work, changes in the price of real estate would have larger negative effects for firms in the higher quintiles of labor intensity.

Furthermore, we use model specifications of the following form to investigate the work of the cost channel:

$$Cost_{i,j,c,t} = \alpha + \beta_1 \ ln\left(RE_{c,t}\right) + \beta_2 FirmVars_{i,t} + \beta_3 IndVars_{j,t} + \beta_4 FirmVars_{i,t0} \times ln\left(RE_{c,t}\right) + \mu_i + \sigma_t + \varepsilon_{i,j,c,t}. \tag{3}$$

This specification is similar to equation (1), except that the outcome variables become proxies for labor and finance costs. We use firms' expenditure on wages, normalized by total value added and interest and other costs of finance divided by total income, to measure labor and finance costs, respectively.

4.3. Identification strategy

Equations (1)–(3) are potentially biased due to several endogeneity issues. Local factors not captured in the model, such as unobserved fluctuations in local economic conditions, might simultaneously influence real estate prices and firm investment. Furthermore, a firm's investment in a region could spur employment growth, which in turn may boost real estate demand and elevate prices. To resolve these concerns, we follow the procedure in Chen and Kung (2016) to construct the measure of land areas unsuitable for constructions – consisting of land with a slope greater than 15° (based on architectural safety standards) and bodies of water – as the source of exogenous variation in real estate prices.[2] We interact the variable with nationwide movements in the real interest rate because the mortgage rate is an important component of the cost of owning property and thus affects real estate demand.[3]

The underlying logic is that cities with less developable land would witness larger changes in real estate prices, given the magnitude of demand shocks caused by changes in the national interest rate. Previous studies, such as Mian and Sufi (2011), Chaney et al. (2012), and Cvijanovic (2014), use the elasticity of land supply (sometimes interacted with the interest rate or the trend in local real estate prices to allow over-year variations) as an instrument for local real estate prices. The underlying theory is that land supply elasticity is primarily determined by geographic and regulation constraints on real estate (Saiz, 2010).

In addition, the supply of (residential) land is largely controlled by the local governments in China. The supply of land thus creates another source of potentially exogenous variation in land constraints. Cities with relatively scarce land supply, proxied by land granting area divided by the previous year's GDP, are likely to witness faster growth in real estate prices. Therefore, we use the amount of urban land transferred via the public land granting markets (adjusted by the local government by the intensity of local economic activity – measured by last year's GDP of the city) as the other instrumental variable.

Thus, we estimate the following first-stage regression model (simultaneously with the second stage regression):

$$\ln RE_{c,t} = a_c + d_t + b * S_c{*}IR_t + c * \ln\left(land\_gdp_{ct}\right) + \omega_{c,t,} \tag{4}$$

where a_c and d_t are the full sets of city and year fixed effects. The interaction term $S_c{*}IR_t$ denotes the interaction between the share of unsuitable land and the long-term interest rate. $land\_gdp_{c,t}$ is the land-granting area adjusted by local GDP in the previous year.

The coefficient b is expected to be positive, whereas the parameter c is expected to be negative. However, there are reasons to suspect that land area granted by the government is endogenous. Therefore, the use of instrumental variables proceeds in a cautious manner, sometimes excluding the land-granting area instrument but only using the conventional instrument.

5. Main results

This section contains the regression results for equations (1)–(3) using the balanced panel data. That is, only firms that exist in the full period, 2003–07, are considered. In so doing, we can better control for the firm and city fixed effects. Nevertheless, we return to using unbalanced panel data in Section 6.2.

5.1. Net effect of real estate prices on firm investment

We start by estimating the net effects of real estate prices on firm investment (equation (1)). Table 4 shows the regression results using the ordinary least squares (OLS) estimation method. In Table 5, we present the results using the instrumental variable method.

5.1.1. The OLS results

In Table 4, column 1, we include only real estate prices and the firm and year fixed effects as the explanatory variables. In column 2, we add other firm- and industry-level variables. In striking contrast with previous studies, the estimated coefficients of real estate prices (ln *RE*) are consistently negative and significant at the 1% level. The coefficient estimate for the log of real estate prices in column 2 is −3.438, implying that an average annual change in real estate prices (i.e., 10%) will reduce firm investment by approximately 0.34 percentage point.

In column 3, we test the results by excluding firms from Beijing, Tianjin, Shanghai, and Chongqing – the four cities are much larger in size and/or experienced much faster growth in real estate prices than the average city in the sample. The negative effects of real estate prices become more pronounced (Probably, firms sorting into the large cities were more competitive and could better adapt to real estate price shocks). Lastly, we conduct weighted OLS estimation in column 4. The weights used equal the inverse of the square root of the number of firms in the sample for each city. The weighting scheme, therefore, limits the dominance of cities with more firms in the estimation results. The coefficient estimate for real estate prices remains significant and consistent.

The estimates for the other variables are consistent with previous studies. For instance, the estimated coefficients for ROA and CASH are positive and significant, indicating that profitability and internal cash flows have positive effects on investment.

In addition, the product between the initial values of CASH (but not ROA) and the log of real estate prices has significant and positive effects, indicating that firms with more liquidity initially gain more from the collateral effect. A question is, when does the positive effect of CASH dominate the effect of real estate prices? The results in column 2 imply that the CASH variable should be greater than 33 (=3.438/0.077), which is at least the top 25 percentile of firms, according to the statistics in Table 2 (p75 of CASH = 26.13).

5.1.2. The IV-method results

In Table 5, we present the results using the instrumental strategy. In the first two columns of panel A, we suppress the interaction terms between the initial values of ROA/CASH and real estate prices; thus, it is a simpler model, with only one endogenous variable. In

[2] We thank Dr. Jianghao Wang for helping us construct the measure.

[3] We use the benchmark long-term lending rate (more than five years) as the measure of the mortgage rate. When it changed one or more times in a given year, the interest rate for that year is calculated as the effective days weighted interest rate. The data are from the website of the Peoples Bank of China.

Table 4
Real estate prices and firm investment (OLS).

	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	Weighted OLS
Ln (RE)	−11.807***	−3.438***	−4.588***	−2.543***
	(0.583)	(1.317)	(1.183)	(0.925)
ROA		0.089***	0.090***	0.095***
		(0.006)	(0.007)	(0.006)
CASH		0.077***	0.079***	0.072***
		(0.004)	(0.004)	(0.004)
Initial ROA X Ln (RE)		0.015	0.021	0.053*
		(0.030)	(0.033)	(0.030)
Initial CASH X Ln (RE)		0.103***	0.107***	0.077***
		(0.011)	(0.011)	(0.011)
Industrial controls	No	Yes	Yes	Yes
Observations	307,467	307,467	265,229	307,467
Adj. R-squared	0.026	0.073	0.069	0.059
Number of firms	64,640	64,640	55,837	64,640

Note: Column 3 uses only the data set for the subsample that excludes firms from four municipalities, Beijing, Tianjin, Shanghai, and Chongqing. All other columns use the full sample of balanced firm panel data. The weighted OLS estimation uses the inverse of the square root of the number of firms in each city as weights. All regressions control for the median values of ROA and CASH at the three-digit industry level in each year, with firm and year fixed effects. City fixed effects are absorbed by the firm fixed effects, because the firms in our data set are single plant firms. The standard errors in parentheses are clustered at the city level, as our explanatory variables include the city-level real estate prices.
Significance: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 5
Real estate prices and firm investment (OLS-IV).

	Panel A: IV			Panel B: IV-WGT		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln (RE)	−10.543*	−12.039***	−13.514***	−15.138**	−12.350***	−13.848***
	(5.695)	(4.028)	(4.002)	(6.496)	(4.398)	(4.310)
ROA	0.084***	0.083***	0.084***	0.088***	0.089***	0.090***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
CASH	0.071***	0.071***	0.077***	0.068***	0.068***	0.073***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Initial ROA/CASH X Ln (RE)	No	No	Yes	No	No	Yes
	First stage					
Share unsuitable land X interest rate	0.281***	0.290***	0.261***	0.206***	0.206***	0.169***
	(0.066)	(0.073)	(0.074)	(0.054)	(0.053)	(0.056)
Ln (Land supply/GDP)		−0.033**	−0.033**		−0.032***	−0.033***
		(0.014)	(0.015)		(0.010)	(0.011)
Observations	307,467	307,467	307,467	307,467	307,467	307,467
Adj. R-squared	0.069	0.068	0.069	0.054	0.055	0.053
Number of firms	64,640	64,640	64,640	64,640	64,640	64,640
Cragg-Donald Wald F-statistic	19740.860	12688.172	4300.710	8221.242	6207.288	2077.431
LM statistic (p-value)	0.004	0.000	0.000	0.001	0.000	0.000
Hansen J-test (p-value)		0.574	0.479		0.638	0.663

Note: All regressions control for the median values of ROA and CASH at the three-digit industry level in each year, with firm and year fixed effects. Initial ROA/CASH X Ln(RE) refers to the interaction terms between real estate prices and the initial values of ROA and CASH, which are also instrumented when included. For example, the interaction term between ROA in 2003 and real estate prices is instrumented by, e.g., ROA in 2003 X Share unsuitable land and ROA in 2003 X Ln(Land supply/GDP). The standard errors in parentheses are clustered at the city level.
Significance: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

column 1 of panel A, we try to be conservative by only using the conventional instrument, that is, the product between the share of unsuitable land for real estate construction and the movement in the long-term national interest rate. In columns 2 and 3, we include the two proposed instrumental variables together. In panel B, we replicate the same procedures of panel A except using the weighted OLS estimators. As weighting has little impact on the results, the following discussions focus on the results in panel A.

Notably, the coefficient estimates of real estate prices in Table 5 become much larger than their counterparts in Table 4. For instance, the estimated size becomes −10.543 in column 1. Thus, the investment ratio decreases by 1.0543 percentage points if real estate price increase 10% (i.e., $\Delta \ln RE = 0.1$). A 1% decrease in investment is not small; it is approximately 21% of firm investment for firms at the 25th percentile (1/4.67). According to the specification of Equation (4), the instrumental variables we use explicitly capture the effects of land supply-side restrictions in the real estate market. The larger coefficient estimates from the IV estimations indicate that components influenced by these supply-side restrictions are particularly detrimental to manufacturing investment. Turning to the first-stage results, the unsuitable land variable is positively correlated with real estate prices, confirming the intuition that real estate prices in cities where the supply of land is more constrained grow more for a given magnitude of reduction in the interest rate. The first-stage Cragg-Donald Wald F statistics and the p-values for LM statistic show no evidence that the instrument is weak or under identified.

In column 2, we add the other instrument, the log of the supply of land-to-GDP ratio. As expected, binding the supply of land relative to economic activities leads to a higher level of real estate prices, ceteris paribus. The Cragg-Donald Wald F statistics and Hansen-J test also give confidence that the model is neither weakly nor overly identified. The new estimates of the coefficient on real estate prices are still significantly negative.

In column 3, we introduce the products between the initial values of ROA and CASH and the log of real estate prices. They are instrumented with the products between the corresponding initial values and the two instrumental variables. We still find that real estate prices show negative effects on investment.

In sum, our IV regression results suggest that there were significant negative effects of real estate prices on manufacturing investment in China during 2003–07. In terms of magnitude, the OLS estimation results in Table 4 imply that the average coefficient estimate of real estate prices is approximately -3.438, whereas the IV estimate is roughly as large as -13.514, which can be viewed as the lower and upper bounds of the size of the impact of real estate prices on firm investment. Given that the full sample standard deviations of the real estate prices (log) and investment are 0.23 and 18.18, respectively, a one standard deviation change in the log of real estate prices (i.e., real estate prices increase by 23%) can explain 4%–17% of the variation in firm investment, which is economically important.[4]

5.2. The labor cost channel

The above results suggest that appreciation of real estate prices had negative effects on investment. According to Liang et al. (2016), real estate prices have significantly influenced local wages, accounting for as much as 60% of wage variations in recent studies from China. Meng et al. (2023) find that migrants tend to leave cities undergoing housing booms. In this section, we test our hypothesis that the positive effects of real estate prices on the cost of labor contribute to the negative relationship between real estate prices and firm investment.

We first estimate the model specification with the interaction terms between real estate prices and the proxies for sectoral differences in labor intensity. The results are shown in Table 6. We find that the set of quintile dummies, constructed using the median values of the labor-to-capital ratios for all the three-digit industries during our study period, are all significantly negative and larger in the upper categories of labor intensity. Thus, the higher is the labor intensity of an industry, the more investment is reduced. We believe that this is most likely due to the labor cost channel – real estate prices appreciation raises local labor wages, which will reduce the profitability of investment and firms' willingness to invest.

We then investigate whether real estate prices have a direct effect on a firm's labor cost using the model specification of equation (3). Panel A of Table 7 shows the OLS and IV estimation results with firms' expenditure on wages, normalized by total value added, as the dependent variable. In column 1 we find that the coefficient estimates for real estate prices are all positive and significant, suggesting that real estate prices have positive effects on the wage expenditure. In column 2, however, the estimate for real estate prices is positive but insignificant. One explanation is that firms reduce the number of workers employed as labor costs increase.

In sum, we use two methods to explore the labor cost channel. The results of the interaction model provide supports to our hypothesized labor cost effect that the more labor-intensive industries are more vulnerable to real estate price appreciations. Yet the investigations on the relationship between real estate prices and firm's wage expenditures indicate that the positive effects of real estate prices on wages are not robust. We suppose this may be due to the fact that firms mitigate the impact of rising labor costs by adjusting the number of workers employed.[5]

5.3. The finance cost channel

Panel B of Table 7 shows the estimation results for finance expenditures (equation (3)). Results in both columns 3 and 4 indicate that real estate prices have significant positive impacts on finance costs, measured as firm's interest and other costs of finance divided by total income. This evidence supports the hypothesis that appreciation in real estate prices prompts banks to shift their lending focus toward mortgages (Chakraborty et al., 2018). Consequently, this increased focus on mortgage lending elevates the overall cost of finance in the economy.

5.4. The collateral channel

The collateral channel suggests that credit-constrained firms would invest more following real estate price growth. To measure credit constraints, the previous literature uses ex ante measures of financial constraint to sort between constrained and unconstrained

[4] 0.23*(-3.438)/18.18 = 4%; 0.23*(-13.514)/18.18 = 17%.

[5] One option to address the issue is to estimate the relationship between real estate prices and the average wage levels of firms. However, the firm data we use lacks information on the real working hours and labor quality; a measure of average wage per employee can not control for the heterogeneities in labor quality and real working hours and may distort the estimation results. Nonetheless, we hope to tackle the issue with better employment data in the future studies.

Table 6
Real estate prices, labor intensity, and firm investment.

	OLS	OLS-IV
	(1)	(2)
Ln (RE)	−2.792**	−12.833***
	(1.265)	(4.055)
Q2 of Ln (Labor_K) X Ln (RE)	−0.466***	−0.535***
	(0.112)	(0.184)
Q3 of Ln (Labor_K) X Ln (RE)	−0.598***	−0.595***
	(0.146)	(0.192)
Q4 of Ln (Labor_K) X Ln (RE)	−0.849***	−1.006***
	(0.156)	(0.192)
Q5 of Ln (Labor_K) X Ln (RE)	−0.928***	−0.976***
	(0.197)	(0.245)
Instrumental variables	No	Yes
Observations	307,467	307,467
Adj. R-squared	0.073	0.069
Number of firms	64,640	64,640
Cragg-Donald Wald F-statistic		1825.730
LM statistic (p-value)		0.003
Hansen J-test (p-value)		0.328

Note: Quintiles of labor intensity are calculated based the median values of the log labor-to-capital ratio during the study period of 2003–2007. All regressions control for ROA, CASH, and initial values of ROA (CASH) interacted with real estate prices (log), three industry-level variables (median values of ROA and CASH for each industry-year and the EG index), together with the full set of firm and year fixed effects. The instruments used are the products between the share of unsuitable land and the interest rate and log of land supply adjusted by local GDP (lagged one year). Variables interacted with real estate prices are instrumented by the corresponding products with two instrumental variables. The standard errors in parentheses are clustered at the city level.
Significance: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 7
Real estate prices and costs of labor and finance.

	Panel A: Labor cost		Panel B: Finance cost	
	(1) OLS	(2) OLS-IV	(3) OLS	(4) OLS-IV
Ln (RE)	5.603**	1.933	0.487***	1.500***
	(2.657)	(7.120)	(0.124)	(0.514)
ROA	−0.058***	−0.057***	−0.004***	−0.003***
	(0.008)	(0.008)	(0.000)	(0.000)
CASH	0.021***	0.021***	−0.002***	−0.002***
	(0.005)	(0.005)	(0.000)	(0.000)
Cragg-Donald Wald F-statistic		4122.078		4300.177
LM statistic (p-value)		0.000		0.000
Hansen J-test (p-value)		0.190		0.067
Number of firms	64,640	64,640	64,640	64,640
Observations	307,462	307,462	307,462	307,462
Adj. R-squared	0.004	0.004	0.012	0.001

Note: In columns 1 and 2, the dependent variable is firms' expenditure on wages normalized by total value added. In columns 3 and 4, the dependent variable is firm's interest and other costs of finance divided by total income. All regressions control for ROA, CASH, and initial values of ROA and CASH interacted with real estate prices (log), three industry-level variables (median values of ROA and CASH for each industry-year and the EG index), together with the full set of firm and year fixed effects. The instrumental variables used in columns 3 and 4 are the product between the share of unsuitable land and the interest rate and the log of the supply of land divided by local GDP (lagged one year). The standard errors in parentheses are clustered at the city level.
Significance: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

firms. Based on this strand of literature, big firms and SOE firms are classified as "unconstrained" while the small firms and non-SOE as "constrained" (Chaney et al., 2012; Wu et al., 2015).[6] We then add the interaction terms between the firm-level proxies of credit constraints and real estate prices to our baseline model specifications. Table 8 shows the results.

In columns 1 and 3, we find that the coefficient estimates of the interaction term between small firms (dummy = 1) and real estate

[6] Small firms are defined as the firms which own assets less or equal to the median amount of assets in their city in a year; while others are defined as the large firms. Firm ownership is defined according to the registration type of a firm, with a dummy variable SOE indicating state-owned enterprises.

Table 8
Real estate prices, the collateral effect, and firm investment.

	OLS	OLS	OLS-IV	OLS-IV
	(1)	(2)	(3)	(4)
Ln (RE)	−3.460***	−3.435***	−13.210***	−13.619***
	(1.320)	(1.317)	(4.078)	(4.000)
Small firm X Ln (RE)	0.102		0.094*	
	(0.062)		(0.057)	
SOE firm X Ln (RE)		−0.061		0.207**
		(0.083)		(0.094)
Instrumental variables	No	No	Yes	Yes
Observations	307,467	307,467	307,467	307,467
Adj. R-squared	0.073	0.073	0.069	0.069
Number of firms	64,640	64,640	64,640	64,640
Cragg-Donald Wald F-statistic			3263.045	3227.922
LM statistic (p-value)			0.000	0.001
Hansen J-test			0.335	0.131

Note: All regressions control for ROA, CASH, and initial values of ROA (CASH) interacted with real estate prices (log), three industry-level variables (median values of ROA and CASH for each industry-year and the EG index), together with the full set of firm and year fixed effects. Small firms are defined as firms that own assets less or equal to the median amount of assets in their city in a year; others are defined as large firms. The instruments used are the products between the share of unsuitable land and the interest rate and log of the supply of land adjusted by local GDP (lagged one year). Variables interacted with real estate prices are also instrumented by the corresponding products with the two instrumental variables. The standard errors in parentheses are clustered at the city level.
Significance: ***p < 0.01, **p < 0.05, *p < 0.1.

prices are positive, suggesting that small firms benefit from growth in real estate prices. Yet the point estimates are small and only significant at 10% level (column 3). In columns 2 and 4, we include the SOE dummy interacted with the log of real estate prices in our regression models. The OLS results imply no significant heterogeneous effects between SOEs and non-SOEs, while IV regression predicts a positive effect for SOEs. Overall, the results do not show robust support for the collateral channel. Instead, the credit unconstrained SOEs absorb more collateral effects. The results are consistent with the findings of Wu et al. (2015), indicating that firms' ownership and ties with governments, aside from real estate assets, are crucial for credit access and firm investment.

6. Further discussions

6.1. Temporary versus sustained effects

To detect whether there is a correlation between real estate prices and investment in the long run, we run first-difference regressions using data at the starting and ending years. Specifically, we estimate a long-differenced version of equation (1), that is, a four-year difference between the beginning and ending years of our data set:

$$\Delta^{03-07} Investment_{i,j,c} = \vartheta * \Delta^{03-07} \ln RE_c + \boldsymbol{\rho} \Delta^{03-07} \boldsymbol{X}_{i,j,c} + \boldsymbol{\pi} \Delta^{03-07} \boldsymbol{IND}_j + \epsilon_{i,j,c}. \tag{5}$$

The regression results are shown in Table 9. Panel A contains the results using OLS estimation method and Panel B shows the results using IV method. As only cross-firm-city variations are used in the regressions, the instrument variable becomes the share of unsuitable land. The results show that the estimates for real estate prices are consistently negative across both panels. Therefore, the negative effect of real estate prices on investment lasts for years rather than only appears as a short-run correlation.

As to the economic significance of the impacts of real estate prices in the long, the IV regression results suggest that the estimated coefficients of the main effect of real estate prices are around 0.23. In other words, if real estate prices grew by 50%, the modest growth rate for 2003–07, the estimated reduction in the firm investment rate would be 11.5 percentage points (i.e., −0.23*0.5), which is equivalent to the difference in investment between firms at the 75th and 50th percentiles in our sample.

We also investigate whether the labor cost and collateral effects exist in the long term. Consistent with our previous results, we find that the growth of real estate prices has significant and positive effects on the investment of SOE firms but not the small firms. For the labor cost channel, we still find that labor intensive industries invest less, indicating that the labor cost channel is also at work in the long run.

6.2. Results using unbalanced panels: entry and exit

All our results so far are obtained using the balanced firm panel sample for 2003–07. A concern is whether the negative effects of real estate prices on firm investment exist for the entry firms. Ideally, we could estimate a growth equation of the numbers of firms

Table 9
Real estate prices and firm investment: the long-term effect.

	(1)	(2)	(3)	(4)
Panel A: OLS				
ln (RE)	−4.960**	−5.182**	−5.146**	−4.440*
	(2.299)	(2.382)	(2.289)	(2.393)
Small firm X ln (RE)		0.699		
		(0.625)		
SOE firm X ln (RE)			7.836***	
			(0.811)	
High labor intensity X ln (RE)				−1.312**
				(0.610)
ROA	0.107***	0.106***	0.107***	0.107***
	(0.011)	(0.010)	(0.010)	(0.010)
CASH	0.056***	0.056***	0.057***	0.057***
	(0.005)	(0.005)	(0.005)	(0.005)
Observations	48,909	48,909	48,909	48,909
Adj. R-squared	0.030	0.030	0.031	0.030
Panel B OLS-IV				
	(5)	(6)	(7)	(8)
ln (RE)	−22.791***	−23.042***	−22.742***	−21.999***
	(8.131)	(8.107)	(8.129)	(8.003)
Small firm X ln (RE)		1.207*		
		(0.716)		
SOE firm X ln (RE)			5.071**	
			(2.190)	
High labor intensity X ln (RE)				−1.816**
				(0.789)
ROA	0.095***	0.094***	0.095***	0.096***
	(0.013)	(0.013)	(0.014)	(0.013)
CASH	0.056***	0.056***	0.057***	0.057***
	(0.005)	(0.005)	(0.005)	(0.005)
First stage				
Share unsuitable land	0.331***	0.334***	0.339***	0.350***
	(0.114)	(0.115)	(0.113)	(0.115)
Cragg-Donald Wald F-statistic	4531.859	2261.156	2209.767	2266.999
LM statistic (p-value)	0.0234	0.0233	0.0222	0.0234
Observations	48,909	48,909	48,909	48,909
Adj. R-squared	0.010	0.011	0.012	0.011

Note: All regressions control for initial values of ROA and CASH. The standard errors in parentheses are clustered at the city level.
Significance: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

entering and exiting, to test the impact of real estate prices on the entry and exit decisions of firms. However, the ASIF data have only information on firms with sales greater than 500 million RMB.[7] Nevertheless, we employ the same instrumental strategy to estimate the previously specified investment equations with the unbalanced firm panel data.[8]

Table 10 contains the results using the unbalanced firm panels. In the first two columns, we consider the panel of firms with at least four consecutive years of observations. The results are close to those with the balanced panel, but the estimates for real estate prices are much smaller. When we use the sample of firms with at least three consecutive years of observations, the estimates become even smaller, and the IV regressions report insignificant estimates for real estate prices (column 4). Therefore, it seems that the entry firms could largely avoid the negative impacts of rising production costs caused by real estate price growth, whereas the incumbent firms lack flexibility because of the rigidity of investment adjustments (and/or the fixed costs of production) (e.g., Tang et al., 2020).

7. Conclusions

In this paper, we investigate the effects of booming real estate prices on firm investment in China. Previous studies on the collateral channel of real estate suggest that real estate price appreciation increases the collateral value of firm owned assets, which will facilitate the borrowing of credit-constrained firms for investment. Recent studies also document that firm investment may be adversely impacted by real estate prices. One the one hand, banks may reallocate capital from commercial loans in industrial sectors to mortgage loans to households. On the other hand, the rise of real estate prices can incentivize industrial firms to speculate in land or real estate

[7] The NBS has carried out three economy censuses that cover all economic units in the secondary and services sectors (2004, 2008, and 2013). Those data would facilitate a better understanding of this topic with full coverage of firms.

[8] It is worth noting that the previous IV strategy may not help when emerging firms are included. For instance, entry firms can observe real estate prices (levels and/or changes) and make investment decisions correspondingly – likely by setting up in places where land and other production costs are cheaper.

Table 10
Real estate prices and investment: unbalanced panels.

	(1)	(2)	(3)	(4)
	≥4	≥4	≥3	≥3
	OLS	OLS-IV	OLS	OLS-IV
Ln (RE)	−3.303***	−7.869*	−2.862**	−3.550
	(1.167)	(4.508)	(1.164)	(4.914)
ROA	0.085***	0.083***	0.081***	0.080***
	(0.007)	(0.007)	(0.007)	(0.007)
CASH	0.095***	0.095***	0.100***	0.100***
	(0.004)	(0.004)	(0.004)	(0.004)
Observations	527,662	527,662	648,395	643,530
Adj. R-squared	0.063	0.062	0.060	0.060
Number of firms	134,037	134,037	187,012	182,147
Cragg-Donald Wald F-statistic		5170.602		5443.437
LM statistic (p-value)		0.002		0.004
Hansen J test (p-value)		0.309		0.097

Note: The regressions in columns 1 to 4 also control for ROA, CASH, and initial values of ROA (CASH) interacted with real estate price (log), three industry-level variables (median values of ROA and CASH for each industry-year, and the EG index), together with the full set of firm and year fixed effects.
Significance: ***p < 0.01, **p < 0.05, *p < 0.1.

markets, thus crowding out their investments in production equipment and technological innovation.

Our study uses a large panel data set of Chinese manufacturing firms over 2003–07 to examine the relationship between local real estate prices and firm investment. In contrast to the previous studies, we find that there exists a significantly negative effect of local real estate prices on firm investment. Further exploration reveals that such negative effects are stronger for firms in labor-intensive sectors, suggesting that real estate price appreciation may push up production costs and thus discourage firms' investment incentives. We also find local real estate boom raises the finance costs of local firms. The reason possibly is that the interest rate facing local firms goes up when banks prefer household mortgage loans to commercial loans following the boom of local real estate markets. Contradicting the prediction of the collateral channel, we find little evidence that the credit-constrained firms increase their investment as a result of rising local real estate prices. On the contrary, we find that the SOEs, which are usually credit-unconstrained, become more aggressive in investment following the appreciation of real estate prices – possibly a sign indicating that SOEs over invest or speculate in land and real estate markets when local real estate prices increase.

Our results should be interpreted cautiously. First, our estimates do not convey general equilibrium effects. Specifically, we focus on the local effects of real estate prices, while real estate prices may have positive spillovers to other cities. Second, our data set does not allow us to separate investment in machinery and equipment from other investments, especially land or real estate holdings. Third, the instrumental variables we use allow us to identify the impact of real estate price variation related to geographical and policy constraints in land supply on firm investment. Therefore, the effects of real estate prices on firm investment we documented are subject to the land supply constraints related real estate price growth. However, the changes in real estate prices can be caused by other factors. There is evidence that the heterogeneities in the sources of real estate price changes matter in understanding the relationship between real estate prices and firm investment. For instance, a positive local productivity shock, particularly when there are higher constraints in local land and housing supply, can drive up local real estate prices and wages simultaneously (see Glaeser et al., 2006). Differences in bank deregulation and consequent credit expansion may determine local real estate prices and at the same time have various impacts on the real economy (Mian et al., 2020). Future studies may focus on other sources of real estate price changes and explore their effects on firm investment and local economy at large.

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Declaration of competing interest

There are no conflicts of interest to declare.

Data availability

Data will be made available on request.

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