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Article

Research on the Impact of Housing Prices on the Innovation of Manufacturing Enterprises in China

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Abstract

The manufacturing industry is the "ballast stone" of China's economy, and innovation in the manufacturing industry plays a key role in promoting high-quality economic development and propelling the modernization drive. Based on relevant theoretical analysis, this study uses data from 441 manufacturing companies (ME) listed on the Shanghai and Shenzhen A-shares in China from 2013 to 2022 to empirically analyze the impact mechanism of housing prices (HP) on innovation in manufacturing enterprises (IME) by constructing an econometric model. The results of the benchmark regression model indicate that in the short term, the rise of housing prices is beneficial for manufacturing enterprise innovation. However, as housing prices continue to rise, high housing prices can have a suppressive effect on innovation, indicating an inverted U-shaped relationship between the two variables. Mediating effect analysis shows that housing prices have different effects on enterprise innovation through resource allocation (RA), financial constraints (FC), and real estate investment (REI). Heterogeneity analysis reveals that in the long term, the inhibitory effect of housing prices on enterprise innovation is more significant in eastern cities than in central and western cities. Our study recommends actively stabilizing housing prices, establishing a sound real estate supervision system, and strengthening independent innovation.

Keywords: HP; ME; IME; crowding out effect
JEL: D22, D47, O35

1. Introduction

Since the reform and opening-up, China's economy has achieved sustained and high-speed growth. Rapid advancements in industrialization and urbanization have become the two core engines driving China's growth. In this development process, the real estate industry has rapidly grown and not only plays a significant role as an important pillar industry of the national economy but also profoundly influences residents' lifestyles, asset allocation preferences, and the evolution of economic structure. Furthermore, the prosperity of the real estate industry not only promotes the agglomeration effect of resources and activity in the capital market but also has a complex and profound impact on resource allocation (RA) and innovation behavior in the real economy, especially manufacturing enterprises (ME), through multiple mechanisms. In recent years, with the rapid rise of housing prices (HP) in China and the significant intensification of regional differences, resource competition between the real estate industry and manufacturing industry has become increasingly prominent, drawing significant attention from academia and policy makers on the impact of HP on manufacturing enterprise innovation (IME).

As the core area of China's economic structure optimization and transformation and upgrading, the innovation capability of the manufacturing industry is not only the key to promoting high-quality economic development but also an important foundation for the country to enhance its global competitiveness. However, innovation activities in the manufacturing industry generally have the characteristics of high investment, high risk, and long cycle, with a high dependence on resources, especially the ability to acquire key factors such as land, capital, and high-skilled labor. In this context, HP has complex and multidimensional effects on the innovation behavior of MEs through various economic and institutional channels. On the one hand, the rise of HP may lead to a significant increase in key resource costs, manifested as high land costs, increased labor costs, and the "crowding out effect" of financial resources, thereby suppressing the ability of MEs to invest in research and development. On the other hand, the appreciation of real estate asset values (a rise in HP) may provide enterprises with greater mortgage finance capabilities, alleviating financial constraints (FC) to some extent and supporting innovation investment. In addition, HP may indirectly alter a company's focus on long-term innovation activities by influencing its strategic choices.

In terms of resource allocation (RA), the "crowding out effect" of the rise of HP on the manufacturing industry is mainly manifested in the excessive flow of factor resources such as land and capital to the real estate sector. Especially in the context of a limited supply of land and low efficiency of RA, MEs are facing increasing land costs, which may directly compress their budget space for innovative activities. At the same time, the rise of HP may further attract capital into the real estate sector, creating a more competitive financing environment for MEs. Additionally, the rapid rise of HP may produce spillover effects in the labor market, such as the loss of highly skilled talent or rising labor costs for MEs, thereby indirectly weakening their innovation capabilities.

However, the rise of HP does not necessarily have a negative impact on the innovation activities of MEs. As real estate assets become important collateral for financing, rising HP can significantly improve the balance sheets of MEs, thereby enhancing their access to external funding. The alleviation of FC may provide necessary capital support for implementing corporate innovation initiatives. Additionally, rising HP may boost consumer spending and market demand through the "wealth effect", providing more opportunities for the market-oriented application of MEs' innovative achievements.

Moreover, the impact of HP on the innovation behavior of MEs is not homogeneous but influenced by multiple factors such as regional development level, industrial structure, enterprise scale, and policy environment. For example, in China, the impact of HP on IME in developed coastal areas may differ significantly from that in underdeveloped central and western regions. Large and medium-sized enterprises may exhibit greater resilience in responding to rising HP due to their advantages in asset size and resource integration capabilities, whereas small and medium-sized enterprises may be more vulnerable due to resource constraints. Moreover, as real estate market regulations continue to tighten, the impact of HP on IME may evolve dynamically over time.

Based on the above background, this study aims to examine the impact of HP on IME and its underlying mechanisms. Specifically, it accounts for regional and firm-level heterogeneity in China's HP and IME, employing micro-level data and econometric models to systematically analyze the interaction pathways and complexities between these two elements. The main objectives of the research include the following three aspects: firstly, to clarify the overall impact and direction of HP on IME; secondly, to reveal the specific mechanism by which HP affects innovation behavior through RA, FC, and real estate investment (REI); thirdly, to provide policy recommendations to promote the coordinated development of the real estate market and manufacturing industry and assist in the high-quality development of China's economy.

The remaining parts of this study are as follows. Section 2 provides a literature review on relevant topics. Section 3 presents the theoretical background and research hypotheses. Section 4 explains the research design. Section 5 introduces the empirical results, covering the benchmark regression, mediating effects, heterogeneity analysis, and robustness tests. Section 6 summarizes the conclusions and provides corresponding policy suggestions.

2. Literature Review

The existing literature on the impact of HP on IME can be broadly categorized into four perspectives. The first holds that rising HP promotes IME. For instance, Miao and Wang (2014), from the perspective of FC, argue that higher HP creates a "credit easing effect" by increasing the value of collateral assets, enabling firms to expand financing and invest more in innovation. From the perspective of consumption, Li and Guo (2020) contend that real estate investment and rising HP have a "promoting effect" on manufacturing innovation through the consumption channel, increasing the scale of innovation investment and enhancing firms' innovation capacity. The second perspective argues that rising HP inhibits IME. Higher HP has brought higher returns in the real estate sector, making it more likely for manufacturing companies to divert resources into real estate investments, reducing their commitment to innovation. Due to limited resources, once these companies invest in real estate development, their investment in innovation will decrease (Rong et al, 2016). In addition, there is a threshold in the negative correlation between HP and IME; beyond this threshold, the negative impact of HP on IME increases significantly (Chu et al, 2024). Given China's vast geographic expanse, spatial heterogeneity persists in the extent of HP's negative impact on IME (Li et al, 2023). The third perspective holds that HP and IME exert mutual influence. As Yu and Cai (2021) propose, there is an interactive relationship in which HP affects IME, and in turn, improvements in innovation capabilities can drive HP higher. Additionally, scholars have proposed that population mobility may positively affect both HP and IME and, conversely, that innovation vitality can contribute to rising HP (Zhang et al, 2023). The fourth viewpoint holds that the role of HP in IME is not static. For example, Yu and Cai (2021) argue that HP exerts an inverted U-shaped effect on IME. Lin et al (2021) study the relationship between HP and innovation from a temporal perspective, finding that HP over the past decade has inhibited IME, whereas 20–30 years ago, it had a positive effect. Conversely, some studies examine the reverse mechanism—how innovation influences HP (Dong and Zhu, 2022). Further research also examines the relationship between HP and land (Wu and Liu, 2005), market innovation (Liu et al, 2008), monetary policy (Yan, 2009), residents' consumption (Zhang and Shen, 2016), and digital economy (Cong et al, 2024).

Some scholars have studied how governments and companies can make management decisions to improve innovation capabilities and efficiency in the context of changes in HP. From the perspective of policymakers, local governments should incorporate HP management into their policy framework and regulate HP reasonably and effectively (Fang and Lv, 2023). For example, local governments should solve the problem from the source, that is, strengthen land management. Local governments must change the way land is supplied, moderately increase land supply in cities and regions where housing prices are growing too fast, and change the regional bias of land supply, directing land to areas where people, goods, and capital flows are concentrated (Liu and Shi, 2019). Yin et al (2022) point out that the government must strengthen the supervision and management of real estate, establish a long-term regulatory mechanism, take advantage of the positive impact of rising housing prices, and cultivate the innovative vitality of enterprises. Some scholars also believe that policymakers should strengthen talent management and attract talent. Zhu and Liu (2025) contend that the government should strengthen urban planning and management, prioritize the importance of housing density, and strategically combine office locations with residential areas to attract and retain high-level talent. Local governments should strengthen talent management, improve the selection, cultivation, and reward mechanisms for innovative employees, promote the gathering of high-level innovative talents, and enhance the innovation capabilities of enterprises and their respective regions (He et al, 2022). From the perspective of enterprise managers, enterprises should actively respond to cost pressures brought by the rise of HP, transform management strategies, increase investment in core technologies, and maintain high market competitiveness (Du et al, 2020). Lu et al (2019) also believe that in the face of fluctuations in HP, companies should incorporate innovation into their long-term strategic planning and develop more environmentally conscious and sustainable innovation management strategies. Enterprises should adjust their investment management strategies, appropriately seek investment returns on real estate investment, avoid excessive dependence on the real estate industry, and prevent the formation of investment bubbles that may hinder future development (Zhang et al, 2025).

In summary, existing research has achieved certain findings on the impact of HP on the innovation capability of ME, but there is still ongoing controversy over the specific effects, and a unified understanding has not yet emerged. In addition, in recent years, China has introduced multiple policies aimed at stabilizing HP, effectively curbing the rapid rise of HP and creating a real estate environment that differs significantly from that of the past. However, most of the data used in previous studies were collected during the rapid development period of the real estate industry several years ago, which may not reflect current conditions. This deviation between past conclusions and current realities hinders the formation of an accurate understanding of the current state of the real estate sector and its impact on IME. As for the strengths of the methodologies employed in previous research, scholars have acknowledged that the impact of HP on IME is dynamic rather than static. In addition, scholars have considered inverted U-shaped relationships rather than simple linear relationships. As for the weaknesses, scholars have not considered spatial heterogeneity and only examined the effect of HP on IME from a temporal perspective. In addition, few studies examine the mediating effect, solely focusing on the direct effect of HP on IME. Therefore, this article will examine the impact of HP on IME from a spatial perspective, enriching the research framework. Furthermore, multiple mediating variables will be selected to study the relevant mediating effects.

The contribution of this study is that, on the one hand, it attempts to clarify the complex interactive relationship between the real estate market and the real economy, providing a theoretical basis for policy-making. On the other hand, this study aims to provide useful practical insights for achieving a dynamic balance between the normal development of the real estate market and the high-quality development of the manufacturing industry. On this basis, in-depth exploration of the regional heterogeneity and micro impact of HP on IME will help further reveal the inherent laws of RA optimization and economic transformation and upgrading. Moreover, this study aims to provide policy recommendations from a management perspective, offering practical suggestions for government efforts to stabilize HP and for enterprises seeking to enhance innovation performance. Compared with previous studies, the key innovations of this study are as follows: First, it analyzes the impact mechanism of HP on IME from a theoretical perspective, empirically verifies the relationship between the two variables, and examines the impact of HP on IME from both short- and long-term perspectives. Second, it investigates the indirect effects of HP on IME through the channels of RA, FC, and REI, broadening the research perspective. Third, the research sample is divided into two groups to explore heterogeneity.

3. Theoretical Background and Hypotheses Development

3.1 The Direct Effect of HP on IME

Innovation investment of MEs is substantial and costly, and their innovation activities are easily affected by external influences. As for the influencing factor of real estate price, HP can affect the expectations of market entities, thereby affecting IME. Market expectations integrate multidimensional considerations from multiple parties, such as enterprises and individuals, and are an important factor affecting investment management and consumption (Beracha et al, 2022). The fluctuation of HP is closely linked to market expectations. Therefore, fluctuations in HP profoundly impact society and the economy (Li and Guo, 2020). A rise in HP can stimulate an increase in investment in the real estate industry and change related enterprises' investment management strategies, which can have a significant driving effect on the development of related industries (Teng et al, 2021). HP can directly or indirectly drive the development of related fields such as decoration, construction, and even retail, resulting in a prosperous economy in the short term (Chen et al, 2020). People generally have optimistic expectations about the future, and this sentiment is reflected in the behavior of market participants. The positive economic outlook and increased demand for high-tech products driven by rising HP can lead to higher returns on innovative products, prompting MEs to allocate more resources and energy into innovation to increase investment in independent research and development (Yu and Zhang, 2017). In addition, a moderate increase in HP may lead to an increase in production costs for ME, but it may also encourage them to change management strategies and focus on efficiency improvements and technological innovation to offset the cost increase. Furthermore, because real estate can serve as collateral, and MEs generally have substantial housing assets, the rise of HP will increase the value of the housing assets owned by ME, which helps alleviate the FC faced by ME, thereby enhancing their willingness to innovate and promoting innovation research and development expenditures. Based on these arguments, hypothesis H1 is formed.

H1: In the short term, the rise of HP is beneficial for IME.

In recent years, the profit margins of ME in China have continued to decline. In contrast, the profit margins of the real estate industry have steadily increased, with the continuous rise in HP directly driving the increase in investment returns in the real estate industry. In the long run, the continuous rise of HP has two main effects on IME. On the one hand, when the return on investment in industries such as manufacturing falls below that of real estate, the speculative arbitrage motive of enterprise management prompts them to shift capital toward real estate to obtain higher profits. The profit-driven nature of capital has led to a large influx of capital into the real estate sector, further exacerbating the misallocation of resources. The rise of HP drives up land and rental prices, which increases the production costs of enterprises. The rise of HP also diverts funds needed for production, operations, and innovation toward the real estate market, weakening innovation capacity, and hindering the sustainable development of the manufacturing industry (Miles, 2009). On the other hand, during an economic downturn, the excess returns on general bank loans often fail to compensate for their associated risks. As a result, banks tend to shift their asset allocation strategies and direct loans toward sectors with higher returns and lower risk. In the context of rising HP, the real estate industry is considered a typical high-profit, low-risk, and high-quality lending sector. The high investment return rate of the real estate industry leads credit resources to tilt toward real estate enterprises (Chaney et al, 2012). Attracted by these high profit levels, banks adjust their fund management strategies, increase credit allocation to real estate enterprises, and reduce credit availability to other industries, resulting in a decline in research and development (R&D) lending for enterprises. Furthermore, social capital as a whole becomes increasingly inclined toward the real estate sector in terms of investment willingness, reducing investment in the manufacturing industry and creating a crowding-out effect on innovation in the manufacturing economy (IME). Based on these arguments, Hypothesis H2 is proposed.

H2: In the long term, there is an inverted U-shaped relationship between HP and IME.

3.2 The Indirect Effect of HP on IME

The rise in HP typically attracts capital into the real estate sector, thereby reducing the availability of capital for the real economy, especially the manufacturing industry. In the context of segmented capital markets, the siphoning effect of high HP may lead enterprises to divert funds into speculative ventures, limiting investment in research and development (R&D) and weakening innovation capacity. This resource misallocation and imbalance in fund management not only reduce the capital utilization efficiency of the manufacturing sector but may also further hinder the growth of total factor productivity (Chen et al, 2011). Moreover, rising HP is often accompanied by increased land costs—one of the key production factors for MEs. High land prices may undermine the competitiveness of MEs in resource allocation, prompting some firms to shift management strategies away from innovation activities requiring substantial R&D investment toward production activities with higher short-term returns, thereby obstructing innovation-driven development (Zhu, 2018). Finally, the impact of high HP on the labor market is also significant. Increased HP often drives up living costs, especially in areas where housing expenses comprise a large share of household expenditure. This may compel firms to adjust management strategies by raising wages to attract high-skilled labor (Tao and Xue, 2019). For small and medium-sized MEs with limited resources, such cost pressures may reduce innovation budgets, leading to inadequate R&D investment. In addition, high HP may push skilled workers to migrate from manufacturing to real estate-related industries or regions, further exacerbating labor resource mismatches. The impact of HP on innovation in manufacturing enterprises (IME) through the RA mechanism is reflected in the reallocation of key production factors such as capital, land, and labor. This mechanism not only affects the internal optimization of enterprise resources but also influences industrial upgrading and economic growth through broader macroeconomic structural adjustments (Wang and Wen, 2019). Based on these arguments, hypothesis H3 is formed.

H3: HP has an impact on IME through RA.

The rise of HP will significantly increase the market value of the real estate held by enterprises, thereby enhancing their asset collateral capacity. This process creates more opportunities for enterprises to obtain external funds by alleviating FC and improving their credit rating in the capital market. For innovative activities, due to their high risk and

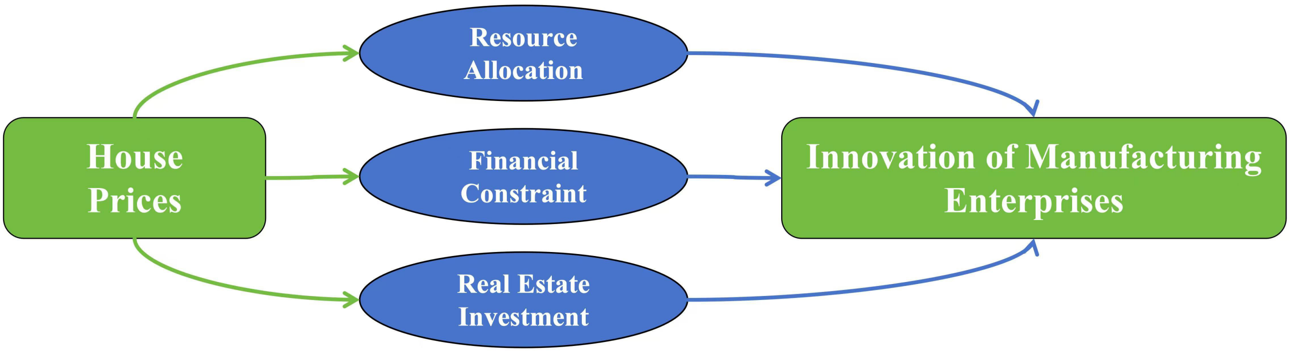

Fig. 1. The Path of HP acting on IME. HP, housing prices; IME, innovation of manufacturing enterprises.

long-term characteristics, financing needs are more urgent. Therefore, the increase in mortgage capacity caused by the rise of HP may have a positive incentive effect on innovation investment (Sasidharan et al, 2015). Furthermore, the rise of HP improves the financing conditions of enterprises by enhancing their balance sheet. On the one hand, the increase in real estate value enhances the financial stability of enterprises, making it easier for them to obtain low-cost funds from banks or other financial institutions. On the other hand, asset appreciation may reduce a company's cost of capital, making it more feasible to conduct high risk and high investment innovation activities. In addition, from the perspective of corporate behavior decisions, the rise of HP may indirectly affect innovation activities by changing corporate investment preferences (Liu et al, 2023). On the one hand, high HP may encourage companies to invest more resources in investment areas related to real estate, thereby diverting funds that should be used for research and technological innovation, forming a "crowding out effect" on innovation activities. On the other hand, the wealth effect released by high HP may prompt companies to increase their R&D investment to cope with a more competitive market environment. Finally, from a macroeconomic perspective, fluctuations in HP may indirectly affect corporate innovation activities through the risk transmission mechanism of financial markets. On the one hand, the rise of HP may trigger excessive credit expansion in the financial market, lead to a decrease in the efficiency of capital allocation, and suppress innovation activities (Wang and Zhang, 2016). On the other hand, if HP fluctuate too much, companies may face increasing uncertainty, which may further worsen their investment decisions, especially in supporting long-term innovation projects. Based on these arguments, hypothesis H4 is formed.

H4: HP have an impact on IME through FC.

High HP raise expectations for real estate appreciation—particularly for assets such as land—thereby encouraging MEs to divert funds originally allocated for research and technological innovation into the real estate sector. This capital reallocation or shift in management strategy may lead to internal resource mismatches, weakening both the ability and willingness of firms to invest in long-term innovation and ultimately suppressing their innovation efficiency. Specifically, firms may become more inclined to pursue asset appreciation through short-term, high-return real estate investments rather than engage in high-risk, long-term R&D initiatives (Cheng and Xia, 2020). Furthermore, rising HP may alter the behavioral incentives of ME management and ownership. In an environment of rapid HP growth, high returns from real estate investments may prompt managers to prioritize short-term profit maximization over long-term innovation strategies (Wu et al, 2021). Such short-termism can further exacerbate firms' neglect of innovation. In addition, under persistently high HP, enterprises may face rising pressures on employee wages, rents, and overall operating costs, further constraining the financial space available for innovation-related activities. While high HP can potentially enhance a firm's financing capacity by increasing the value of its property holdings, this benefit is likely to be more pronounced for small and micro enterprises with severe financial constraints and may have limited relevance for larger firms with abundant capital (Karahan, 2015). More importantly, even when financing capacity improves, firms may still channel these funds into real estate investments due to preferences shaped by high HP, rather than allocating them to innovation—thereby weakening the intended pro-innovation effect of increased financing. Based on these considerations, Hypothesis H5 is proposed.

H5: HP have an impact on IME through REI.

In summary, the path of HP acting on IME is shown in Fig. 1.

3.3 The Regional Heterogeneity of HP and IME

Due to uneven regional development in China, there are significant differences in economic levels and industrial structures among different regions. Therefore, the impact of HP on IME in different regions is also not the same. When HP continue to rise, the impact of high HP on IME is reflected in two aspects. On the one hand, local governments monopolize land resources and use them as collateral to obtain loans from banks (Rong et al, 2016). However, government financing will significantly inhibit IME, and this mismatch of land resources will lead to premature "deindustrialization" in China, significantly reducing urban innovation. This impact is more pronounced in developed regions, such as the eastern region of China (Feng et al, 2019). On the other hand, due to the close connection between the real estate market and the land market, the rise of HP will directly push up the land use costs of ME.

Specifically, HP in the eastern region of China is generally high, which may lead to an increase in operating costs (such as labor costs and rent) for enterprises, thereby affecting innovation investment. In addition, the eastern region has more research institutions, universities, and talent and has great potential for innovation in the manufacturing industry. However, high HP may inhibit the innovation capabilities of small and medium-sized enterprises. The policies in the eastern region tend to support high-end manufacturing and innovative industries, which may partially offset the negative impact of rising HP. On the contrary, HP in the central and western regions are relatively low, and there is less pressure on business operating costs. However, low HP may reflect insufficient market demand and limit the motivation for companies to expand production. There are relatively few scientific research institutions and talents in the central and western regions, and the innovation foundation of the manufacturing industry is weak. Moreover, the impact of HP on innovation may be more direct. The central and western regions attract investment and industrial transfer through national policies, but the improvement of innovation capabilities still requires time.

Compared to the central and western regions, HP in the eastern region of China is generally higher, and land use costs are also higher. This situation will encourage ME to consider the production cost differences caused by the price differences of land factors when innovating and laying out production. In addition, when HP is at a high level, it will also increase the cost of living for residents, who will demand an increase in wages, thereby affecting the labor costs of enterprises (Liu and Shi, 2019). Based on these arguments, hypothesis H6 is formed.

H6: There are regional differences in the inhibitory effect of HP on IME, with the eastern cities being more significantly affected compared to the central and western cities in China.

4. Research Design

4.1 Sample Selection and Data Source

This study selected ME listed on the Shanghai and Shenzhen A-shares in 275 cities in China from 2013 to 2022 as the research sample. The data about the input and output of IME were from the China Research Data Service Platform (CNRDS). Other data related to listed companies were sourced from the China Stock Market & Accounting Research (CSMAR) database, Wind database, and official websites of listed companies. The HP data came from housing transaction websites such as Anjuke, Fangtianxia, and Housing Price Market Network. Other data related to cities were sourced from the National Bureau of Statistics of China, the China Regional Economic Statistical Yearbook and the China Urban Statistical Yearbook for relevant years.

In terms of research observations, on the one hand, the securities code of listed companies was used as a matching identifier, and missing data such as the establishment date and ownership form of individual companies were searched and filled in through the "Tonghuashun" software (4.6.0, Zhejiang Hexin Flush Network Services Ltd, Hangzhou, Zhejiang, China). On the other hand, companies that were treated by Special Treatment (ST), Special Treatment (delisting warning) (*ST), or Particular Transfer (PT) due to financial system abnormalities during the sample period and companies in the real estate industry were deleted. In addition, considering the differences in financial data requirements for companies in the B-share market, we also excluded companies listed on the B-share market during the sample period.

Based on the above data, this study matched the information of the city where the listed company is located with the city's HP data, and screened the sample data as follows. Firstly, we listed companies registered in county-level cities were excluded. Secondly, because of missing data, the samples of Qinghai, Xizang, Inner Mongolia and Xinjiang were excluded. Furthermore, Hong Kong, Macau, and Taiwan were not included. Finally, a matching data set was formed, which includes 441 listed ME and 275 cities in China. Through the above methods, we selected 1760 valid samples. To reduce the interference of extreme values on the results, winsorization was applied to the 1% and 99% quantiles of continuous variables.

4.2 Definition of Variables

4.2.1 Dependent Variable

We selected IME as the dependent variable for this study. Following the approach of Zhan et al (2021), IME was measured from two dimensions: innovation input and innovation output. For innovation input, we used the full-time equivalent of R&D personnel and R&D expenditure of industrial enterprises above a designated size as indicators. For innovation output, we used the number of patent applications by industrial enterprises above a certain scale as the measurement indicator. Finally, the entropy method was applied to construct a composite measure of IME (Zhang and Jiao, 2017).

4.2.2 Independent Variable

We selected HP as the independent variable for this study. Following the approach of Yu and Cai (2021), HP was measured using the average sales price of commercial housing, calculated as the ratio of sales revenue to sales area. In addition, the quadratic term of HP (HP^2) was in-

Table 1. The definition of variables.

Type	Name	Measure
Dependent Variable	Innovation of Manufacturing Enterprises (IME)	Entropy method
Independent Variables	Housing Prices (HP)	Sales revenue/Sales area of commercial housing
	HP^2	Quadratic term of HP
Control Variables of Enterprises	Enterprise Region (ER)	Eastern region = 1, Central and western regions = 0
	Enterprise Size (ES)	Total assets
	Enterprise Age (EA)	2022 - Year of establishment
	Asset Liability Ratio (ALR)	Total liabilities/Total assets
	Free Cash Ratio (FCR)	Current assets/Current liabilities
	Return On Equity (ROE)	Net profit/Net assets
	Enterprise Asset Structure (EAS)	Net fixed assets/Total assets
Control Variables of Cities	Economic Development Level (EDL)	Per capita Gross Domestic Product (GDP)
	Government Support Intensity (GSI)	Science and technology expenditures/General budget expenditures
	Financial Development Level (FDL)	Total deposits and loans of financial institutions/GDP
	Openness Level (OPL)	Total import and export volume/GDP
	Industrial Structure Development (ISD)	Output value of the tertiary industry/the secondary industry
Mediator Variables	Resource Allocation (RA)	Entropy method
	Financial Constraint (FC)	Financing Constraint Index (FCI)
	Real Estate Investment (REI)	Investment properties/Total assets

cluded to examine whether an inverted U-shaped relationship exists between HP and IME (Yu and Cai, 2021).

4.2.3 Control Variables of Enterprises

We selected seven enterprise-level control variables for this study. Enterprise Region (ER) was a dummy variable; enterprises located in the eastern region were assigned a value of 1, while those in the central and western regions were assigned a value of 0 (Wei et al, 2024). Enterprise Size (ES) was measured by the total assets of the company (Hu, 2022). Enterprise Age (EA) was calculated as 2022 minus the year of the enterprise's establishment (Duan and Sun, 2024). Asset-Liability Ratio (ALR) was measured as the ratio of total liabilities to total assets (Qun et al, 2015). Free Cash Ratio (FCR) was measured as the ratio of current assets to current liabilities (Bronzini and Piselli, 2016). Return on Equity (ROE) was calculated as the ratio of net profit to net assets (Frank and Shen, 2016). Enterprise Asset Structure (EAS) was measured as the ratio of net fixed assets to total assets (Glaeser and Gyourko, 2018).

4.2.4 Control Variables of Cities

We selected five city-level control variables for this study. Economic Development Level (EDL) was measured using per capita Gross Domestic Product (GDP) (Wu et al, 2024). Government Support Intensity (GSI) was measured as the ratio of local fiscal expenditures on science and technology to the local general budget expenditures (Bostic et al, 2009). Financial Development Level (FDL) was measured as the ratio of total deposits and loans of financial institutions to GDP (Li et al, 2017). Openness Level (OPL) was measured by the ratio of total import and export volume to GDP (Chen and Zhu, 2017). Industrial Structure Development (ISD) was measured as the ratio of the output value of the tertiary industry to that of the secondary industry (Guan and Yam, 2015).

4.2.5 Mediator Variables

We selected three variables as the mediator variables for this study. As for RA, this study measured resource allocation indicators from three dimensions: capital, land, and labor. The total financing amount, total land area, and number of employees of the enterprise were selected and processed using the entropy method (Wen and Goodman, 2013). As for FC, this study selected the financing constraint index (FCI) as the measurement indicator (Bostic et al, 2009). As for REI, this study selected the ratio of investment properties to total assets as the measurement indicator (Sinai and Souleles, 2005).

For the convenience of browsing, each specific variable is defined in Table 1.

4.2.6 Descriptive Statistics of Variables

The descriptive statistics of variables are shown in Table 2. Table 2 shows that the mean of IME is 0.539, the standard deviation is 0.063, the minimum value is 0.427, and the maximum value is 0.914, which indicates that there are significant differences in IME between different cities. In addition, it can be seen that there are significant differences in ES, EA, EDL and REI.

Table 2. The descriptive statistics.

Variables	Observations	Mean	Std.Dev.	Min	Max
IME	1760	0.539	0.063	0.427	0.914
HP	1760	1.926	0.982	0.482	6.472
HP^2	1760	2.586	0.637	0.232	41.887
ER	1760	0.642	0.480	0.000	1.000
ES	1760	0.960	2.671	0.073	89.526
EA	1760	21.337	5.248	10.000	55.000
ALR	1760	0.359	0.176	0.028	1.204
FCR	1760	3.017	3.264	0.243	42.138
ROE	1760	0.093	0.101	–1.385	0.637
EAS	1760	0.549	0.057	0.411	1.000
EDL	1760	4.625	1.137	2.749	25.868
GSI	1760	0.017	0.037	0.003	0.065
FDL	1760	0.116	0.027	0.082	0.193
OPL	1760	0.095	0.048	0.009	0.367
ISD	1760	0.8736	0.512	0.093	5.256
RA	1760	0.358	0.137	0.295	0.763
FC	1760	–3.463	0.246	–5.356	–2.924
REI	1760	0.534	1.873	0.000	30.347

Std.Dev., Standard Deviation; Min, Minimum; Max, Maximum.

4.3 Model Setting

4.3.1 Benchmark Regression Model

According to the previous analysis, HP have a short-term positive effect on China's economic growth, that is, they have a positive impact on IME in the early stages, but they overall inhibit IME. To verify the specific relationship between the two variables, we introduced the quadratic term of HP (HP^2) to construct a benchmark model for testing. The specific formula is shown in Eqn. 1:

$$MEI_{it} = \alpha_0 + \alpha_1 HP_{it} + \alpha_2 HP_{it}^2 + \beta_j \sum_{j=1}^{n} Control_{jit} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where α_0 refers to constant; α_1, α_2, and β_j denote the coefficients of the variables. Moreover, Control refers to the control variables of enterprises and cities, i represents the city, and t represents the year. In addition, μ_i, δ_t, and ε_{it} denote the individual fixed effect, the time fixed effect, and the random error term of the model.

4.3.2 Mediating Effect Model

We used the stepwise regression method (Baron and Kenny, 1986) to analyze the relationship between HP and IME from the perspectives of the single effect of RA, FC, and REI. The mediating effect model based on stepwise regression is constructed in Eqns. 2,3,4,5,6, and 7:

$$RA_{it} = \alpha_0 + \alpha_1 HP_{it} + \alpha_2 HP_{it}^2 + \beta_j \sum_{j=1}^{n} Control_{jit} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

$$MEI_{it} = \alpha_0 + \alpha_1 HP_{it} + \alpha_2 HP_{it}^2 + RA_{it} + \beta_j \sum_{j=1}^{n} Control_{jit} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

$$FC_{it} = \alpha_0 + \alpha_1 HP_{it} + \alpha_2 HP_{it}^2 + \beta_j \sum_{j=1}^{n} Control_{jit} + \mu_i + \delta_t + \varepsilon_{it} \quad (4)$$

$$MEI_{it} = \alpha_0 + \alpha_1 HP_{it} + \alpha_2 HP_{it}^2 + FC_{it} + \beta_j \sum_{j=1}^{n} Control_{jit} + \mu_i + \delta_t + \varepsilon_{it} \quad (5)$$

$$REI_{it} = \alpha_0 + \alpha_1 HP_{it} + \alpha_2 HP_{it}^2 + \beta_j \sum_{j=1}^{n} Control_{jit} + \mu_i + \delta_t + \varepsilon_{it} \quad (6)$$

$$MEI_{it} = \alpha_0 + \alpha_1 HP_{it} + \alpha_2 HP_{it}^2 + REI_{it} + \beta_j \sum_{j=1}^{n} Control_{jit} + \mu_i + \delta_t + \varepsilon_{it} \quad (7)$$

where α_0 refers to the constant; α_1, α_2 and β_j denote the coefficients of the variables. Moreover, RA_{it}, FC_{it}, and REI_{it} refer to the values of RA, FC, and REI for the i-th city of China in the t-th year.

5. Results

With the help of Stata15.0 software (15.0, StataCorp LLC, College Station, TX, USA), firstly we conducted unit root test and multicollinearity test, in order to ensure that the panel data is stable and the empirical results are accurate. Then, we obtained the following empirical results, such as benchmark regression, mediating effect, heterogeneity analysis and robustness test.

5.1 The Results of Some Important Tests

5.1.1 The Results of Unit Root Test

We drew on the approach of Guo and Shen (2015), using the Hadri test, Levin-Lin-Chu (LLC) test, and Im-

Table 3. Unit toot test.

Variables	Hadri test	LLC test	IPS test
IME	2.486***	–10.148***	–7.046***
	[0.000]	[0.000]	[0.000]
HP	3.854***	–8.205***	–5.221***
	[0.000]	[0.000]	[0.000]
HP^2	8.315***	–26.036***	–12.943***
	[0.000]	[0.000]	[0.000]
EDL	4.236***	–5.834***	–4.856***
	[0.005]	[0.002]	[0.004]
GSI	2.983***	–9.271***	–5.793***
	[0.000]	[0.000]	[0.000]
FDL	3.182***	–8.025***	–6.582***
	[0.000]	[0.000]	[0.000]
OPL	3.589***	–6.117***	–4.237***
	[0.000]	[0.000]	[0.000]
ISD	5.370**	–8.350**	–5.448**
	[0.034]	[0.025]	[0.046]

Notes: **, *** indicate significant at 5%, 1% confidence levels respectively, and *p*-values are in square brackets, same below. LLC, Levin-Lin-Chu; IPS, Im-Pesaran-Shin.

Table 4. The VIF of variables.

Variables	VIF	1/VIF
HP	1.230	0.813
HP^2	2.120	0.471
EDL	1.170	0.854
GSI	1.260	0.793
FDL	1.110	0.902
OPL	1.290	0.775
ISD	1.340	0.746
Mean VIF	1.354	

VIF, Variance Inflation Factor.

Pesaran-Shin (IPS) test to determine if there is a unit root. According to the results in Table 3, the variables selected all pass the 1% significance level test. This indicates that these variables are stable and that there is no unit root. Thus, we can ensure the correctness of the following regression results, and we do not need to conduct a panel cointegration test.

5.1.2 The Results of Multicollinearity Test

To determine whether there is a high correlation between the independent variables, which in turn affects the explanatory power of the model, we conducted a multicollinearity test by the Variance Inflation Factor (VIF) method. According to the results in Table 4, we find that the VIF for all independent variables and control variables is less than 10. Thus, there is no multicollinearity problem in this study, and the model is well constructed.

5.2 The Results of Benchmark Regression

According to the benchmark regression results in Table 5, HP, as the core explanatory variable, has a significant negative impact on IME. After controlling for individual and time fixed effects, it can be seen from column (1) that the estimated coefficient of HP is –0.454, which is statistically significant at the 1% level. This indicates that the rise of HP is not conducive to the improvement of manufacturing innovation capabilities. Subsequently, after controlling for variables such as EDL, GSI, FDL, and OPL, we again conducted an estimated regression analysis on the model. From column (2), it can be seen that the estimated coefficient of HP is –0.428, which is significant at the 1% level. According to the estimated regression results in column (2), after considering control variables, high HP still has a significant negative impact on IME. This study preliminarily suggests that as the real estate industry develops excessively, high HP tends to suppress innovation in the manufacturing industry. According to the bubble theory, the rapid rise of HP leads to an increase in speculation in the real estate industry. High returns lead ME to focus on short-term interests, reduce innovative research and development, diminish patent output, and further weaken innovation capability.

In addition, considering the possible non-linear relationship between HP and IME, this study added a quadratic term of HP for estimation regression. According to column (3) and column (4) in Table 5, it can be seen that the coefficient of HP and its quadratic terms are statistically significant. Regardless of whether control variables are added or not, the coefficient of HP remains significantly positive, indicating that HP has a positive impact on IME. This validates hypothesis 1 that HP is beneficial for IME in the short term. The coefficient of HP^2 is significantly negative, indicating that HP may have an inverted U-shaped relationship with IME. It should be noted that to verify the existence of the inverted U-shaped relationship, researchers usually add the square term of the independent variable to the regression model and determine the inverted U-shaped relationship by whether the quadratic coefficient is significant and whether the quadratic coefficient is different from the first-order coefficient. This method is generally feasible. However, this method has certain limitations because inverted U-shaped relationships can appear everywhere, even in places where inverted U-shaped relationships do not exist. Therefore, the inverted U-shaped relationship can lead to the conclusion that the quadratic coefficient of the independent variable is significant, but the significant quadratic coefficient of the independent variable cannot lead to the conclusion that there is an inverted U-shaped relationship (Simonsohn and Nelson, 2014).

To avoid the above errors, we need to adopt the approach of Aghion et al (2005), and the specific steps are as follows. Firstly, we should find the maximum point of the inverted U-shaped curve. The regression coefficients

Table 5. The results of benchmark regression.

Variables/Statistics	(1)	(2)	(3)	(4)	(5)
HP	–0.454***	–0.428***	1.841***	1.745***	
	(–6.632)	(–6.218)	(8.219)	(7.006)	
HP^2			–3.848***	–3.753***	
			(–5.415)	(–5.081)	
HP_{low}					2.173***
					(3.375)
HP_{high}					–3.296***
					(–3.924)
HIGH					0.104*
					(1.78)
EDL		0.183***		0.164**	0.182***
		(3.169)		(2.409)	(2.893)
GSI		0.295***		0.274***	0.295***
		(3.773)		(3.050)	(3.549)
FDL		0.081*		0.075*	0.080*
		(1.947)		(1.735)	(1.934)
OPL		0.059		0.053	0.058
		(1.628)		(1.087)	(1.537)
ISD		0.365***		0.352***	0.359***
		(4.211)		(3.924)	(3.993)
Constant	13.671***	13.361***	2.748***	2.522**	13.284**
	(12.435)	(11.736)	(3.121)	(2.548)	(11.165)
Individual Fixed Effect	Yes	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes
Observations	1760	1760	1760	1760	1760
R-squared	0.648	0.673	0.652	0.684	0.679

Notes: *, ** and *** indicate significant at 10%, 5% and 1% confidence levels respectively, and *t*-values are in parentheses, same below.

of HP and HP^2 are 1.745 and –3.753, respectively. We assume that the coefficient of HP^2 is *a* and the coefficient of HP is *b*. According to the formula for finding the maximum value of a quadratic function, when HP = *b*/–2*a*, IME has the maximum value. Note that the HP at this time is HP_{max}. We will continue to generate three new variables: HP_{low}, HP_{high}, and *high*. The specific definitions of variables are shown in Eqns. 8,9, and 10:

$$HP_{low} = \begin{cases} HP - HP_{max}, \text{ if } HP \leq HP_{max} \\ 0, \text{ otherwise} \end{cases} \quad (8)$$

$$HP_{high} = \begin{cases} HP - HP_{max}, \text{ if } HP \geq HP_{max} \\ 0, \text{ otherwise} \end{cases} \quad (9)$$

$$high = \begin{cases} 1, \text{ if } HP \geq HP_{max} \\ 0, \text{ otherwise} \end{cases} \quad (10)$$

Finally, we need to perform breakpoint regression, as shown in Eqn. 11.

$$MEI = c * HP_{low} + d * HP_{high} + e * high \quad (11)$$

If the signs of coefficients *c* and *d* are opposite and both are significant, it can be determined that there is indeed an inverted U-shaped relationship between IME and HP (Aghion et al, 2005). Through mathematical formulas, we can calculate that the turning point of HP (HP_{max}) is 0.232. By using Stata15.0, we conducted breakpoint regression and obtained coefficients of 2.173 for HP_{low}, –3.296 for HP_{high}, and 0.104* for *high*. From the results, it can be seen that the coefficient signs of HP_{low} and HP_{high} are opposite, and both are statistically significant at the 1% level. Therefore, we can conclude that there is an inverted U-shaped relationship between HP and IME, which verifies hypothesis 2. On the one hand, in the early stages of the rise of HP, HP can increase the financing scale of enterprises, increase their willingness to engage in technological innovation, and promote patent inventions by enterprises. On the other hand, when HP continues to rise, the positive effect of HP on IME weakens and gradually produces signif-

Table 6. The results of mediating effect.

Variables/Statistics	(1)	(2)	(3)	(4)	(5)	(6)
	RA	IME	FC	IME	REI	IME
HP	0.317***	–0.538***	–0.804***	0.817***	0.479***	–0.935***
	(2.67)	(–2.72)	(–4.117)	(2.896)	(4.162)	(–3.227)
RA		–0.220**				
		(–2.319)				
FC				–0.712***		
				(–4.473)		
REI						–0.483***
						(–3.14)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.026**	3.475***	8.297***	5.471***	6.138***	3.872***
	(3.847)	(3.139)	(7.632)	(5.396)	(6.285)	(4.661)
Individual Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1760	1760	1760	1760	1760	1760
R-squared	0.816	0.703	0.825	0.753	0.750	0.782

Notes: ** and *** indicate significant at 5% and 1% confidence levels respectively.

icant negative effects. This is mainly due to the high-yield nature of real estate, which leads to an increase in speculative demand and triggers more manufacturing enterprises to turn to real estate investment, reducing investment in IME.

In terms of control variables, the coefficients for EDL, GSI and ISD are significantly positive, indicating that they are conducive to IME to a certain extent. The good development of the social economy, government's support and reasonable industrial structure can provide a favorable environment and relevant policy support for ME to carry out innovation activities. The coefficient of FDL is positive, passes the 10% significance test, and indicates that financial development can provide financial support for innovative activities of ME. Although the coefficient of OPL is positive, it is not significant enough, indicating that the promoting effect of OPL on IME is not significant enough in the research sample of this study.

5.3 The Results of Mediating Effect

We have analyzed the mediating effect of HP on IME through stepwise regression. Table 6 shows the empirical results. Column (2) and (3) present the regression results with the mediating effect of RA added, column (4) and (5) show the results with the mediating effect of FC added, and column (6) and (7) display the regression results with REI added.

From the perspective of RA, column (1) shows that HP has a positive impact on RA at a significance level of 1%, with an impact coefficient of 0.317. Column (2) shows that RA effectively inhibits IME at a significance level of 5%. HP can effectively hinder IME through RA. Therefore, it can be concluded that RA plays a mediating role and has a significant impact. With the misallocation of resources, HP can inhibit IME, and hypothesis 3 has been verified.

From the perspective of FC, model (3) shows that the impact coefficient of HP on FC is –0.804, which passes the significance test at the 1% level. This indicates that the higher the HP, the less FC MEs face. Column (4) shows that FC is still significant, and the coefficient of HP is significant after introducing FC. The coefficient of HP is positive, while the coefficient of FC is negative, indicating that HP can improve IME through decreasing FC. Therefore, hypothesis 4 has been verified.

From the perspective of REI, column (5) shows that HP has a positive impact on REI at a significance level of 1%, with an impact coefficient of 0.479. Column (6) shows that REI hinders IME at a significance level of 1%. Therefore, it can be concluded that REI plays a mediating role, whereby with the increase of REI, HP can inhibit IME, and thus hypothesis 5 has been verified.

However, traditional mediation models may have some shortcomings, such as limited applicability and potential endogeneity concerns. When dealing with mediation effects, the testing ability of the Sobel test is generally higher than that of stepwise regression method (Wen and Ye, 2014). Therefore, we followed the approach of Combs et al (2007) in conducting the Sobel test on the mediating effect. The results are shown in Table 7.

According to the results in Table 7, the values of the Soble test of the three mediating variables all passed the 1% significance level test, as did the values of Goodman-1 (Aroian) and Goodman-2 of the three mediating variables. In addition, the proportion represents the proportion of the indirect effect to the total effect, indicating the strength of the mediating effect. The proportion of these three mediating variables all exceeded 50% and passed the 1% significance level test. This once again indicates that these three variables do indeed play a mediating role and validates hypotheses 3 to 5.

Table 7. The results of Sobel test.

	(1)	(2)	(3)
	RA	FC	REI
Sobel	0.053***	0.083***	0.061***
	(3.48)	(4.25)	(3.72)
Goodman-1 (Aroian)	0.053***	0.083***	0.061***
	(3.45)	(4.21)	(3.69)
Goodman-2	0.053***	0.083***	0.061***
	(3.53)	(4.29)	(3.74)
Indirect Effect	0.457***	0.689***	0.526***
	(3.59)	(4.73)	(3.97)
Direct Effect	0.377***	0.145*	0.308***
	(3.23)	(1.92)	(3.01)
Total Effect	0.834***	0.834***	0.834***
	(5.24)	(5.26)	(5.30)
Proportion	0.548	0.826	0.631

Notes: * and *** indicate significant at 10% and 1% confidence levels respectively.

Table 8. The results of heterogeneity analysis.

Variables/Statistics	Eastern Cities	Central and Western Cities
HP	1.385***	1.594***
	(4.529)	(5.357)
HP^2	–4.951***	–3.016***
	(–7.156)	(–5.240)
Control variables	Yes	Yes
Constant	3.134***	2.994***
	(3.522)	(3.237)
Individual Fixed Effect	Yes	Yes
Time Fixed Effect	Yes	Yes
Observations	1132	632
R-squared	0.704	0.674

Notes: *** indicates significant at 1% confidence levels.

5.4 The Results of Heterogeneity Analysis

To further understand the heterogeneity of the impact of HP on IME, we conducted a heterogeneity test and classified 275 cities in 27 provinces of China into eastern cities and central and western cities for regression analysis. Based on China's administrative regional planning and academic conventions, we divided the 27 provinces of China into two regions: the eastern region and the central and western regions. The eastern region includes 11 provinces, namely, Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. The central and western regions include 16 provinces: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, and Ningxia. By matching with ME, there are 1132 valid samples in eastern cities and 632 valid samples in central and western cities, with the results shown in Table 8.

According to the regression results, whether in eastern cities or central and western cities, HP has a significant impact on IME, and the relationship between the two still shows an inverted U-shape. However, this impact also has regional differences. The results show that high HP in eastern cities have a greater inhibitory effect on IME than in central and western cities, thus verifying hypothesis 6. The possible reason for this is that high HP in the eastern cities exert a significant inhibitory effect on IME through mechanisms such as increasing enterprise costs, suppressing talent inflows, squeezing financing resources, and guiding short-term corporate behavior. In contrast, in the central and western cities, due to lower HP and less cost pressure on enterprises, as well as limited innovation resources, the inhibitory effect of HP on IME is relatively weak.

Table 9. The results of robustness test.

Variables/Statistics	(1)	(2)	(3)
HP	1.241***	1.613***	1.437***
	(4.805)	(6.629)	(6.392)
HP^2	–4.740***	–5.078***	–4.049***
	(–6.817)	(–7.375)	(–6.375)
Control Variables	Yes	Yes	Yes
Constant	4.603***	4.273***	3.793***
	(4.281)	(3.983)	(3.462)
Individual Fixed Effect	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes
Observations	1760	1584	2640
R-squared	0.672	0.698	0.685

Notes: *** indicates significant at 1% confidence levels.

5.5 The Results of Robustness Test

We conducted robustness tests on the empirical results of this study through four methods: lagging the independent variable by one period, replacing the dependent variable, changing the sample observation time, and using the instrumental variable (IV) method.

5.5.1 Lagging the Independent Variable by One Period

Given that using current HP as an independent variable may lead to endogeneity issues—where HP does affect IME, and HP may also be negatively affected by IME, resulting in a reverse causality problem—HP and IME are jointly influenced by other factors; however, limited data have not controlled for these variables, resulting in omitted variables and measurement errors. Lagged HP is related to the current HP, but not directly related to the IME in the current period. Therefore, this study lags the independent variables by one period (Rao et al, 2017). The results are shown in column (1) of Table 9. The coefficients and significance of the independent variable and its quadratic term have not changed significantly, and the goodness of fit has changed little, verifying the robustness of the empirical results in this study.

5.5.2 Replacing Dependent Variable

To test the sensitivity of the research results to measurement methods, eliminate the influence of measurement errors, capture the multidimensional characteristics of independent variables, and improve the robustness and credibility of the research conclusions, we use the logarithmic method of adding 1 to the total number of enterprise patent applications to replace the original dependent variable (Wang and Lu, 2019). The specific formula is shown in Eqn. 12:

$$MEI_{new} = ln(Patant + 1) \tag{12}$$

where Patent refers to the total number of patent applications filed by enterprises. The results are shown in column (2) of Table 9. The coefficients and significance of the independent variable and its quadratic term do not show significant changes, and the goodness of fit changes little, verifying the robustness of the empirical results in this study.

5.5.3 Changing Sample Observation Time

To verify the robustness of the empirical results again, this study adopts the method of changing the sample observation time (Du et al, 2017) from 2013–2022 to 2008–2022. The main purpose of changing the sample observation time is to enhance the robustness and universality of the research results, eliminate the influence of time-related factors, and verify whether the research conclusions are valid in different time periods. By adjusting the time window, we can more comprehensively evaluate the reliability and external effectiveness of the model. The results are shown in column (3) of Table 9. The coefficients and significance of the independent variable and its quadratic term have not changed significantly, and the goodness of fit has changed little, verifying the robustness of the empirical results in this study.

5.5.4 IV Method

After conducting robustness tests using the above three methods, we still need to consider another possibility, namely, that the rise of HP and the decrease of corporate innovation may be due to some unobservable regional factors, such as policy guidance from local governments. In this case, the results of the benchmark regression do not necessarily indicate that real estate investment has "squeezed out" innovative activities, and the endogeneity problem caused by the rise of HP needs to be solved through the IV method (Wang and Rong, 2014).

To avoid endogeneity problems in the benchmark regression caused by omitted variables, measurement errors, and causal relationships, this study generates two IVs. One is the land transfer area (LTA). It is appropriate to use the logarithm of the LTA lagged by one period in a certain city as IV_1 (Lu et al, 2015). Because land supply directly affects HP, and land scarcity can push up HP, LTA meets the theoretical requirements of exogenous instrumental variables (Yu and Zhang, 2017). The second IV is natural geographical slope (NGS). We have selected urban slope data as the IV and constructed an interaction term between urban slope (related to individual changes) and the completed area of real estate in the country in the previous year (related to time) as IV_2 (Nunn and Qian, 2014; Yu and Li, 2019). The two-stage least squares (2SLS) method is used for robustness testing, and the specific results are shown in Table 10. From the results of 2SLS, it can be seen that for both IV, the p-values of the Kleiberen-Paap LM test are both 0, significantly negating the null hypothesis of identification problems in the first stage regression. In addition, for LTA and NGS, the Cragg-Donald Wald F Statistics are both greater than 10, indicating the absence of weak IV. Therefore, the conclusion that the rise of HP can suppress IME is reliable.

Table 10. The results of 2SLS.

Variables/Statistics	(1)	(2)
	IV_1: LTA	IV_2: NGS
HP	1.846***	1.958***
	(5.045)	(6.227)
HP^2	–3.283***	–3.381***
	(–4.106)	(–3.562)
Control Variables	Yes	Yes
Constant	6.194***	5.836***
	(6.105)	(4.037)
Individual Fixed Effect	Yes	Yes
Time Fixed Effect	Yes	Yes
Observations	1760	1760
R-squared	0.583	0.621
First Stage F	46.147	52.391
	[0.000]	[0.000]
Second Stage F	56.382	63.425
	[0.000]	[0.000]
Kleibergen-Paap	69.873***	97.359***
LM Statistic	[0.000]	[0.000]
Cragg-Donald	149.256***	182.749***
Wald F statistic	{>10}	{>10}

Notes: *** indicates significant at 1% confidence levels. The requirement for F statistic is enclosed in curly brackets. LTA, Land Transfer Area; NGS, Natural Geographical Slope; LM Statistic, Lagrange Multiplier Statistic; 2SLS, Two-Stage Least Squares.

6. Conclusions and Suggestions

6.1 Conclusions

This study finds that: (1) There is an inverted U-shaped relationship between HP and IME. When the level of HP is low, the rise of HP plays a promoting role in innovation for manufacturing enterprises. When the overall level of HP is too high and exhibits a bubble-like trend, the rise of HP tends to inhibit IME. Therefore, the level of HP in China can only play a positive role in IME when it matches the level of the national economy. (2) HP affects

IME through RA, FC, and REI. Among them, HP hinders IME through RA and REI, while HP promotes IME through alleviation of FC. (3) The impact of HP on IME varies regionally. When HP is at a high level, rapid rise of HP has a significant inhibitory effect on IME in eastern and central western cities of China. Among them, the inhibitory impact of HP on IME in eastern cities is more significant than in central and western cities.

6.2 Suggestions

Based on the above research conclusions, this study proposes the following policy recommendations.

There is an inverted U-shaped relationship between HP and IME, which means that HP only plays a positive role when the level of HP in China matches the level of the national economy. Therefore, the government should actively stabilize real HP, establish a sound real estate supervision and management system, regulate the financial investment attributes of real estate, and crack down on illegal speculation. Additionally, the government should establish a dynamic monitoring and management mechanism for the relationship between HP and IME and flexibly adjust policies according to actual situations. For example, the government regularly evaluates the relationship between HP and IME, identifies reasonable ranges for HP, and adjusts real estate supervision and management policies and manufacturing support policies in a timely manner based on monitoring results.

HP hinders IME through RA and REI but promotes IME through reduction of FC. Therefore, on the one hand, the government can continuously optimize the RA of the housing supply system, improve the housing system that combines renting and purchasing, increase public rental housing to meet the basic housing needs of residents, and alleviate the drawbacks of high HP on IME. The government should also continuously optimize the allocation of financial resources, optimize the financing scale allocation between various sub sectors of the manufacturing industry, improve the financial service capabilities for small and medium-sized ME, and encourage more financial resources to flow into the innovation field of the manufacturing industry. On the other hand, the government should allow for moderate rise of HP in areas where HP is too low. Such an approach can enhance the market value of real estate for enterprises, strengthen their asset collateral capabilities, and bring about positive chain reactions such as improving the credit rating of enterprises in the capital market, easing FC, promoting the acquisition of external funds, and enhancing the financial stability of enterprises.

Finally, compared to cities in the central and western regions, HP has a more significant inhibitory impact on IME in eastern cities. The government should implement differentiated HP adjustment policies according to local conditions. For eastern cities, especially large cities with many ME, the government should strictly control HP to prevent excessive HP from having adverse effects on IME. For example, the government can implement subsidy policies to mitigate the adverse effects of high HP on IME. In addition, we recommend establishing manufacturing bases in the central and western cities with lower HP, providing policy support and infrastructure support, and encouraging the establishment of R&D centers or branch offices in these areas.

Abbreviations

ME, Manufacturing Enterprises; HP, Housing Prices; IME, Innovation of Manufacturing Enterprises; RA, Resource Allocation; FC, Financial Constraint; REI, Real Estate Investment; EDL, Economic Development Level; GSI, Government Support Intensity; FDL, Financial Development Level; OPL, Openness Level; ISD, Industrial Structure Development; ER, Enterprise Region; ES, Enterprise Size; EA, Enterprise Age; ALR, Asset Liability Ratio; FCR, Free Cash Ratio; ROE, Return On Equity; EAS, Enterprise Asset Structure; LTA, Land Transfer Area; NGS, Natural Geographical Slope.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available in the [China Research Data Service Platform] repository, [https://www.cnrds.com]; [China Research Data Service Platform] repository, [https://data.csmar.com]; [Wind] repository, [https://www.wind.com.cn]; [National Bureau of Statistics of China] repository, [https://www.stats.gov.cn].

Author Contributions

YX designed the research study. XL performed the research analyzed the data. YX and XL wrote the manuscript. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

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Conflict of Interest

The authors declare no conflict of interest.

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