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Does Land Resource Misallocation Affect Technological Innovation of Enterprises

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Abstract

We use the data at the prefecture-level city level of land transfer from 2003 to 2013 to match the patent data of Chinese industrial enterprises to examine the impact of land resource misallocation on technological innovation of enterprises. The empirical study finds that at the micro-enterprise level, the mismatch of land resources caused by the expansion of industrial land supply has a significant inhibitory effect on technological innovation. The conclusion is still valid after the introduction of instrumental variables and the robustness test. Further mechanism analysis shows that land resource misallocation has an impact on enterprise innovation by affecting the structure of government fiscal expenditure, urban environmental quality and human capital accumulation.

Keywords

Misallocation of Land Resources; Enterprise Innovation; Land Supply Structure.

1. Introduction

After the tax-sharing reform in China in the 1990s, the central government empowered local governments to operate the land market, and the land transfer fee did not have to be paid to the central finance. Therefore, the land income has become an important part of the extra-budgetary income of local governments, and it is a breakthrough for local governments to alleviate the imbalance fiscal revenue and expenditure. Under the background of economic performance as an important evaluation index for the promotion of local officials, the practice of low-cost and large-scale transfer of industrial land has become an important weapon in the competition of investment promotion among regions. The ' land-based investment ' model can rapidly increase the possibility of introducing large industrial projects in the region in the short term, thereby boosting GDP growth and fiscal revenue generation within the jurisdiction. Under this model, by virtue of the regional land resource reserve and the government 's dual monopoly dominance in land expropriation and supply, local governments supply a large number of industrial land at low prices to attract investment to promote the rapid growth of GDP in the short term. At the same time, they also limit the supply of residential land at high prices, maximize the use of land dividends to improve the government `s land revenue and land mortgage financing as to ensure the government `s public service function. This kind of government-led dual-hand land supply strategy that is not market-oriented has caused the phenomenon of low efficiency of land resource allocation for a long time and widely exists. Many scholars also call the phenomenon of low efficiency caused by the distortion of supply structure between uses, industries and regions caused by land factor allocation under this model as land resource misallocation[1,2][2].

Many scholars have carried out rich and detailed studies on the low efficiency of land resource allocation. On the basis of the existing research, this paper first discusses the mechanism of land resource mismatch affecting technological innovation at the theoretical level, and then uses the data of industrial enterprises at the micro level to empirically analyze the effect of land resource

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mismatch on innovation level, in order to provide empirical evidence at the micro level of land resource mismatch affecting innovation ability. Specifically, the industrial enterprise database is matched with the patent database of the National Bureau of Statistics to investigate the impact of land resource mismatch on the innovation level of micro enterprises, and the government expenditure structure bias, urban environmental quality and human capital accumulation are included in the unified analysis framework to verify the transmission mechanism of land resource mismatch affecting enterprise innovation. In addition, the intersection of urban average slope and benchmark interest rate is used as a tool variable to alleviate the endogenous problems caused by reverse causality and missing variables.

The remainder of this paper proceeds as follows. In the next section, we will review the background literature on land resource allocation and innovation, and then we will introduce mechanism analysis and theoretical hypothesis in section 3. In Section 4, we describe our data source and define our variables, and construct a model for subsequent empirical research. In Section 5, we report and discuss the benchmark results of our empirical analysis. Section 6 gives conclusions and policy implications.

2. Literature Review and Theoretical Hypotheses

As the basic carrier of production and living activities, the development and utilization of land resources have multiple and complex externalities. The allocation of land resources is not only closely related to the sustainable development of economy and the optimization and upgrading of industrial structure, but also related to China 's urbanization process, ecological environment protection and people 's well-being. Since the founding of the People 's Republic of China, the state-owned land has gradually shifted from free allocation to paid transfer. Especially after 2007, in order to curb the disorderly expansion and extensive use of industrial land, the Ministry of Land and Resources promulgated the “Provisions on the use right of state-owned construction land to be transferred by bidding, auction and listing”, which clearly stipulates that industrial land must be transferred by bidding, auction and listing. The market-oriented transfer model can make the pricing of land transfer more reasonable. However, in the supply structure of state-owned construction land, industrial land and residential land are still over-allocated, while commercial land is under-allocated, and the price of industrial land is still at a low level. At the same time, the price of residential land and commercial land is between 8 and 10 times[4], that is, the situation of land resource misallocation is still severe.

Many scholars have carried out rich explorations on the impact of land resource allocation distortion. Some scholars believe that it will have a negative impact on productivity[5]. Restuccia and Santaeulalia-Llopis[6] used household data to verify that improper land allocation will reduce the actual productivity of agriculture. Lixing Li0 combined land transfer data and industrial and enterprise data to empirically verify that in industries with stronger dependence on land, the loss of enterprise productivity caused by land resource misallocation will be greater. In addition, misallocation of land resources will hinder the pace of industrial structure optimization and upgrading[7], further reducing the cost of high-energy enterprises to stay, thereby increasing urban environmental pollution[8]. Xie et al. [9] tested the negative effect of the expansionary allocation of industrial land on urban innovation from the perspective of urban industry, and concluded that the land resource allocation model has more negative effects on developed regions with strong industrial foundation and high-tech industries.

The above research results provide a theoretical basis for the study of this paper, but there are still shortcomings. The existing literature on the structure of land supply is mostly based on the macro perspective, and analyzes the external characteristics brought about by the inefficient allocation of land resources from the overall dimension of the city. It does not go deep into the

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micro level, and there is a lack of micro evidence for the discussion of the expansionary allocation of industrial land affecting technological innovation. Therefore, on the basis of existing research, this paper extends the research perspective to the micro enterprise level, and deeply analyzes the mechanism of land supply structure distortion affecting enterprise technology innovation, in order to provide decision-making reference for promoting the precise allocation of land resources, promoting the quality of urban innovation and enterprise innovation vitality.

3. Theoretical Framework and Hypothesis

In the initial stage of economic development, the government `s development strategy of attracting local investment has rapidly attracted the inflow of highly mobile manufacturing enterprises, which can quickly lay the industrial foundation for economic development and urban construction, and complete the original accumulation of industrial capital. The inspiration and demand of innovation mainly comes from production activities, and good industrial foundation is the support and carrier of innovation activities[9]. In addition, industrial agglomeration will create more jobs to attract the labor force including innovative talents, thus forming a certain human capital advantage. At the same time, the government `s strategy of "generating finance by land" provides sufficient financial support for urban infrastructure construction, and provides sufficient financial guarantee for promoting urbanization and industrialization. Therefore, the strategies of low-cost large-scale supply of industrial land and high-cost limited supply of commercial and residential land have a positive role in stimulating the improvement of innovation level in the early stages of urbanization and industrialization.

However, with the deepening of industrialization, excessive low-cost supply of industrial land and high-cost unsaturated supply of commercial and residential land have brought many problems. The expansion of industrial land allocation has led to extensive land development and utilization, which has multiple externalities on urban economic activities. The low supply price of industrial land reduces the factor input cost of industrial enterprises, ensures a certain profit space for most enterprises with low productivity and insufficient competitiveness, and makes enterprises lack the motivation to increase R&D efforts to improve business performance, resulting in low technology lock-in effect. The distortion of resource allocation also hinders the correct transmission of price signals, and the economic activities of the whole city, inter-industry, enterprise subjects and individuals within the jurisdiction are disturbed. The resulting increase in rent-seeking space is not even conducive to the construction of the business environment and fair competition in the market[10]. In addition, local governments rely on the excessive allocation of industrial land to attract investment, which tends to attract more middle- and low-end enterprises with low technology content and low degree of intensive utilization of resources. When the proportion of such enterprises is higher, it will not only crowd out and compete for the production and operation space and resources of innovative enterprises, but also strengthen the rigidity of regional industrial structure[7], resulting in a great increase in the resistance of the economic development mode from factor-driven to innovation-driven after a certain stage of urban development. So we put forward the first hypothesis :

H1: Land resource misallocation will restrict the improvement of technological innovation level of micro-enterprises.

This paper focuses on the transmission path of land resource misallocation affecting enterprise innovation. First, the second-hand land allocation makes the government fiscal expenditure structure reflect the characteristics of heavy production, light innovation. The low-price transfer of industrial land for investment can increase the government `s tax revenue, while the

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high-price transfer of commercial and residential land can obtain high land transfer income, which relaxes the government `s fiscal budget constraints. In theory, the government will have more sufficient funds to allocate to the innovation field to enhance the innovation vitality of enterprises in the jurisdiction. However, in fact, when the improvement of the government `s financial strength is mainly due to land transfer, it tends to invest the land transfer income into productive expenditure such as infrastructure construction that is conducive to further improving the land value and attracting investment to leverage greater land demand and build a strong source of land finance[10]. When fiscal expenditure is biased towards productive expenditure such as infrastructure construction, it has a crowding-out effect on government R&D investment, and the financial support for scientific and technological innovation has decreased[11], thus affecting the overall innovation vitality of the city and the individual innovation enthusiasm of enterprises.

Second, misallocation of land resources will reduce urban environmental quality. Cities that rely too much on attracting investment will lower the entry threshold of enterprises in the competition with neighboring cities, and then introduce a group of enterprises with high energy consumption, high emission and low efficiency, forming the locking effect of extensive industrial structure and aggravating urban environmental pollution[8]. In other words, a large number of low-price supply of industrial land will cause the decline of urban environmental quality. The improvement of environmental pollution will not only affect the entry of innovative enterprises, but also reduce the performance output of innovative talents by affecting individual emotions and health levels[12]. Therefore, we believe that one of the channels of land resource mismatch affecting enterprise innovation is the decline of urban environmental quality.

Third, the misallocation of land resources will reduce the agglomeration effect of innovative talents. Innovation is a mental activity, and talent is the key input factor of innovation. High-quality and abundant talent reserve is the guarantee for the effective development of innovative R&D in cities. In cities with serious land resource misallocation, on the one hand, limiting the supply area of commercial and residential land will further raise the living cost of urban labor force ; on the other hand, with the deepening of land misallocation, urban environmental pollution intensifies, and the level of urban livability declines, which will reduce the attractiveness to talents. Innovative talents have stronger mobility than ordinary labor force, so the distorted allocation of land resources is not conducive to the effective play of the agglomeration effect of human capital. The demand for knowledge workers and innovative talents has not been fully met, and the innovation efficiency of enterprises will also be restricted.

H2: Misallocation of land resources will affect the level of enterprise innovation through the mechanism of fiscal expenditure, the quality of the urban environment, and the mechanism of human capital accumulation.

4. Empirical Results

4.1. Model Settings

4.1.1. The Benchmark Regression Model

Based on the above theoretical analysis and research hypotheses, this paper explores the effect of land resource misallocation on individual innovation level of enterprises from a micro perspective, and constructs a benchmark model at the micro enterprise level as shown in Equation (1):

$$lnpatent_{j,i,t} = \theta_0 + \theta_1 \mathrm{lrm}_{\mathrm{i,t}} + \gamma \sum X_{\mathrm{j,i,t}} + \lambda_i + \sigma_j + \mu_t + \varepsilon_{\mathrm{j,i,t}} \quad (1)$$

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where j indexes a enterprises, i indexes a city and t indexes a year. lnpatentj,i,t represent the innovation level of enterprises, and the innovation level at the enterprise level is measured by logarithm after adding 1 to the total amount of patent applications of enterprises; lrmi,t is the core explanatory variable: land resource misallocation; X is a series of control variables that reflect the characteristics of cities and enterprises ; λi is regional fixed effect, σj is industry fixed effect, μt is annual fixed effect,εit is random disturbance.

4.1.2. Mechanism Test Model

According to the results of theoretical analysis and literature review, the mechanism of land resource mismatch affecting enterprise innovation is mainly in three aspects:

First, distort the government 's fiscal expenditure bias, the government will be more limited budget into infrastructure construction, reducing the proportion of science and technology spending ; second, large-scale investment to reduce the quality of investment led to increased urban pollution, difficult to attract innovative enterprises ; third, the inefficient expansion of industrial land leads to the continuous improvement of urban living costs and pollution levels, which has a dilution effect on human capital. To verify Hypothesis 2, the following mechanism test model is constructed to further identify the transmission channels that have an impact:

$$med_{i,t} = \beta_0 + \beta_1 lrm_{i,t} + \gamma \sum X_{i,t} + \lambda_i + \mu_t + \varepsilon_{i,t} \quad (2)$$

$$lnnov_{i,t} = \varphi_0 + \varphi_1 lrm_{i,t} + \varphi_2 med_{i,t} + \gamma \sum X_{i,t} + \lambda_i + \mu_t + \varepsilon_{i,t} \quad (3)$$

Among them, medit represents channel variables, according to the theoretical analysis of this paper, including local government fiscal expenditure bias (scexp), urban environmental quality (lnpm25), human capital accumulation (technologypop) three intermediary variables.

4.2. Sample Selection and Definition of Major Variables

This paper matches the database of China 's industrial enterprises with the database of China Intellectual Property Patent Office, and measures the innovation level of enterprises by the number of patent applications of industrial enterprises. The sample interval is 2003-2013. In order to ensure the rigor of the data, the method of Brandt et al.[14] and Huihua Nie et al.[15] was used to clean the data, and the unbalanced panel data of about 400,000 enterprises with a total of more than 2 million samples were obtained, with a time span of 2-11 years.

The land transfer strategy of local governments ‘expansionary supply of industrial land and contractionary suppliers’ residential land has led to the persistence of inefficient allocation of land factors, namely, land resource misallocation. Referring to the existing research, this paper measures the degree of land resource misallocation by using the amount of industrial land transfer as the total amount of land transfer. In view of the availability of data, land resource misallocation between 2003 and 2008 was measured by the proportion of agreed land transfers to total land transfers ; the misallocation of land resources between 2009 and 2013 was measured by the ratio of industrial and mining storage land to total land transfer.

The mediating effect mainly includes three mediating variables, and the measurement methods are as follows : (I) The fiscal expenditure structure bias of the government is measured by the proportion of science and technology expenditure in total budget expenditure. (II) Urban environmental pollution environmental quality, using PM2.5 concentration to measure. (III) Human capital accumulation, measured by the number of scientific research, technical services and geological survey practitioners.

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4.3. Data Sources

Enterprise data comes from the Chinese industrial enterprise database. enterprise patent data comes from the China Intellectual Property Patent Office, land resource mismatch related data comes from the China Land and Assets Statistical Yearbook, and the control variables at the urban level come from the China Urban Statistical Yearbook and China Regional Economic Statistical Yearbook over the years. GDP and investment data are converted to constant prices in 1996, and some missing data are supplemented by linear interpolation. Table 1 is the descriptive statistical results of the main variables.

Table 1. Summary statistics.s

variable	Variable description	Number of Obs.	Std. dev.	min	max
lninnov	Number of patent applications filed by enterprises	2006325	.469	0	2.565
lnpatent	Urban Innovation Index	2,882	.9099	0	6.299097
lrm	The proportion of industrial land transfers	2006325	.26	0	.96
Lev	Gearing ratio	2006325	.26	0	1
Roa	Return on assets	2006325	.196	0	1
Asra	Proportion of fixed assets of enterprises	2006325	.229	0	1
lnage	Age of business	2006325	.739	0	6.023
Export	Exit dummy variables	2006325	.419	0	1
lntotasset	Total assets of the enterprise	2006325	1.461	0	19.427
lnGDP	GDP	2,882	1.004	12.669	19.191
lnStudents	Students of higher education institutions	2,882	1.275	7.67	13.603
invest	Proportion of investment in fixed assets	2,882	.181	.087	2.169
gov	Proportion of government expenditure	2,882	.046	.053	.273
finance	Degree of financial development	2,882	.515	.075	3.45
deficit	(Fiscal Revenue - Expenditure)/Fiscal Revenue	2,882	.824	-.089	4.453
lnpdensity	population density	2,882	.628	1.74	7.887

5. Empirical Findings

5.1. Baseline Regression Results

The regression results of the baseline model are shown in Table 2. column (1) is the regression result without adding control variables. We take column (2) with control variables as the benchmark regression result.It can be seen that the estimated coefficient of the key explanatory variable land resource misallocation (lrm) is -0.04, which is significantly negative at the 1 per cent level, indicating that land resource misallocation has a significant negative impact on the innovation level of industrial enterprises, indicating that the innovation inhibitory effect of land resource misallocation remains significant at the micro-enterprise level. As a preliminary robustness test, this paper also examines the impact of land resource misallocation on the number of invention patents, utility model patents and design patents applied by enterprises. The estimated results are columns (3) to (5) of Table 2. The results show that for different patent types, land resource misallocation has a significantly negative impact, and the benchmark conclusion is not interfered by different indicators of enterprise innovation measurement. Preliminary validation of the hypothesis 1.

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Table 2. Misallocation of land resources and the level of enterprise innovation

	(1)	(2)	(3)	(4)	(5)
VARIABLES	lninnov	lninnov	lninnov_i	lninnov_id	lninnov_idn
lrm	-0.0622***	-0.0400***	-0.0264***	-0.0318***	-0.0062***
	(0.0021)	(0.0038)	(0.0026)	(0.0030)	(0.0015)
lnGDP		0.0456***	0.0397***	0.0323***	0.0065
		(0.0101)	(0.0067)	(0.0083)	(0.0041)
lnStudents		-0.0085***	-0.0115***	-0.0044*	0.0038***
		(0.0029)	(0.0019)	(0.0025)	(0.0013)
invest		-0.0803***	-0.0522***	-0.0540***	-0.0289***
		(0.0081)	(0.0060)	(0.0072)	(0.0036)
gov		-0.5140***	-0.2336***	-0.4576***	-0.1799***
		(0.0672)	(0.0437)	(0.0564)	(0.0243)
finance		0.0789***	0.0143***	0.0605***	0.0402***
		(0.0073)	(0.0040)	(0.0064)	(0.0031)
deficit		0.0196***	0.0070***	0.0155***	0.0072***
		(0.0020)	(0.0012)	(0.0016)	(0.0009)
lnpdensity		0.0086***	0.0061***	0.0072***	0.0024*
		(0.0026)	(0.0016)	(0.0022)	(0.0013)
Lev		-0.0141***	-0.0180***	-0.0076***	0.0035**
		(0.0027)	(0.0022)	(0.0019)	(0.0014)
Roa		0.0112***	0.0133***	0.0056**	0.0142***
		(0.0030)	(0.0021)	(0.0023)	(0.0018)
asra		-0.0616***	-0.0370***	-0.0429***	-0.0151***
		(0.0054)	(0.0038)	(0.0043)	(0.0020)
lnage		0.0021	0.0005	0.0002	0.0010*
		(0.0014)	(0.0009)	(0.0011)	(0.0005)
export		0.0697***	0.0362***	0.0508***	0.0252***
		(0.0059)	(0.0030)	(0.0045)	(0.0028)
lntotasset		0.0783***	0.0461***	0.0557***	0.0239***
		(0.0035)	(0.0026)	(0.0031)	(0.0017)
Constant	0.1556***	-1.3602***	-0.9294***	-0.9910***	-0.3889***
	(0.0011)	(0.1823)	(0.1234)	(0.1503)	(0.0725)
Industry & City & Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Number of Obs.	2,006,325	2,006,325	2,006,325	2,006,325	2,006,325
R^2	0.0874	0.1430	0.0998	0.1228	0.0455

Note: standard error in brackets; *, * * and * * * represent significant aboriginality at the statistical levels of 10%, 5% and 1%, respectively. The following Tables are the same.

5.2. Test of Endogeneity and Instrumental Variables

The model in this paper may have endogenous problems. Specifically, first, there may be reverse causality leading to endogeneity problems. Second, the proportion of industrial and mining storage land supply as the proxy variable of land resource mismatch may have measurement error, which will produce endogeneity problems, leading to the use of fixed effect model to underestimate the impact of land resource mismatch on enterprise innovation ability. Third, there may be missing variables. In order to overcome the endogeneity problem, slope_base is selected as the instrumental variable of land resource mismatch. On the one hand, as a natural geographical condition, slope itself does not have other effects on the discrete degree of industrial enterprise innovation, which conforms to the exogenous conditions of instrumental variables. The steepness of terrain will affect the type of urban land transfer[10]. On the level of land supply, when the terrain is steeper, the smaller the available land area is, the proportion of industrial land in the city will decrease with the increase of the average slope. The benchmark interest rate is formed by decision-making at the national level, and local economy and individual enterprises cannot affect it. The benchmark interest rate will affect the lending rate of local commercial banks, thereby affecting land prices and land supply structure. Table 3 reports the regression results of instrumental variables. According to the results of the first stage in Column (1) of Table (3), there is a significant negative correlation between

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instrumental variables and land resource misallocation. In the first stage, the F value is 42.27, which is greater than the corresponding critical value, and there is no weak instrumental variable problem. The regression results of column (1) show that the larger the average slope, the lower the proportion of industrial land supply, consistent with our expectations. From the results of the second stage, the estimation coefficient of land resource mismatch is significantly negative at the level of 10% aboriginality, and the estimated value is larger than the benchmark result, which means that the endogeneity problem underestimates the negative impact of land mismatch on innovation level, and once again verifies the robustness of the conclusion of this paper.

Table 3. Tool Variable Regression Results

	(1) Stage 1	(2) Stage 2
	lrm	lninnov
Slope_base	-.0003***	
	(0.0003)	
lrm		-1.1104**
		(0.4791)
Control variables	Yes	
Industry & City & Year Fixed Effect	Yes	
Phase 1 F statistics	42.27	
Sargan statistics	0.00	
Number of Obs.	2376024	

5.3. Mechanism Test of Misallocation of Land Resources Affecting Enterprise Innovation

As shown in Table 5, column (1) and (2) reports the estimation results of fiscal expenditure bias as an intermediary variable. Among them, the regression results of column (1) show that the land resource mismatch is significantly negative at the 1% level, indicating that the deepening of the degree of land resource mismatch will lead to the decrease of the proportion of government fiscal expenditure on science and technology. In column (2), the estimation coefficient of land resource mismatch and the proportion of government fiscal expenditure on science and technology are included in the model at the same time. Compared with the baseline estimation results of -0.04 in Table 2 column (2), the estimation coefficient of land resource mismatch is smaller, indicating that fiscal expenditure bias is one of the important transmission mechanisms of land resource mismatch affecting enterprise innovation level.

The estimation results with urban environmental quality as the mediating variable are reported in (3) to (4). As shown in Column (3), with PM2.5 concentration as the proxy variable of urban environmental pollution level, lrm is significantly positive at the level of 1%, indicating that land resource misallocation will lead to increased urban environmental pollution. Column (4) incorporates the mismatch between urban environmental pollution and land resources into the model. The results show that the level of environmental pollution significantly reduces the innovation ability of enterprises, and the estimated coefficient of the key explanatory variable lrm is significantly negative, which is lower than that of the benchmark regression. It supports that urban environmental quality is an important transmission path of land factor mismatch affecting the innovation level of enterprises.

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Columns (5) and (6) report the estimation results with human capital accumulation (techpop) as the mediating variable. The estimation results in Column (5) show that land resource misallocation significantly inhibits the accumulation of human capital. The mediating variables of human capital accumulation and the key explanatory variables are included in the model. The results show that, as shown in Column (6), the estimated coefficient of land misallocation is significantly lower than the benchmark result, confirming that the dilution effect of human capital has a partial mediating effect in the process of land misallocation affecting enterprise innovation. The mediating effect test results verify Hypothesis 2.

Table 4. Mechanism test results

	The structure of government fiscal expenditure is biased		Quality of the urban environment		Human capital dilution effect	
	(1)	(2)	(3)	(4)	(5)	(6)
	Government fiscal spending is biased	Enterprise innovation	air pollution	Enterprise innovation	Accumulation of human capital	Enterprise innovation
lrm	-0.0044***	-0.0387***	0.0031***	-0.0450***	-1.4967***	-0.0322***
	(0.0001)	(0.0021)	(0.0003)	(0.0021)	(0.0064)	(0.0021)
scexp		0.6310***				
		(0.0201)				
lnpm25				-0.0216***		
				(0.0045)		
techpop						0.0053***
						(0.0002)
Constant	-0.0392***	-1.2168***	3.6822***	-1.1215***	32.0718***	-1.5277***
	(0.0026)	(0.0733)	(0.0105)	(0.0760)	(0.2255)	(0.0738)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry & City & Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	2,006,328	2,006,325	2,006,328	2,006,325	2,006,328	2,006,325
R^2	0.8685	0.1432	0.9651	0.1391	0.9547	0.1432

5.4. Robustness Test

In this paper, the robustness test is carried out from four aspects : (1) Due to the lag of enterprise innovation R & D activities from input to output, in order to ensure the robustness of the empirical results, the land resource mismatch variable is delayed for one period to further examine its impact on enterprise innovation. The regression results are shown in column (1) of Table 5. It can be seen that even considering the time lag effect of enterprise innovation, the estimation coefficient of land resource mismatch variables is still significantly negative. (2) Replace the core explanatory variable to measure the mismatch of land resources, using the proportion of industrial land transfer area to the total land transfer area (lrs) to measure the mismatch of land resources. The regression results are shown in column (2) of Table 5, and the estimation coefficient of land resource mismatch is still significantly negative. (3) Excluding the enterprise data after 2010. The enterprise variables in the China Industrial Enterprise Database have a large number of missing values in 2010, so. This article removes samples of industrial enterprises after 2010 from the database. The results are shown in Column (3). The estimated coefficients of key explanatory variables are still significantly negative at the level of 1%. (4) The municipality has great economic particularity, and the impact of local land resources mismatch on enterprise innovation may be different from other regions.Therefore, excluding the data of municipalities, the results can be seen in column (4), and the lrm coefficient is still significantly negative.Overall, the conclusion of this paper has high robustness.

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Table 5. Robustness test results

	(1)	(2)	(3)	(4)
	lninnov	lninnov	lninnov	lninnov
L.lrm	-0.0490***			
	(0.0051)			
lrm			-0.0118***	-0.0326***
			(0.0022)	(0.0035)
lrs		-.0161 ***		
		(0.0027)		
Constant	-2.0085***	-1.3371***	-0.7033***	-1.4625***
	(0.2219)	(0.1799)	(0.1469)	(0.2047)
Control variables	Yes	Yes	Yes	Yes
Industry & City & Year Fixed Effect	Yes	Yes	Yes	Yes
Number of Obs.	1,090,129	2,006,325	1,301,631	1,819,452
R^2	0.1575	0.1432	0.1223	0.1414

5.5. Heterogeneity Test

As the theoretical analysis shows, the impact of land resource misallocation on technological innovation of industrial enterprises of different sizes is heterogeneous. Such as different enterprise ownership nature, enterprise scale differences. Therefore, this paper then examines the impact of land resource misallocation on technological innovation of industrial enterprises with different scales and different ownerships, in order to more accurately describe the characteristics of the impact of land resource misallocation on enterprise innovation. The heterogeneous impact of land resource misallocation on innovation of industrial enterprises of different sizes is shown in Table 6 column (1) to (3). Industrial enterprises are divided into large, medium and small enterprises according to their total assets. The estimation results show that land resource misallocation has a significant negative impact on both large and medium-sized enterprises, and the impact on small enterprises is positive but not significant.

Then according to the real capital of enterprises, the enterprises are divided into state-owned enterprises and private enterprises to test the impact of land resources mismatch on different ownership enterprises. The estimation results are listed in column (4) and (5). Land resource misallocation has a significant negative impact on both state-owned enterprises and private enterprises, but the absolute value of the estimation coefficient of private enterprises is larger, indicating that land resource misallocation has stronger inhibitory effect on innovation of private enterprises. The possible reason is that state-owned enterprises get more government support and more sustainable, so the negative impact of land resource mismatch on the innovation level of state-owned enterprises will be relatively weaker.

Table 6. Heterogeneity analysis results

	Enterprise size			Business ownership	
	(1) Large	(2) Medium-sized businesses	(3)Small Business	(4) State-owned enterprises	(5)Private enterprises
lrm	-0.0408***	-0.0159***	0.0016	-0.0457***	-0.0582***
	(0.0071)	(0.0022)	(0.0015)	(0.0112)	(0.0057)
Constant	-3.3893***	-1.0141***	-0.3841***	-1.6457***	-1.6285***
	(0.3013)	(0.1073)	(0.1171)	(0.4427)	(0.2071)
Control variables	Yes	Yes	Yes	Yes	Yes
Industry & City & Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Number of Obs.	665,516	1,173,944	166,809	117,499	1,175,276
R^2	0.1575	0.0518	0.0181	0.2076	0.1355

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6. Conclusion

Based on the panel data of Chinese industrial enterprises from 2003 to 2013, from the perspective of land resource mismatch caused by the large supply of industrial land and a small amount of commercial and residential land by local governments in the land market, this paper examines the impact of resource mismatch between industrial land and commercial and residential land on enterprise innovation level and its mechanism. The empirical study finds that the higher proportion of industrial and mining storage land supply area to total land supply not only inhibits the urban innovation ability, but also reduces the innovation level of enterprises. Further research on the mechanism of action finds that land resource misallocation affects the technological innovation vitality of enterprises through fiscal expenditure bias, environmental quality destruction and human capital dilution.

According to the research conclusion of this paper, the resource misallocation between industrial land and commercial and residential land under the supply of land monopoly is an important reason to hinder the improvement of urban innovation ability and the level of independent innovation of enterprises. In order to realize the transformation of China 's economy from traditional factor expansion to innovation-driven, first, promote the market-oriented reform of land supply, break the monopoly position of local government in land supply, and further play the basic role of market in the allocation of land resources ; second, optimizing the land supply structure. changing the development mode of local governments relying on a large number of low-cost supply of industrial land to attract investment, and increasing the proportion of commercial and residential land supply; third, reform the performance appraisal system and fiscal and taxation system, fundamentally eliminate the local government in pursuit of land transfer income maximization and restricted high price supply of commercial and residential land intrinsic incentive.

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