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Drinking Poison to Quench Thirst: Local Government Land Financial Dependence and Urban Innovation Quality

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Abstract: Many emerging markets rely on land financing, whereby land grants are used to raise funds for the government. In the short term, land financing eases the government's fiscal deficit and boosts regional economic development. However, the long-term implications of such behaviour have not been adequately discussed. This study focuses on the relationship between local government land finance dependence (LGLFD) and urban innovation quality (UIQ). We find that LGLFD significantly inhibits the improvement of UIQ, and this inhibition occurs through three main channels: changing government spending preferences, reducing financial efficiency, and deteriorating the institutional environment. Our empirical study analyses 3662 samples from 264 Chinese cities from 2003 to 2016, confirming our research hypothesis. Further research finds that there is significant heterogeneity in the effect of LGLFD on UIQ. Based on these conclusions, some policy implications are proposed.

Keywords: land finance dependence; urban innovation quality; government spending preferences; financial efficiency; institutional environment

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1. Introduction

Innovation is recognised as a core element in enhancing long-term economic growth and the ultimate choice for countries and regions to achieve high-quality economic growth [1–3]. Therefore, to achieve rapid economic growth, emerging markets tend to encourage innovative activities and promote 'brute force' economic growth by increasing the number of patents [4]. However, this approach ignores the differences between different types of patents. At the same time, the value of even the same type of patent is very different, and an increase in the number of patents alone is not sufficient to promote high-quality economic growth. Even among patents of the same type, the difference in value can be so great that an increase in the number of patents alone is insufficient to promote high-quality economic growth. For example, in China, the total number of patents granted to Chinese firms increased from 55,000 to 1,720,800 between 1998 and 2017, an average annual growth of nearly 20%. In contrast, the number of patent applications in China surpassed that in the United States in 2011. However, a large gap remains between China and the US in terms of key technological innovations [5,6]. In the same period, China's gross domestic product (GDP) growth rate is about 12.7%. The GDP growth rate is obviously lower than the patent growth rate and is accompanied by excessive depletion of natural resources and serious environmental pollution [7,8]. Therefore, academics and government organizations are increasingly focusing on enhancing innovation quality, specifically the overall value of patents [9].

Concurrently, local governments in China exhibit a pronounced dependency on land finance (LFD), a phenomenon extensively documented in the literature [10,11]. The genesis of land finance is widely attributed to the fiscal adjustments from the 1994 tax-sharing reform, which redefined the revenue allocation between local and central governments. This

reform delineated three primary tax categories: central, local, and shared taxes. Notably, the value-added tax (VAT), previously a significant local revenue source, was reclassified as a shared tax, with distributions of 75% to the central government and 25% to local governments, thereby reducing local government revenues from 80% pre-reform to 45% [12]. Despite diminishing revenues, local governments faced undiminished obligations to provide public services and promote economic development, necessitating alternative revenue sources to address fiscal shortfalls [13].

Further compounding this issue is the legal framework established by China's Land Management Law (unaltered until 2020), which legalized land finance by mandating government expropriation and state ownership conversion of urban land for developmental use [14]. This law effectively granted local governments a monopoly over urban land supply. Following the 1998 housing reform, which marked the real estate industry's transition to marketization, the discrepancy between the earnings from urban land concessions and acquisition costs has consistently expanded [15]. Given that budgetary incomes, particularly from the construction and real estate sectors, accrue to local jurisdictions, local authorities naturally prioritize construction sector development [12]. Moreover, the absence of upper-level government regulation over land transfer revenue management and the local discretion in utilizing these funds foster an intrinsic motivation for land finance implementation, culminating in acute Local Government Land Finance Dependence (LGLFD) [16]. Empirically, in 2020, revenue from local government land concessions surpassed RMB 8.4 trillion (US $1.17 trillion), underscoring the scale and impact of this dependence.

The land finance strategy of local governments has had a profound impact on China's socio-economy. On the one hand, local governments earn fiscal revenues from land concessions, land leases, and land taxes [17,18], easing fiscal pressures, and at the same time investing these revenues in infrastructure construction, which promotes rapid economic growth in a short period of time [19,20]. On the other hand, low-cost industrial land reduces the production costs of enterprises, while land finance revenue is used to subsidise enterprises through taxes and various incentives [21,22], which further promotes economic development. Not only that, LGLFD promotes the prosperity of the regional property market [23], which not only fosters the rapid growth of the regional economy and brings more fiscal revenue for local governments, but also accelerates the process of urbanisation in emerging markets [24–26].

Although there is a near consensus on the role of land finance in boosting the economy, there is still disagreement on its effectiveness in influencing innovation. Optimistic scholars argue that local governments earn land grant spreads through land financing and use the acquired funds to construct local infrastructure in the region [27], which provides better conditions for enterprises to innovate [28,29]. At the same time, low-cost industrial land reduces enterprises' production costs; thus, they have more funds to spend on innovation activities [30]. In addition, land financing increases the linkage between enterprises and regional economic development, reduces the financial constraints and uncertainties that firms face when conducting innovative activities [31], and contributes to innovative activities. However, opponents argue that excessive spending on infrastructure by local governments reduces the government's financial support for innovation and inhibits enterprises' innovative behaviour [32,33]. Moreover, the granting of industrial land at lower prices allows low-end industries, which should have been eliminated to have better living spaces. The over-competitive market environment inhibits the development of innovative industries, which has an obvious 'crowding out effect' on innovation; thus, it is not conducive to improving innovation efficiency [34–36]. Worse still, the excessive intervention of land finance in the economy undermines the market environment of fair competition, causing enterprises with innovative capabilities to lose their willingness to further improve their level of innovation due to a lack of policy support [35].

As the above studies show, there is no consistent conclusion regarding the impact of LGLFD on innovation. Because high-quality innovation, a core element in guiding the green and sustainable development of emerging market economies, requires longer

investment cycles, higher investment costs, and more uncertainty, does LGLFD impact urban innovation quality (UIQ)? What kind of impact? It remains to be seen. To answer this question, we theoretically analyse and empirically test the impact of LGLFD on UIQ using 3662 samples from 264 cities in China over the years 2003–2016. The results show that (1) LGLFD significantly reduces UIQ; (2) LGLFD has an inhibitory effect on UIQ, mainly by changing government spending preferences, reducing regional financial efficiency, and deteriorating the institutional environment; and (3) there is obvious heterogeneity in the effect of LGLFD on UIQ. In the eastern region, LGLFD significantly reduces UIQ, while there is no effect in the central and western regions. The inhibitory effect of LGLFD on UIQ is more prominent in big cities, much larger than that in small cities, and the inhibitory effect of LGLFD on UIQ in the central city is stronger than that in the peripheral cities.

The contributions of this study are as follows: first, it expands and improves the research framework of the consequences of LGLFD by discussing the relationship between LGLFD and UIQ; second, it discusses the path mechanism and heterogeneity of the relationship between LGLFD and UIQ, deepening the understanding of the relationship between them; and third, as innovation is the source of long-term economic growth, this study provides an important reference value for the policy formulation of improving UIQ and promoting long-term high-quality and sustainable growth of China's economy through an in-depth study of the relationship between LGLFD and UIQ.

The remainder of this paper is organised as follows. Section 2 formulates the research hypotheses; Section 3 constructs the model, describes the variables, and explains the sources of the data; Section 4 reports the empirical results; and Section 5 draws conclusions, makes policy recommendations, and summarises the shortcomings of the paper.

2. Research Hypothesis

Since the implementation of the tax-sharing reform in China, local governments have been under dual pressure. On the one hand, the 'GDP Championship' has prompted local governments to urgently promote economic development, that is, local government officials seek higher economic growth targets and higher rankings among their peers due to promotion and performance appraisal pressure [11]. On the other hand, the reduction in the proportion of tax revenue has led local governments to urgently seek new sources of funding to compensate for fiscal deficits [16]. Land financing was created under this dual pressure. Typically, local governments adopt the strategy of granting industrial land at low prices and commercial land at high prices. Specifically, local governments offer industrial land at low prices to attract commercial investment and offer commercial land at high prices to compensate for the loss of fiscal revenues caused by industrial land concessions, which is far below the cost of compensation for agricultural land, and they also invest more of the proceeds from land concessions in productive expenditures, such as infrastructure [37]. Although this strategy has contributed to the rapid economic development of cities, it has also had many adverse effects on UIQ.

On the one hand, cheap industrial land has allowed many inefficient and less innovative firms to survive. An important factor is that the land market can allocate land to enterprises with high productivity and innovation through market competition [38]. Local governments have artificially kept industrial land prices low, undermining the market competition mechanism, which will lead to the preservation of inefficient and low-innovation enterprises that should have been eliminated from the market and will not be conducive to improving UIQ. On the other hand, the high price of commercial land raises the cost of housing construction and increases urban housing prices. At the same time, the growth in government investment in infrastructure development has improved the living environment of residents and the production conditions of enterprises, which may be conducive to a further increase in house prices. At the same time, the increase in government investment in infrastructure has improved the living environment for residents and production conditions for enterprises, which is conducive to the further increase in property prices. Additionally, it promotes the rapid development of the real estate industry [27,39]. Ex-

pensive housing prices not only increase the cost of daily production and operation but also reduce the profitability of enterprises and force them to reduce their investment in innovative activities [40,41].

Additionally, long-term LGLFD induces local governments to introduce policies to maintain stable housing prices. Stable housing prices can ensure that commercial land grant prices remain high, and commercial land grant revenue is key to the local government's land finance revenue [42]. Local government intervention in the real estate market allows the real estate sector to have more stable profits and face less uncertainty than other sectors [35]. Enterprises are attracted to investing more capital in the real estate sector, where technological progress and innovation are limited, rather than innovative activities with higher risks, longer cycles, and more uncertain returns [43]. Therefore, Hypothesis H1 is proposed:

Hypothesis 1 (H1). *Ceteris paribus, LGLFD can inhibit UIQ.*

The enhancement of UIQ is inextricably linked to the support provided by local governments in the realms of science and education, particularly through research and development investment [44,45]. This nexus arises from the inherent nature of innovative investment, characterized by extended duration, gradual outcomes, and considerable uncertainty. Given the capital constraints and profit imperatives, enterprises on their own often struggle to achieve significant innovative outputs. Consequently, external financial support and guidance become crucial in elevating their innovation capabilities [46,47]. This need becomes more pronounced in the context of high-quality innovations, which entail higher costs and greater uncertainties, underscoring the imperative for external assistance [48]. However, to promote rapid regional economic growth and to achieve performance goals, local governments have an inherent incentive to focus on productive investments and avoid innovation expenditures [49,50]. Local governments are more willing to use fiscal revenues from land grants for infrastructure and other productive expenditures while undermining research and innovation expenditures, which are long cycles, highly uncertain, and slow to produce results [51]. When enterprises are unable to implement high-quality innovations due to their financial resources and profitability, this 'focusing on infrastructure, not innovation' spending preference of local governments undoubtedly fails to provide effective support for the innovative activities of enterprises. Therefore, Hypothesis H2 is proposed:

Hypothesis 2 (H2). *Ceteris paribus, LGLFD alters government spending preferences, thereby hindering UIQ.*

As the main body of innovation activities, enterprises' external financing opportunities play a key role in innovation activities [52], while their external financing opportunities will also be affected by land finance. On the one hand, the high price of commercial land and the continuous improvement of infrastructure have increased real estate prices [27,39]. This has led residents to form expectations of a sustained rise in real estate prices, increasing speculative demand for the real estate market and further contributing to the rapid rise in real estate prices [53]. Unreasonable increases in real estate prices drive the creation of real estate bubbles, which in turn increase the probability of triggering systemic risks in the financial system [54]. On the other hand, to expand their business scale, real estate enterprises obtain loans from financial institutions through land mortgage financing [55,56]. The systemic risk in the financial sector is magnified again when there is an irrational rise in land prices and when financial institutions hold a large number of loans financed by land as collateral [54]. To reduce their business risks and ensure the stable operation of the financial system, financial institutions reduce the level of financial resources placed in the market and lower financial efficiency [57]. This undoubtedly increases the threshold and cost for enterprises to obtain external financing from financial institutions, thus reducing

external financing opportunities, which in turn negatively impacts enterprise innovation. Therefore, Hypothesis H3 is proposed:

Hypothesis 3 (H3). *Ceteris paribus, LGLFD reduces financial efficiency, thus hindering UIQ.*

A favourable institutional environment is also an important safeguard for driving innovation. Rent-seeking theory suggests that to obtain economic benefits, when the cost of rent-seeking is less than the cost of production, enterprises or other subjects influence the government's behaviour through rent-seeking means in order to obtain economic benefits, which leads to the crowding out of productive investment. This effect is more pronounced for innovative activities [58]. Rent-seeking is an unavoidable phenomenon in emerging market countries where monitoring mechanisms are inadequate [59]. Land finance has fostered tighter business–government relations, creating a conducive environment for 'political connections' that can facilitate corrupt practices, as documented in the literature [60,61]. Specifically, local governments, monopolizing urban land supplies, wield significant control over land availability and pricing. To secure urban land at reduced costs, businesses often engage in rent-seeking behaviours like lobbying and making political contributions, aiming to lower production expenses. This shift towards 'non-innovative production activities' diverts firms, initially focused on long-term innovation-driven growth, towards rent-seeking strategies, distorting their development agendas [62]. Consequently, the competitive landscape shifts from market and product-based rivalry to one marred by rent-seeking and unfair practices [63–65]. This market mechanism distortion undermines corporate innovation enthusiasm, adversely affecting urban innovation quality. Therefore, Hypothesis H4 is proposed:

Hypothesis 4 (H4). *Ceteris paribus, LGLFD deteriorates the institutional environment, thereby inhibiting UIQ.*

Figure 1 illustrates the research pathway map.

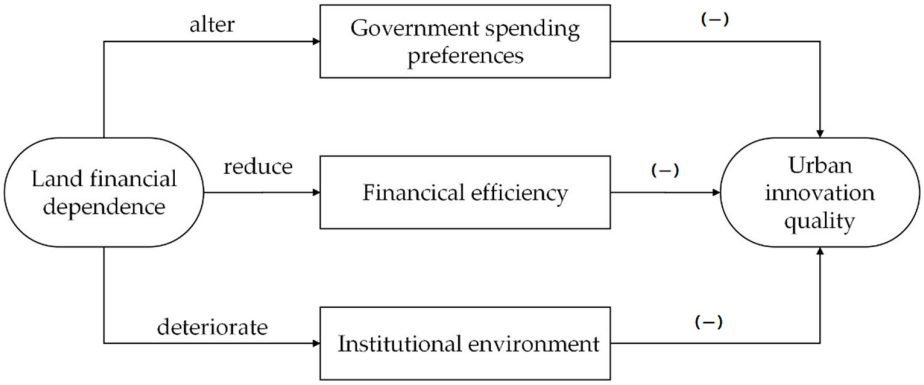

Figure 1. Research pathway map.

3. Empirical Research

3.1. Empirical Modelling

We use a fixed effects model to test the hypotheses of this study, which is constructed as shown in Equation (1).

$$Innov_{i,t} = \alpha + \beta * Landfin_{i,t} + \gamma control_{i,t} + u_i + \lambda_t + \varepsilon_{i,t}, \quad (1)$$

where and i and t indicate the city and year, respectively; $Innov_{i,t}$ is the dependent variable UIQ; $Landfin_{i,t}$ is the independent variable LGLFD; $control_{i,t}$ are control variables; u_i is a city-fixed effect of controlling for latent factors that vary with city but not year; λ_t is a year-fixed effect that is employed to account for the omitted variables, which exclusively

vary with time rather than city; and ε is a random error term. Here, if the hypothesis is valid, β should be significantly negative.

3.2. Variable Definitions

3.2.1. Dependent Variable

Urban Innovation Quality (*Innov*): This study adopts the innovation index compiled by Kou et al. in *the FIND Report on City and Industrial Innovation in China* to measure UIQ. The index is based on patent data from the State Intellectual Property Office and uses a patent renewal model to estimate the average value of patents of different ages. This is used as the basis for constructing an innovation index for each dimension. The specific construction method has been described by Kou et al. [66].

Notably, most current studies use patent data to measure UIQ; however, this method has many shortcomings. First, some enterprises pursue patents unilaterally to obtain government subsidies or innovation policy support, while the actual value of patents is low. Secondly, the number of patents does not reflect their real socioeconomic value, which also leads to the lack of cross-sectional comparability of patent data between different industries. Therefore, this method is not used in this study.

3.2.2. Independent Variable

Land finance dependence (*Landfin*): Land finance revenues mainly include revenues from land grants, land mortgages, and tax revenues such as land use tax, with land grant revenues taking the lead [16,67]. Therefore, this study uses the ratio of the transaction price of construction land grants to budgeted revenue to measure LGLFD.

3.2.3. Control Variables

We also selected six control variables to mitigate the effects of the omitted variable. Six control variables are selected: economic development (*Econo*), industrial structure (*Indus*), financial development (*Finan*), level of openness to the outside world (*Open*), education level (*Educa*), and urbanisation rate (*Urban*).

Econo: measured using GDP per capita and taking the natural logarithm. *Indus:* measured using the share of tertiary GDP. *Finan:* measured using the ratio of total deposits and loans of financial institutions to GDP. *Open:* measured using the ratio of real foreign investment used in the year to GDP. *Educa:* measured using the average number of tertiary education enrolment per 100,000 population and taking the natural logarithm. *Urban:* measured using the share of urban population. Table 1 reports how each variable was calculated.

Table 1. Summary of variable definitions.

Variable Name	Sign	Calculation Method
Urban Innovation Quality	*Innov*	the innovation index compiled by Kou et al. [66]
Land finance dependence	*Landfin*	transaction price of construction land grants/budgeted revenue
economic development	*Econo*	GDP per capita and taking the natural logarithm
industrial structure	*Indus*	Tertiary GDP/Gross Regional Product
financial development	*Open*	Total deposits and loans of financial institutions/GDP
level of openness	*Finan*	Amount of foreign capital/Gross Regional Product
education level	*Educa*	Ln (the tertiary education enrolment per 100,000 population)
urbanisation rate	*Urbani*	Year-end resident population in towns/total resident population

3.3. Sample and Data

The innovation index used in this study is from *the FIND Report on City and Industrial Innovation in China* by the Industrial Development Research Centre of Fudan University (Shanghai, China). The data on land grants are from *the China Statistical Yearbook of Land and Resources*, and all other data are from *the China Urban Statistical Yearbook, the China Statistical Yearbook, and the China Financial Yearbook*.

Simultaneously, to avoid the impact of the price factor, this study uses price indices to convert price-related data into constant 2003-based prices. Additionally, because the innovation index is calculated using the administrative area scope for 2020, this study removes cities whose administrative areas changed during the sample period, such as Jinan, Laiwu, and Hefei, and some cities with serious data deficiencies. All variables are winsorised at the 1% level to eliminate the effect of extreme values. Finally, this study constructs a dataset containing 3662 samples from 264 cities from 2003 to 2016. Table 2 presents the descriptive statistical information for each variable.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Innov	3662	5.294	16.475	0.015	120.73
Landfin	3662	0.58	0.409	0.046	2.113
Econo	3662	9.837	0.726	8.254	11.519
Indus	3662	36.912	8.316	19.08	65.28
Open	3662	0.021	0.022	0	0.11
Finan	3662	2.038	0.978	0.834	6.118
Educa	3662	14.215	18.002	0	93.49
Urbani	3662	0.471	0.171	0.155	0.946

4. Results

4.1. Benchmark Regression Results

Table 3 reports the results of the regression of UIQ on LGLFD. Column (1) has not been added to the control variables; Columns (2)–(4) are the gradual inclusion of additional control variables based on Column (1). When no control variables are added, the *Landfin's* coefficient is −2.655 and is significantly negative at the 1% statistical level; the magnitude and significance of *Landfin*'s coefficient does not change significantly after the control variables are added. This result provides preliminary evidence that LGLFD is detrimental to UIQ and is consistent with the theoretical analyses presented in the previous section.

Table 3. Benchmark regression results.

	(1) *Innov*	(2) *Innov*	(3) *Innov*	(4) *Innov*
Landfin	−2.655 ***	−2.916 ***	−2.716 ***	−2.692 ***
	(−2.627)	(−2.991)	(−2.709)	(−2.697)
Econo		−13.820 ***	−13.845 ***	−14.673 ***
		(−4.131)	(−4.113)	(−4.372)
Indus		0.409 ***	0.397 ***	0.371 ***
		(3.119)	(3.074)	(2.751)
Open			−91.937 ***	−88.758 **
			(−2.654)	(−2.501)
Finan			−2.016 *	−2.491 **
			(−1.673)	(−2.034)
Educa				0.180 *
				(1.745)
Urbani				−2.233
				(−0.660)
_cons	1.992 ***	113.510 ***	120.727 ***	129.476 ***
	(2.726)	(3.957)	(3.934)	(4.150)
N	3662	3662	3662	3662
Adj. R^2	0.186	0.245	0.259	0.265
F	7.128	7.883	7.262	6.274

Note. T-statistics are shown in parentheses (clusters at the city level). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2. Robustness Tests

To ensure that the conclusions of this study remain stable due to changes in the model or the sample, the following five robustness tests were conducted. These include replacing the independent variable, replacing the dependent variable, lagging the independent variables, and shortening the time window with consideration of non-linear relationships.

4.2.1. Replacing the Independent Variable

Table 4, Columns (1) and (2) report the regression results after replacing the independent variables. In particular, Column (1) measures LGLFD using the ratio of land grant revenue to GDP, denoted by *Landfin2*, and Column (2) measures LGLFD using the natural logarithm of per capita land grant revenue, denoted by *Landfin3*. The results show that the regression coefficients remain significantly negative after changing the measure of LGLFD, which also indicates that LGLFD inhibits the improvement of UIQ.

Table 4. Robustness test regression results.

	(1) *Innov*	(2) *Innov*	(3) *Innov2*	(4) *Innov*	(5) *Innov*	(6) *Innov*	(7) *ln*(*Innov*)
$Landfin2$	−29.896 **						
	(−2.004)						
$Landfin3$		−1.859 ***					
		(−3.502)					
$Landfin$			−0.004 ***		−2.108 ***	−5.053 **	−0.136 ***
			(−3.930)		(−3.484)	(−2.186)	(−4.050)
L.$Landfin$				−3.844 ***			
				(−3.752)			
$Landfin^2$						1.241	
						(1.283)	
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3662	3662	3662	3383	2606	3662	3662
Adj. R^2	0.263	0.268	0.399	0.287	0.203	0.265	0.909
F	6.381	6.261	14.627	6.791	4.804	6.076	250.653

*** $p < 0.01$, ** $p < 0.05$.

4.2.2. Replacing the Dependent Variables

Table 4, Column (3) reports the regression results with replacement of the dependent variable. Here, we measure UIQ by per capitalisation of the innovation index (innovation index value per 10,000 people). The results show that the corresponding regression coefficients remain significantly negative after replacing the UIQ measure, consistent with the previous results.

4.2.3. Lagging the Independent Variable

Consideration of endogeneity due to potential reverse causation. Therefore, we lag LGLFD with the control variables by one period and re-run the regression. Column (4) of Table 4 reports the results for the lagged period. The lagged LGLFD is still found to be significantly negative, which does not change the conclusions of this paper.

4.2.4. Reduced Sample Time Period

The base regression in this study uses data from 2003–2016, considering that the central government's increasingly frequent adjustments to land policies after 2012 may have affected the results. Therefore, this study adjusts the sample to 2003–2012 and re-runs the regression. Column (5) of Table 4 reports the results of shortening the time period and shows that even if the time period is shortened to 2003–2012, the LGLFD still has a negative impact on the UIQ.

4.2.5. Consider Other Functional Forms

Another concern we have is that the effect of LGLFD on UIQ may be nonlinear. Usually, the idea of verifying the nonlinear relationship is that the quadratic term of the independent variable is also added to the regression equation. Therefore, we add the quadratic term of LGLFD ($Landfin^2$) to the equation of Equation (1) as well and regress it again. Column (6) of Table 3 reports the results after adding $Landfin^2$ and finds that $Landfin^2$ is not significant. This indicates that there is no non-linear effect of LGLFD on UIQ, which indicates that LGLFD does not have a non-linear effect on UIQ.

Further, we test this using a log-linear model, by re-running the regressions after taking logarithms of the UIQ. The results are reported in column (7) of Table 4, and it can be seen that the empirical results remain robust. It is noteworthy that when the innovation index is logarithmically transformed, the adjusted R-squared (Adj. R^2) increases sharply. This is because logarithmic transformation reduces the dispersion of the explanatory variable, diminishing the impact on regression results caused by excessively high innovation indices in certain cities (also reducing the weight of these cities), leading to smaller regression errors and enhancing the overall explanatory power of the regression. Overall, the findings of this study can be considered robust through the above five robustness tests.

4.3. Placebo Test

Furthermore, we test whether the findings of the correlation between LGLFD and UIQ are due to a range of other unobservable factors, such as omitted variables. Referring to Wang et al. [16] and La Ferrara et al. [68], this study adopts an indirect placebo test. This is done as follows: First, the data for the dependent variable are randomly assigned to each city for the regression, thus obtaining an incorrect estimate of $\hat{\beta}^{random}$; then the above process is repeated 1000 times, thus generating 1000 $\hat{\beta}^{random}$. Figure 2 depicts the distribution of these 1000 $\hat{\beta}^{random}$. It can be seen that the $\hat{\beta}^{random}$ distribution is near 0 and follows a normal distribution, consistent with the theoretical expectations of the placebo test.

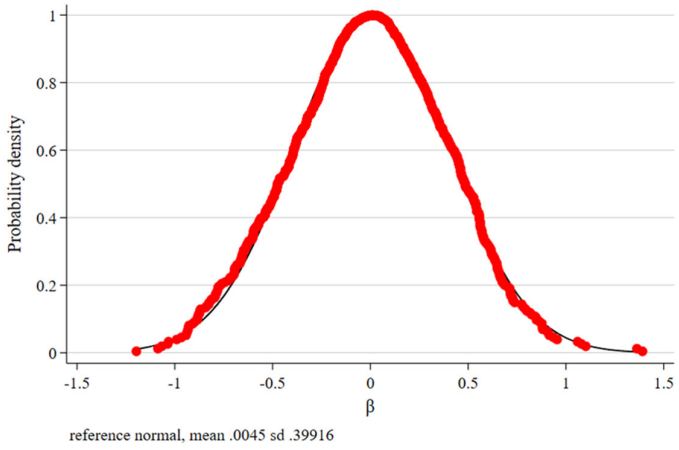

Figure 2. Placebo testing.

4.4. Mechanism of Impact

The negative impact of LGLFD on UIQ was tested previously. Next, we focus on the mechanism underlying the impact of LGLFD on UIQ. Three main mechanisms of action are discussed in this study: government spending preference (Hypothesis H2), financial efficiency (Hypothesis H3), and the institutional environment (Hypothesis H4).

4.4.1. Mechanism: Land Finance Development Inhibits Urban Innovation Quality by Influencing Government Spending Preferences

As analysed in the previous section (H2), LGLFD inhibits UIQ by affecting government spending preferences; that is, local governments reduce the proportion of science and

technology expenditures, which in turn reduces UIQ. To test this mechanism, this study uses the ratio of science and technology spending to public finance spending to measure government spending preferences (*expend_prefer*), which is then regressed on LGLFD. The regression results are reported in Column (1) of Table 5. The coefficient of *Landfin* is −0.002 and significantly negative at the 5% level. This suggests that an increase in LGLFD reduces the proportion of government expenditure on science and technology, a result consistent with the previous analysis. The relative weakening of local government investment in science and technology expenditures undoubtedly weakens the intensity of government support for innovative activities, which is not conducive to improving UIQ.

Table 5. Mechanism of impact.

	(1) Expend_prefer	(2) Financ_eff	(3) Inst_envir
Landfin	−0.002 **	−0.018 ***	0.038 ***
	(−2.133)	(−3.211)	(4.333)
Control	Yes	Yes	Yes
City fixed	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes
N	3662	3662	3651
Adj. R^2	0.919	0.336	0.260
F	412.404	55.536	113.977

*** $p < 0.01$, ** $p < 0.05$.

4.4.2. Mechanism: Land Finance Development Reduces Financial Efficiency and Inhibits Urban Innovation Quality

As the main body of innovation activities, enterprises often have large and sustainable capital needs that must be financed in the financial market due to the long-term and uncertain nature of innovation activities. Therefore, financial efficiency is an equally important factor that affects UIQ. As analysed in the previous section (H3), LGLFD increases financial risk, which reduces financial efficiency and access to financing for businesses, which in turn inhibits UIQ. This study uses the ratio of financial institutions' loan balances to financial institutions' deposit balances to measure financial efficiency (*Financ_eff*) to test this mechanism, which is then regressed on LGLFD (Table 5, Column (2) reports the regression results). The coefficient of *Landfin* is −0.018 and significantly negative at the 1% level. This suggests that LGLFD reduces financial efficiency. This result is consistent with the previous analysis, in which the loss of financial efficiency undoubtedly reduces the firms' access to external financing for innovation inputs and thus reduces UIQ.

4.4.3. Mechanism: Land Finance Development Deteriorates the Institutional Environment and Inhibits the Urban Innovation Quality

The institutional environment is also an important factor influencing innovation. As mentioned earlier (H4), a good institutional environment can reduce a firms' rent-seeking behaviour and allow them to spend more money on innovative production activities, thus improving their UIQ. We use ln (the number of regional corruption cases) to measure the institutional environment (*Inst_envir*), followed by a regression on LGLFD. Table 5, Column (3) reports the regression results. It can be seen that the coefficient of *Landfin* is 0.038 and significantly positive at the 1% level. This suggests that LGLFD exacerbates regional corruption and deteriorates the institutional environment, which is not conducive to UIQ.

4.5. Heterogeneity Analysis

We find that the LGLFD has a negative effect on UIQ. However, does this negative effect hold across all cities? In other words, is the effect of LGLFD on UIQ heterogeneous? The answer to this question, it is important to enable the rulers to tailor their policies to the local context. Therefore, we further examine the heterogeneous impact of LGLFD on UIQ.

We focus on three main perspectives: regional heterogeneity, city size heterogeneity and city administrative level heterogeneity. Figure 3 illustrates the spatial distribution of cities.

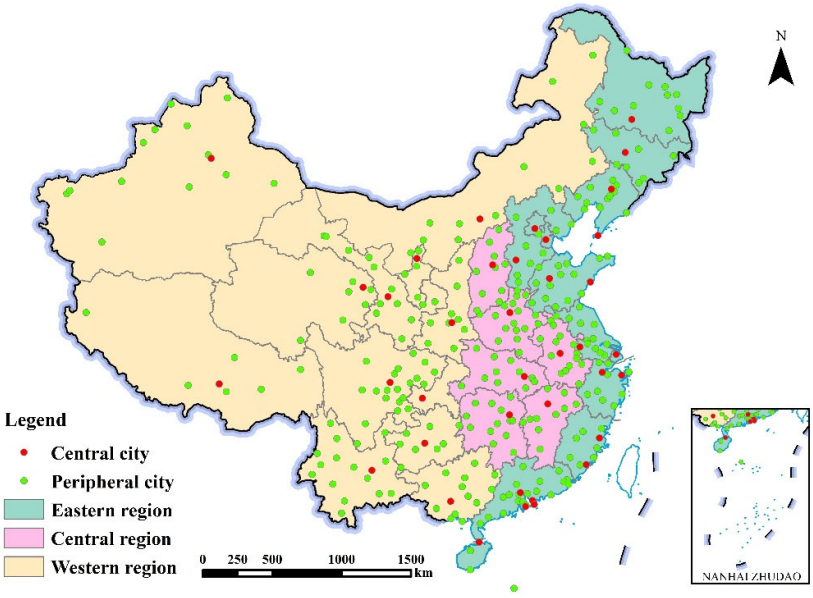

Figure 3. Spatial distribution of cities.

4.5.1. Regional Heterogeneity

China has a vast land area, and there is a big gap between the resource endowment, human environment and economic foundation of each region. Compared with the eastern region, the economic base of the central and western regions is relatively weak. Since 2003, in order to promote the development of the central and western regions and to reduce the gap between regions, the central government has allocated more construction land targets to the central and western regions, while reducing the construction land targets of the eastern regions. This approach results in different land use strategies in the East and the Midwest, and the impact of LGLFD on UIQ may differ in these two regions. Therefore, we split the sample into a Midwest sample and an East sample and then run separate regressions using Equation (1). Table 6 Columns (1) and (2) report the regression results. The regression results show that in the eastern region, LGLFD significantly reduced UIQ, whereas in the central and western regions, the negative effect of LGLFD on UIQ is not significant. This result is not difficult to understand. The central government has reduced the target of construction land in the eastern region, which makes urban construction land in eastern cities scarcer and indirectly raises the price of housing, which on the one hand attracts enterprises to invest their capital in the real estate industry, and on the other hand increases their operating costs, which is detrimental to the improvement of the UIQ.

Table 6. Empirical findings from heterogeneity analysis.

	(1) Eastern Regions	(2) Midwest Regions	(3) Big City Size	(4) Small City Size	(5) Central Cities	(6) Peripheral Cities
Landfin	−2.959 **	−1.864	−5.383 ***	−0.676 ***	−8.167 **	−1.08 **
	(−2.032)	(−1.461)	(−2.857)	(−2.723)	(−2.294)	(−2.502)
Control	Yes	Yes	Yes	Yes	Yes	Yes
City fixed	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes
N	1666	1996	1831	1831	460	3202
Adj. R^2	0.336	0.224	0.395	0.316	0.702	0.289
F	5.798	6.003	5.915	6.958	18.524	8.990

*** $p < 0.01$, ** $p < 0.05$.

4.5.2. Urban Size Heterogeneity

Innovation is essentially a knowledge-production process, and the UIQ cannot be improved without knowledge sharing and acquisition. In general, the larger the population, the easier it is to generate scale effects and the easier it is to share and acquire knowledge. At the same time, a larger population size also means a larger market, which can provide more opportunities for innovative firms. Therefore, the impact of LGLFD on UIQ can vary in cities of different sizes. We take the dichotomy of the number of city populations as the benchmark and consider cities above the dichotomy as the high city-size group and cities below the dichotomy as the low city-size group, and then run the regressions using Equation (1) separately. The results are reported in Columns (3) and (4) of Table 6. The results show that although LGLFD reduces UIQ in both the big and small city size groups, the reduction is much stronger in the big city size group than in the small city size group. This is due to the presence of scale effects that magnify the negative impacts of LGLFD on UIQ. That is, the larger the city, the more businesses are affected by the LGLFD and the more likely it is to have adverse consequences.

4.5.3. City Administrative Level Heterogeneity

In China, some cities have a higher administrative level and economic status and are usually subject to more favourable policies. For example, provincial capital cities generally account for about 50 per cent of the province's state-owned construction land target in planning. This huge gap in policy support will also lead to the effect of LGLFD on UIQ showing different effects. Therefore, we classify municipalities, provincial capitals and sub-provincial cities as central cities, and other prefecture-level cities as peripheral cities, and then conduct regressions using Equation (1), respectively. Table 6 Columns (5) and (6) report the regression results. LGLFD negatively affected UIQ in both central and peripheral cities, but the inhibitory effect of LFD on UIQ is stronger in central cities. This result is not surprising, as central cities tend to be more dependent on land finance than peripheral cities due to greater policy support and more building land targets, and for this reason the negative impact on UIQ is more severe.

5. Conclusions and Policy Implications

As an important way for governments to raise extra-budgetary funds in emerging market countries [69], LGLFD has improved the regional economy [20], but its long-term impacts remain highly controversial. In particular, the impact on UIQ is still not unanimously concluded. This is not only closely related to long-term economic growth, but also to the overall development strategy of the country. In view of this, this study analysed and empirically tested the effect of LGLFD on UIQ based on a sample of 264 cities in China from 2003 to 2016. The results showed that LGLFD significantly inhibited UIQ. Specifically, LGLFD reduces UIQ through three main channels: changing government spending preferences, reducing financial efficiency, and deteriorating the institutional environment. Further research found significant heterogeneity in the effect of LGLFD on UIQ. From a city-region perspective, LGLFD significantly reduces UIQ in the eastern region, whereas it has no effect in the central and western regions. From the perspective of city size, LFD significantly reduced UIQ in both large and small cities; however, this reduction effect was more prominent in large cities. From the perspective of the city's administrative level, the inhibitory effect of LFD on UIQ was stronger in central cities than in peripheral cities.

Accordingly, we make three policy recommendations. First, the central government should accelerate the reform of the fiscal and taxation system, reasonably adjust the ratio of tax revenue distribution between the central government and local governments, give local governments greater autonomy in fiscal and taxation, and gradually reduce the dependence of local governments on land-based fiscal revenues [16]. Second, the government should change the current GDP growth-oriented performance assessment standards, urge local governments to increase the proportion of innovation-related science and education financial expenditures, and transform economic development from the original "infrastructure

construction-driven" approach to an "innovation-driven" approach. Third, deepen the reform of the financial system and provide appropriate financial support to innovative enterprises to help them alleviate the financing difficulties they face in their innovative activities. Finally, accelerate the market-oriented reform of urban land grant, change the monopoly of local governments in the urban land grant market, reduce rent-seeking behaviour, and mitigate the adverse impact of distorted market mechanisms on innovation.

Although much work has been done in this study, it has some limitations. First, this study explored three mechanisms by which LGLFD affects UIQ; in fact, there may still be other mechanisms of influence, and future research should explore other possible mechanisms of influence. Second, under the pressure of competition championships, local governments may have an imitation effect, and LGLFD may show spatial correlation; however, due to the length of the article, this study does not consider the spatial spillover effect of LGLFD on UIQ, which will be the focus of our next work.

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