



Research article

Does rising land price promote the circulation industry development? An analysis of internet-based moderating effects

Yuanyuan Yin ^a, Zhang Liu ^{b,*}, Chen Gao ^{a,**}

^a The School of Finance, Hunan University of Technology and Business, Changsha, China

^b School of Economics and Trade, Hunan University of Technology and Business, Changsha, China

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ABSTRACT

With the rapid development of the Internet, digital technology is increasingly integrating into the modern circulation system. The influence mechanisms of land prices on the development of the circulation industry are gradually transforming. Using data from 104 major cities in China from 2003 to 2021, this study uses the panel two-way fixed effects model, moderating effects model and threshold regression method to examine the mechanisms by which land prices affect the circulation industry development and the moderating role of Internet development. The results show that elevated land prices significantly stimulate the growth of the circulation industry, leading to an expansion in the circulation industry scale, optimization of its structure, and enhancement of its facilities. The findings remain robust even after addressing endogeneity concerns and conducting various robustness tests. Moreover, the impact of high land prices on the circulation industry is more pronounced in small and medium-sized cities group as well as central region cities group. Real estate investment and industrial structure upgrading are the key channels through which high land prices promote the development of the circulation industry. Additionally, Internet development has a positive moderating effect on the promotion that high land prices stimulate the development of the circulation industry. Notably, only when Internet development surpasses a certain threshold that the promotional effect of land prices on the circulation industry development be fully realized. Based on the above conclusions, the government should continue to deepen the market-oriented reform of land elements, implement precise industrial policy support for the circulation industry and promote circulation digital transformation.

1. Introduction

Circulation is one of the four pillars of social reproduction, serving as the vital link connecting various fields, sectors, and chains within the national economy [1]. The circulation industry not only plays an essential role in the modern circulation system but also acts as the primary carrier to fulfill the fundamental and strategic functions of circulation. In the past decade, China's domestic trade circulation system has experienced rapid growth, with significant achievements realized through the reform of the circulation sector. The Report of the 20th National Congress of the Communist Party of China (CPC) highlighted the importance of "building an efficient

* Corresponding author.

** Corresponding author.

E-mail addresses: liuzhang0113@163.com (Z. Liu), gaoc9206@163.com (C. Gao).

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and seamless circulation system.” The development of the circulation industry has facilitated employment opportunities and contributed to narrowing the income and consumption gap between urban and rural areas [2]. Furthermore, economic growth also benefited from the development of the circulation sector [3]. Despite advancements, modernization in the circulation industry is still insufficient to meet the demands of high-quality economic development, with challenges like high costs and inefficiencies still constraining the industry’s progress [4,5]. Against the backdrop of efforts to expand domestic demand and promote consumption, coordinating and advancing the circulation industry development will be a crucial focus of China’s economic agenda in the upcoming phase.

Land plays a pivotal role as an element and fundamental carrier for circulation activities and industrial advancement [6]. The land price directly impacts the cost associated with circulation enterprises, significantly influencing urban real economy investment and circulation networks [7]. In recent years, Digital technology’s rapid advancement has profoundly reshaped the circulation sector [8]. Serving as an essential infrastructure, the Internet facilitates digital technologies’ continuous development and integration into global circulation networks. The Internet growth has spurred the emergence of novel circulation methods and business models, fostering diverse circulation patterns and instigating transformations within the circulation industry [9]. Against the background, the mechanisms by which land price influences the circulation industry development are gradually transforming. Elevated land prices foster innovation and evolution in business models, precipitating notable alterations in key aspects like circulation channels and the operational landscape [10]. These alterations have fueled an expanding market for the circulation industry while expediting the renovation and modernization of physical stores [11].

There is substantial research on the circulation industry, focusing primarily on its efficiency, development, and the challenges of digitization [12]. Notably, pertinent studies analyze factors influencing industry growth, highlighting the key role of policy, talent, and technological innovation [13,14]. In addition, finance has also contributed significantly to the development of the circulation industry [15]. The circulation industry stimulates the advancement of agriculture and manufacturing, enhancing residents’ income and consumption levels [16,17]. Concerning research on land prices, scholars have delved into the nature and influencing factors of land prices, emphasizing the impact of land price distortions on economic development [18,19]. Besides, scholars also explore how land prices influence economic development and manufacturing innovation [20]. After further summarizing the literature, we find that first, research on the impact of land prices on the manufacturing industry has been quite abundant. In contrast, studies related to the impact of land prices on the circulation industry have yet to be emphasized by scholars, and there is a certain research gap. Second, when analyzing the multidimensional factors of circulation industry development, the key element of land price is placed in a marginal position. The effect and mechanism of land price on the circulation industry development still need to be made clear. Third, existing studies have not encompassed land price, Internet and circulation industry development in the same research framework. Scholars have not explored the complex and changing interactions among the three and their potential influence mechanisms, leading to weak precision in government policy formulation and market regulation. Therefore, this study aims to fill the research gap by thoroughly exploring the effects and mechanisms of land prices on the development of the circulation industry and the moderating effects of the Internet.

This paper has three research objectives: Firstly, this study will analyze the effect of land price on the development of the circulation industry, aiming to reveal the important role of land factors in developing the circulation industry. Secondly, we will use industrial structure upgrading and real estate investment as mechanism variables to deeply explore the role of land price on the circulation industry development and further enrich the theoretical system of land economic effect and circulation industry driving factors. Finally, given the era of rapid development of the digital economy, this study will incorporate Internet development as a regulating variable. The moderating effect of the Internet on the relationship between land prices and circulation industry development is expected to be verified to provide a solid theoretical basis and practical guidance for constructing a unified national market and a new development pattern of double circulation in the digital era.

The theoretical and practical significance of this paper is both profound and paramount. At the theoretical level, this paper analyzes the intrinsic connection between land prices, the Internet and the circulation industry development, introducing a novel perspective for the theory of the development of the circulation industry. This paper also deepens the understanding of the complex mechanism of land price in economic activities, especially in the circulation industry development, and provides valuable theoretical contributions to the study of land economics and related fields. On the practical level, this study helps to improve the efficiency of land resource utilization and alleviate the contradiction between the limited urban land space and the growth of the circulation industry. The study’s conclusions will provide strategic support for constructing a modern circulation system and help build a unified national market and a new development pattern of double circulation, thus promoting high-quality economic development.

The marginal contribution of this paper lies in its meticulous filling of a notable research gap: Firstly, existing research predominantly focuses on the impact of land prices on the manufacturing sector. More studies need to examine the effects of land prices on the development of the circulation industry. This study expands the theoretical perspective of the development of the circulation industry from the perspective of land prices. The paper deeply explores the impact of land prices on the development of the circulation industry, filling the corresponding research gap. Secondly, this study advances the understanding of how land prices influence the circulation industry development, choosing industrial structure upgrading and real estate investment as mechanism variables and explaining the internal logic between the two from an industrial perspective. We enrich the research on the economic effects of land and the determinants of the circulation industry development. Thirdly, against the backdrop of the digital economy’s progression, this study incorporates the development of the Internet into the research framework, exploring the interactive mechanism between the Internet, land prices, and the circulation industry development. We explore the moderating and threshold effects of the Internet on the relationship between land prices and the development of the circulation industry to provide a theoretical basis for constructing a national unified market and establishing a “dual circulation” development pattern in the digital era. Lastly, most studies on the circulation

industry development typically adopt the national or provincial levels as their analytical scope. There needs to be more research specific to the city level. This study selects 105 major cities in China as the research object to provide empirical evidence at the city level for assessing the circulation industry development level and related inquiries.

The remainder of this study is organized as follows: Section 2 describes the literature review and research hypothesis. Section 3 outlines the methodology, which mainly introduces variables and model setting. Section 4 reports the empirical results and discussions. Section 5 includes the conclusions and policy implications of this study.

2. Literature review and research hypothesis

2.1. Land price and circulation industry development

Since the establishment of China's "bidding, listing and auctioning" system for commercial land in 2003, the economic significance of land has increasingly come to the forefront. Land plays an important role in fostering robust economic growth and facilitating the spatial expansion of cities [21]. Given the finite nature of land resources, urban land scarcity emerges as industries concentrate on a certain threshold [22]. As a result, the escalating land prices, driven by the tension between scarce land resources and the imperative of sustainable urban development, have persisted. Rising land prices signal greater development prospects and city market size, offering substantial business opportunities for circulation enterprises. The allure of high land prices attracts an influx of circulation firms into the market, propelling circulation infrastructure enhancements and catalyzing the circulation industry's overall expansion [23,24].

However, the escalation of land prices cascades into housing prices and wages. Employees seek higher wage compensations to uphold their standard of living. Consequently, a mismatch phenomenon between rising worker housing costs and the level of economic development is beginning to emerge, precipitating a scenario where wages surpass labor productivity, ushering in elevated production costs and notable pressure on enterprise profit margins [25]. To thrive and increase profitability in a brutally competitive market, enterprises will intensify their focus on self-innovation to navigate the substantial cost burdens. Concurrently, circulation enterprises continuously refine their business strategies and reconfigure resources, giving rise to novel circulation forms and models [26]. A paradigm of survival of the fittest is gradually taking shape among enterprises, fostering healthy competition within the circulation sector and enhancing their core competencies [27]. Circulation enterprises exhibiting robust business acumen and growth potential are being singled out. Thus, the circulation industry has been continuously restructured, which has contributed to the rapid development of the circulation industry [28].

The scarcity of land has prompted a continuous rise in land prices, which has accelerated the circulation industry's expansion and increased circulation enterprises' operating costs. To cope with the challenges, circulation enterprises actively innovate and continuously improve their competitiveness. In the process, the survival mechanism of the fittest continues to promote the restructuring and sustainable development of the circulation industry. Based on the above analysis, we propose the following Hypothesis.

Hypothesis 1. High land prices can promote the development of the circulation industry.

2.2. Land price, real estate investment, and circulation industry development

Rental rates and property values of commercial real estate, such as shopping streets and shopping centers, are on a continual upsurge due to the escalating land prices [29]. The upsurge of capital has piqued the interest of developers and investors, leading to an uptick in real estate and commercial property acquisitions, thereby bolstering overall social and real estate investments [30]. Simultaneously, the development model of the real estate industry is transitioning from incremental growth to stock development, causing a "softening" effect on real estate-associated industrial structure. With an extensive industry chain spanning diverse sectors, the real estate industry holds significant power in driving industrial activities [31]. Particularly in China, the real estate industry is a crucial link connecting diverse sectors, including manufacturing, social and living services. Consequently, real estate significantly correlates with various industries [32]. In particular, the symbiotic relationship between the real estate and consumer service sectors is increasingly intertwined and interdependent, bolstering the vibrancy and progress of service industries like commerce [33].

Real estate investment, a key indicator of real estate industry development, is a focal point of national macroeconomic regulation and continues to constitute a substantial proportion of total fixed asset investment [34]. The influx of substantial capital has increased market dynamism, with the real estate sector exerting a circular effect on the circulation industry in both demand-driven and supply-driven directions, driving the growth of wholesale, retail, and other circulation businesses [35]. Additionally, real estate investment generates a wealth effect that facilitates asset appreciation, increasing consumer purchasing power and stimulating new forms of consumption and circulation [36]. Real estate investment plays an important role in facilitating infrastructure development, such as roads and commercial districts, thereby enhancing the competitiveness and service capabilities of the circulation industry [37]. With people and resources gravitating towards real estate hubs, the peripheral area witnesses a boost in goods logistics, which fosters the holistic advancement of the circulation industry [38].

As a result, the increase in land prices has substantially increased the value of commercial real estate and stimulated investment enthusiasm in the real estate market. Thanks to the circular correlation effect of real estate, retail and other circulation industries continue to thrive. At the same time, the wealth effect of real estate investment enhances the purchasing power of consumers, giving rise to new forms of circulation. In addition, the acceleration of infrastructure construction brought about by real estate investment has enhanced the competitiveness and service capacity of the circulation industry, greatly promoting the development of the circulation industry. Based on the above analysis, we propose the following Hypothesis.

Hypothesis 2. High land price stimulates real estate investment to play an industry-driven effect, further promoting the development of the circulation industry.

2.3. Land price, industrial structural upgrading, and circulation industry development

Within the framework of a market economy, the scale of production and economic efficiency of enterprises are significantly influenced by land prices and the effectiveness of land utilization [39]. Land plays a pivotal role in shaping the industrial structure and fostering the high-quality development of the economy, as evidenced by the “Porter Effect” [40] and the “Sanctuary Effect” [41]. In response to escalating land prices, investors have adjusted their land use practices, transitioning from extensive to intensive land development methods [42]. Moreover, China’s policy directive of “suppressing the secondary industry and promoting the tertiary industry” has led to a continual shift of lower-yielding industrial land resources towards the higher-yielding commercial and service sectors [43]. Simultaneously, increased social resources have been injected into the commercial and service sectors through the dual-pronged land supply strategy of offering industrial land at lower prices and commercial land at premium prices [44]. The urban land use structure is characterized by a growing predominance of commercial and residential land use, displacing the traditional industrial sector [45]. As the growth rate of the secondary industry decelerates, a trend of “de-industrialization” is gradually emerging in urban areas, with the industrial landscape transitioning towards dominance by the service sector [46]. The Porter effect and resource allocation impact arising from industrial structure upgrades guide the reallocation of resources from traditional, high-energy-consuming sectors to emerging and high-value-added service industries and contribute to the growth of the circulation industry [47,48].

Technology is essential in promoting industrial structural upgrading [49]. Technological advancements facilitate the shift from old to new sources of energy, leading to a technological spillover effect within the circulation industry [50]. Particularly in recent years, the advancement of digital technologies has propelled the optimization of the circulation supply chain. Novel circulation forms and methods, such as new retail models and live e-commerce, are continuously emerging. Consequently, the circulation industry chain undergoes continuous restructuring, resulting in a notable reduction in intermediary segments and the time required. The spatial barriers hindering the development of the circulation industry have been substantially weakened. Through the integration of digital technologies, resources are effectively combined, leading to significant reductions in inventory costs and operating expenses for circulation companies [51]. The circulation process is becoming more efficient and seamless, driving continuous enhancements in circulation efficiency, thereby facilitating the development of the circulation industry.

High land prices have driven the transformation of the industrial structure into an efficient service sector, with industrial resources gradually being absorbed by the commercial and service sectors. The upgrading of industrial structure has profoundly transformed the circulation industry through technological spillover effects, especially the empowerment of digital technology. New retail, live e-commerce, and other new mode models of circulation continue to emerge. Circulation processes have been drastically downsized, and circulation efficiency has been significantly improved, thus contributing to the vigorous development of the circulation industry. Based on the above analysis, we propose the following Hypothesis.

Hypothesis 3. High land prices have contributed to the industrial structural upgrading to play the resource allocation effect and technology spillover effect, further improving the development level of the circulation industry.

2.4. Land price, Internet, and circulation industry development

Leveraging the power of the Internet, the circulation industry is well positioned to effectively contribute to facilitating dual circulation in the thriving digital economy landscape [52]. The Internet, with its inherent attributes of connectivity and immediacy, plays a crucial role in underpinning the fundamental functions of the circulation industry within the national economy. The circulation industry is one of the service sectors most closely intertwined with Internet advancement, which leads to extensive reorganization and integration of resource elements [53,54]. However, variations in Internet development levels may influence the impact of land prices on the circulation industry’s progress.

In earlier times, when Internet development was limited, circulation companies depended mostly on physical locations [55]. Urban hubs, characterized by higher business density and consumer footfall, are favoured by enterprises for setting up their operations [56]. Nonetheless, such prime locations often suffer from constrained land availability and soaring land prices, impeding circulation enterprises’ expansion and operational efficacy. Enterprises primarily depend on traditional sales and logistics channels, with land prices playing a relatively peripheral role in bolstering circulation sector development due to the limitations of existing infrastructure and distribution networks.

The progressive advancement and widespread adoption of Internet technology have brought about transformative changes in circulation enterprises. On the one hand, the connectivity and openness afforded by the Internet have expanded the range and diversity of corporate resources, consequently enhancing the efficiency of resource utilization and fostering innovation within enterprises [57]. On the other hand, the proliferation of Internet technologies has led to a substantial increase in the virtual accessibility of enterprises. The significance of physical geographic space has significantly diminished through the virtual expanse of information networks, enabling circulation activities to transcend urban centers and extend into a broader spectrum of virtual realms [58]. Companies must seek out new developmental spaces as land prices continue to soar. Therefore, the Internet presents opportunities and avenues for growth, and circulation enterprises have transcended geographical constraints and achieved expansive market coverage with the aid of the Internet [59].

Circulation enterprises use the Internet to realize virtual agglomeration, gradually diminishing the influence of geographical location on business operations and giving rise to industrial suburbanization [60]. With the aid of the Internet, companies are further reconfiguring their supply chains. Retail activities and the landscape of retail commerce are transforming [61]. Direct circulation channels are being expanded, leading to a significant enhancement in circulation efficiency [7]. Retail-oriented circulation companies are delving deeper into utilizing Internet resources for model innovation and scene expansion, continuously integrating online and offline resources. In particular, the e-commerce model, exemplified by live e-commerce, has brought about dramatic changes in the development environment and primary sales channels of the circulation industry [62,63]. E-commerce promotes enterprises to increase innovation and improves the logistics and distribution capacity of the circulation industry and the online service capacity [4]. As high land prices persist, circulation enterprises actively leverage Internet technology for innovation. Companies are optimizing resource allocation and enhancing operational efficiency, underscoring the strategic and leading role of the circulation industry in the modern industrial system. However, when Internet development is too high, there may be a bubble in Internet development, weakening the role of land prices in promoting the circulation industry development [64].

In exploring the impact of land prices on the development of the circulation industry, the Internet has undoubtedly played a key role as a moderating variable. Initially, with the low level of Internet development, the role of land prices in promoting the circulation industry was relatively limited. High land costs limit the expansion of circulation enterprises, and the advantages of the Internet have yet to be effectively utilized. Circulation enterprises are still mainly dependent on the traditional mode of operation. However, with the popularization and in-depth application of the Internet, the unique connectivity and openness have brought unprecedented changes to the circulation industry. Circulation enterprises use Internet technology to break geographical restrictions and optimize resource allocation. Land prices' role in driving the circulation industry's development has also increased.

In summary, the degree of Internet development is a moderating factor in the correlation between land prices and the evolution of the circulation industry, with this moderating impact being non-linear. Only when Internet development surpasses a specific threshold can the stimulatory influence that elevated land prices on circulation industry development be maximally realized. Based on the above analysis, we propose the following Hypotheses.

Hypothesis 4A. The Internet development level has a moderating effect on the relationship between land price and the development of the circulation industry.

Hypothesis 4B. The Internet development level has a threshold effect on the relationship between land price and the development of the circulation industry.

3. Methodology

3.1. Sample selection and data sources

This study selected 104 major cities in China from 2003 to 2021 for the test.¹ The commercial land prices were sourced from the China Land Price Information Service Platform's dynamic monitoring of land prices in 104 major cities over the specified time frame. These cities are distributed across 30 provincial-level administrative regions in mainland China (excluding the Xizang Autonomous Region), encompassing four municipalities directly under the central government, 26 provincial capitals, and 74 key cities. Based on the geographic location of their provincial administrative regions, the 104 cities were classified into three regional groups: eastern, central, and western regions, with the eastern cities comprising 50 %, central cities 34.6 %, and western cities 15.4 % of the total. Furthermore, cities were stratified into first-, second-, third-, fourth-, and fifth-tier cities according to their population and economic significance. Specifically, four first-tier cities, 42 s-tier cities, 28 third-tier cities, 22 fourth-tier cities, and eight fifth-tier cities are among the studied samples. Data on other pertinent variables were primarily extracted from the 2004–2022 China Urban Statistical Yearbook and relevant provincial and municipal statistical yearbooks. Missing values were addressed through linear interpolation, resulting in a dataset of 1976 valid samples for analysis.

3.2. Variable description

3.2.1. Explained variable

The level of development of the circulation industry (Cir). We gauge the development level of the circulation industry across three dimensions: scale, structure, and facilities [14,65]:

The scale of the circulation industry (Cir_1). The scale of the circulation industry serves as a key indicator reflecting the industry's development level, showcasing its resource allocation and value creation capabilities [66]. Therefore, we utilize the Total Retail Sales of Consumer Goods Per Capita as a metric to assess the scale of the circulation industry.

The structure of the circulation industry (Cir_2). The structure of the circulation industry plays a crucial role in influencing national economic development and industrial structural upgrades. This study considers the proportion of total sales from the wholesale and retail industry to GDP and the proportion of urban employment in the circulation industry to total urban employment to gauge the industry's structure [67].

¹ Land price data published on the China Land Price Information Service Platform are only available until 2021, so land price data after 2021 are not included in the study.

The facilities of the circulation industry (*Cir₃*). Circulation facilities, such as logistics nodes and circulation centers, are vital elements ensuring the efficient flow of the national economy and supporting the industry’s growth [68]. Thus, we select the number of wholesale and retail trade enterprises above the quota and the area of real urban roads at the end of the year to evaluate the facilities aspect.

As one of the objective assignment methods, the Entropy method can objectively reflect the degree of discrete and the amount of information of the data itself, avoiding the influence of subjective weight allocation. The Entropy method is scientific, reasonable, highly operational, widely applicable to the multi-indicator evaluation system, and can effectively ensure the accuracy and comprehensiveness of the evaluation results. Therefore, to establish a weighted evaluation index system, we apply the Entropy method to assign weights to the development level of the circulation industry in the 104 major cities in China. The specific index system and corresponding weighting results are shown in Table 1 below.

3.2.2. Explanatory variable

The explanatory variable of the model in this study is the land price (*Pcl*). Circulation land is classified as commercial service land, so commercial service land prices are utilized to represent land prices [69]. Commercial land prices are seen as a reflection of market competition and are governed by an inherent price mechanism. They offer a more accurate reflection of market supply and demand dynamics, facilitating the regulation of resource allocation and enhancing resource utilization efficiency.

3.2.3. Control variables

We further select the factors that may affect the circulation industry’s development level [70,71]. The control variables are as follows: (1) Economic development (*Pgdp*): Economic development is closely linked to market demand and consumption capacity, exerting a significant influence on the scale and advancement of the circulation industry. Hence, per capita Gross Domestic Product (GDP) chooses economic development as a control variable. (2) Population size (*Pop*): The size of the population directly impacts the market size and growth potential of the circulation industry. Therefore, population size is chosen as the control variable and is expressed by the year-end resident population. (3) Technology level (*Tec*): Advancements in technology can enhance circulation efficiency and reduce operational costs. Hence, the technology level is selected as a control variable, expressed as the logarithm of the number of students enrolled in general secondary schools [72]. (4) R&D and innovation (*Innov*): R&D and innovation play a crucial role in promoting technological and model innovation within the circulation industry, enhancing its competitiveness. Therefore, R&D innovation is chosen as a control variable and expressed by the logarithm of the number of domestic invention patent applications received. (5) Government support (*Gov*): Government financial and policy support significantly impact the external environment and conditions for the circulation industry’s development [73]. Hence, government support is chosen as a control variable and is expressed by the logarithm of the expenditure in the general budget of local finance. (6) Openness (*Open*): The extent of openness to the external environment influences capital investment in the circulation industry and the level of competition. Thus, the degree of openness is used as a control variable, expressed as the logarithm of the amount of foreign investment used in the year.

3.2.4. Mechanism variables

(1) Industrial structure upgrading (*Ind*). With the further advanced industrial structure, the service-oriented industrial structure has become a prominent feature of industrial structure upgrading. The proportion of added value of the service industry in GDP has emerged as a crucial indicator reflecting the progress in industrial structure upgrading. This paper uses the ratio of the added value of the service industry in GDP as a metric for assessing the upgrading of industrial structure [74]. (2) Real estate investment (*Invest*). Land prices and real estate investment are closely intertwined, with a significant correlation between real estate and economic development. We utilize the amount of real estate exploration investment to measure real estate investment [75].

3.2.5. Moderator variable

Internet development (*Inter*). Drawing from prior research and leveraging urban data availability, we use the ratio of Internet broadband access subscribers to the resident population to measure the level of Internet development [76].

The type, sign, and implication of each variable are described in Table 2 below.

Table 1
Circulation industry development level evaluation indicator system.

First-level indicators	Second-level indicators	Indicators measurement methodology	Weight
The scale of the circulation industry	The total retail sales of consumer goods per capita	The total retail sales of consumer goods/Total population at the end of the year	0.1984
The structure of the circulation industry	Total sales of wholesale and retail trade above the limit as a share of GDP	Over-limited wholesale and retail trade total merchandise sales/GDP	0.2046
	Employment in urban units in the circulation sector as a proportion of employment in urban units	(Number of employees in wholesale and retail trade + transportation, storage, post and telecommunications + accommodation and catering)/number of employees per unit at the end of the year	0.2300
The facilities of the circulation industry	Number of circulation enterprises	Number of wholesale and retail trade enterprises above the quota	0.1713
	Road area	Real urban road area at the end of the year	0.1957

3.3. Model establishment

Before the empirical testing, we conducted a Hausman test to select the best model. The results show a p-value of 0.0000, indicating a significant correlation between individual effects and explanatory variables. The finding directly supports the applicability of the fixed effects model over the random effects model, as the random effects model assumes that individual effects are uncorrelated with explanatory variables. Furthermore, the fixed effects model has the advantage of controlling for individual-specific characteristics that may confound the relationship between land prices and circulation industry progress, thus improving the accuracy and reliability of our estimates. Given that temporal heterogeneity cannot be ignored, we adopt a two-way fixed-effects model to fully capture and control the fixed effects at the province and temporal levels to ensure that the estimation results are more accurate to reality. Thus, to examine the mechanism and hypotheses, we employ urban data to examine the impact of land prices on the progress of the circulation industry. Subsequently, we construct the following panel two-way fixed-effects model to conduct empirical analysis:

$$Cir_{it} = \alpha_0 + \beta_1 Pcl_{it} + \eta_n Controls_{it} + \lambda_i + \mu_t + \varepsilon_{it} \tag{1}$$

where *Cir* is the level of development of the circulation industry, *Pcl* is the price of land, *Controls* represents a series of control variables that may affect the level of development of the circulation industry, λ_i and μ_t denote area and time fixed effects, ε_{it} denotes the randomized disturbance term, *i* and *t* are area and year.

3.4. Descriptive statistics

The descriptive statistics of the variables are shown in Table 3 below. The results show that the mean value of the circulation industry development is 0.1906, suggesting that the development of the circulation industry is currently at a relatively low level, aligning closely with real-world observations. The standard deviation is 0.0811, with minimum and maximum values of 0.0607 and 0.8390, respectively, highlighting variations in the circulation industry development across different cities. Furthermore, the average land price level is 0.5262, with minimum and maximum values of 0.0238 and 5.8390, indicating significant diversity in land prices across different cities.

4. Results and discussions

4.1. Benchmark regression results

Table 4 reports the results of the impact of land price on the level of development of the circulation industry and its subdimensions. All regressions include year-fixed effects and city-fixed effects. Column (1) contains only the explanatory variable of land price. Column (2) adds further control variables based on column (1). Columns (3)–(5) show the empirical regression outcomes concerning the influence of land prices on the size (*Cir₁*), structure (*Cir₂*), and facilities (*Cir₃*) of the circulation industry, respectively. The results show that the coefficient of land price on the development level of the circulation industry is 0.032 at the 1 % significance level, which is a significant positive effect. Specifically, the level of circulation industry development is expected to increase by 0.032 units when the price of land per square meter increases by 10000 yuan. The findings reveal a strong link between land price and circulation industry development, indicating that the optimal allocation of land resources can effectively promote the prosperity of the circulation

Table 2
Variable description.

Variables types	Variables	Sign	Implication	Unit
Explained variable	The level of development of the circulation industry	<i>Cir</i>	The level of development of the circulation industry	/
explanatory variable	Land Price	<i>Pcl</i>	Commercial land price	Million yuan/square meter
Mechanism variables	Industrial structure upgrading	<i>Ind</i>	Value added of service sector/GDP	%
	Real estate investment	<i>Invest</i>	The amount of real estate exploration investment	Billions of yuan
Moderator variable	The level of Internet development	<i>Inter</i>	Number of international Internet users/number of resident population	%
Instrumental variable	Topographic slope	<i>Tops</i>	The logarithm of (average slope of urban topography * year)	/
Control variables	Economic development	<i>Pgdp</i>	Per capita gross domestic product	Ten thousand yuan/person
	Population size	<i>Pop</i>	The year-end resident population	ten million people
	Technology level	<i>Tec</i>	The logarithm of the number of students enrolled in general secondary schools	Million people
	R&D and innovation	<i>Innov</i>	The logarithm of the number of domestic invention patent applications received	Item
	Government support	<i>Gov</i>	The logarithm of the expenditure in the general budget of local finance	Million yuan
	Openness	<i>Open</i>	The logarithm of the amount of foreign capital used in the year.	Million dollars

Table 3
Descriptive statistics results of variables.

Variables	Observation	Mean	Std.Dev.	Min	Max
<i>Cir</i>	1976	0.1906	0.0811	0.0607	0.8390
<i>Pcl</i>	1976	0.5262	0.6974	0.0238	5.8930
<i>Pgdp</i>	1976	6.8070	14.876	0.4134	642.1762
<i>Pop</i>	1976	0.5569	0.4047	0.0820	3.4160
<i>Tec</i>	1976	3.1957	0.6539	1.0543	5.2576
<i>Innov</i>	1976	6.6718	2.0790	1.0986	11.9838
<i>Gov</i>	1976	4.9886	1.3050	0.8910	9.0397
<i>Open</i>	1976	1.5538	1.8102	−6.7254	5.7304
<i>Ind</i>	1976	0.4399	0.1072	0.1105	0.8957
<i>Invest</i>	1976	4.9865	7.7613	0.0000	100.4957
<i>Inter</i>	1976	0.2441	0.2363	0.0012	3.6635

Sources: China Land Price Information Service Platform, China Urban Statistical Yearbook, statistical yearbooks of relevant provinces (cities and autonomous regions).

Table 4
The effect of land price on circulation development levels.

Variables	(1)	(2)	(3)	(4)	(5)
	<i>Cir</i>	<i>Cir</i>	<i>Cir</i> ₁	<i>Cir</i> ₂	<i>Cir</i> ₃
<i>Pcl</i>	0.038*** (21.084)	0.032*** (16.668)	0.006*** (16.668)	0.014*** (16.668)	0.012*** (16.668)
<i>Pgdp</i>		0.000 (0.528)	0.000 (0.528)	0.000 (0.528)	0.000 (0.528)
<i>Pop</i>		0.061*** (7.095)	0.012*** (7.095)	0.027*** (7.095)	0.022*** (7.095)
<i>Tec</i>		0.026*** (6.619)	0.005*** (6.619)	0.011*** (6.619)	0.010*** (6.619)
<i>Innov</i>		0.002* (1.861)	0.000* (1.861)	0.001* (1.861)	0.001* (1.861)
<i>Gov</i>		−0.003 (−1.584)	−0.001 (−1.584)	−0.001 (−1.584)	−0.001 (−1.584)
<i>Open</i>		−0.002*** (−2.856)	−0.000*** (−2.856)	−0.001*** (−2.856)	−0.001*** (−2.856)
Constant	0.137*** (53.598)	0.023 (1.534)	0.005 (1.534)	0.010 (1.534)	0.008 (1.534)
City fixed	YES	YES	YES	YES	YES
Year fixed	YES	YES	YES	YES	YES
Observation	1976	1976	1976	1976	1976
R ²	0.632	0.656	0.656	0.656	0.656

Note: The symbols ***, **, and * represent statistical significance levels of 1 %, 5 %, and 10 %, respectively. The values in () are the t-values of the corresponding parameters. Same as below.

industry. The result suggests a theoretical contribution by expanding our understanding of the relationship between land prices and circulation industry development, emphasizing the role of land resource allocation in fostering circulation industry growth. In addition, the impacts of land prices on the circulation industry’s size, structure, and facilities are all notably positive at the 1 % significance level. The finding suggests that increasing land prices contributes to expanding the scale, optimizing the structure, and enhancing the facilities of the circulation industry, thereby fostering circulation development. Practically, the finding underscores the need for policymakers to consider land price adjustments as a tool for stimulating circulation industry growth and guiding urban development strategies. Hypothesis 1 is proved. This study’s results align with the studies [77,78]. In response to the ongoing escalation of land prices, companies are grappling with mounting cost pressures, compelling them to explore new survival strategies and adjust their business strategies and resource allocation practices. By intensifying their focus on independent innovation and maximizing the efficient utilization of land resources, organizations are driving the sustainable development of the circulation industry [79].

Among the control variables, the estimated coefficients of *Pop*, *Tec*, and *Innov* are all significantly positive, while the estimated coefficient of *Open* is negative. The results show that population size, technological progress, and innovation all contribute positively to the development of the circulation industry. In contrast, a higher degree of openness may act as a hindrance. The finding highlights a theoretical nuance regarding the mixed effects of openness on circulation industry development, providing a more detailed understanding of how external factors influence the sector. The result corroborates the findings of a great deal of the previous work in related research. Specifically, after entering the Chinese circulation sector, foreign-invested and foreign circulation enterprises wield significant pricing power and continue to leverage their advanced technology and management expertise to extract profits, impacting the viability of local firms and intensifying competitive pressures on them [80]. The robust entry of foreign enterprises into China has

threatened the circulation industry chain to some extent, resulting in a suppressive effect on developing China’s circulation industry [81].

4.2. Endogeneity tests

4.2.1. Two-stage least squares method

The relationship between land prices and circulation industry development may be subject to endogeneity issues such as reverse causality, omitted variable bias, and measurement errors, leading to biased estimates. First of all, there may be a potential for reverse causality. The profitability generated by the circulation industry could incentivize investors to increase their investments in commercial real estate. Subsequently, the expansion of commercial real estate investments may drive up land prices, thereby creating an inverse relationship between the development of the circulation industry and land prices. Furthermore, despite including a series of control variables in this study, it is impossible to account for all factors influencing the development of the circulation industry. Finally, potential endogeneity issues in this study could arise from measurement methods and errors in land prices and the development of the circulation industry.

Two-stage least squares method is commonly used to solve the endogeneity problem. By introducing exogenous variables that are correlated with the endogenous explanatory variables but uncorrelated with the error term, the two-stage least squares method can effectively solve the endogeneity problem and provide reliable and efficient parameter estimation. The two-stage least squares method is widely used in multiple fields, applicable to different data types and flexible in its implementation. In empirical studies, the rational selection and validation of instrumental variables is the key to ensuring the accuracy of the estimation results. Based on the analysis above, this study aims to address the estimation bias resulting from endogeneity by identifying instrumental variables for land prices. The instrumental variables must exhibit a strong correlation with land prices while remaining uncorrelated with the development of the circulation industry. This study selects the average topography slope of each city as the instrumental variable for land prices [82]. Previous research demonstrated that topography slope influences land transfer revenue, indicating a high correlation with land prices [83]. Given that topography slope is a natural feature with limited potential impact on circulation development, serving as a suitable and strictly exogenous instrumental variable. However, as the topographic mean slope data is time-invariant, it cannot be directly incorporated into the two-way fixed effects regression. Therefore, we transform the average slope of the topography by multiplying it by the year and taking the logarithm, resulting in the creation of the instrumental variable *Tops.y*. Subsequently, the two-stage least squares method is employed for estimation and the obtained results are shown in Table 5 below.

Column (1) reports the two-stage least squares (2SLS) regression results with instrumental variables. The finding indicates a significant and positive relationship between the average slope of city topography and land prices, as evidenced by the validation through the Kleibergen-Paap rk LM test and the Cragg-Donald Wald F test. These tests confirm a strong correlation between the instrumental and explanatory variables. Notably, the number of instrumental variables aligns with the number of endogenous variables, demonstrating model validity. Thus, the effectiveness of the instrumental variables was proved while the findings of the benchmark regression were reinforced. By employing instrumental variables to address endogeneity issues, the estimated coefficient for land prices increased from 0.032 to 0.038. The change in the coefficient suggests a significant downward bias in the initial estimation results due to endogeneity concerns, emphasizing the necessity of utilizing 2SLS for estimation.

4.2.2. Dynamic panel estimation method

The Systematic Generalized Method of Moments (SYS-GMM) has significant advantages in assessing exogeneity of instrumental

Table 5
Endogeneity test results.

Variables	(1)	(2)	(3)
	2SLS	SYS-GMM	Control variables lagged one period
	<i>Cir</i>	<i>Cir</i>	<i>Cir</i>
<i>Pcl</i>	0.038** (2.255)	0.003** (2.250)	0.026*** (13.810)
<i>L.Cir</i>		0.986*** (33.624)	
<i>Controls</i>	YES	YES	
<i>L.Controls</i>			YES
City fixed	YES	YES	YES
Year fixed	YES	YES	YES
Kleibergen-Paap rk LM statistic	16.132*** [0.0001]		
Cragg-Donald Wald F statistic	22.895 [16.38]		
Hansen/Sargan		[1.000]	
AR(1)		0.000	
AR(2)		0.298	
Observation	1976	1768	1872
R ²	0.813		0.680

Note: Values in [] are p-values of the corresponding test statistics. Notably, the value of the Cragg-Donald Wald F statistic in [] is the critical value at the 10 % level of the Stock-Yogo test.

variables and solving endogeneity problems in dynamic panel models. Although Differential GMM (D-GMM) can deal with part of the endogeneity problem, it may lead to loss of information based on differential data only and face the problem of weak instrumental variables. In contrast, by combining the information from difference and level equations, SYS-GMM improves the estimation efficiency and accuracy, can effectively deal with the endogeneity problem, and reduces the estimation bias by introducing appropriate instrumental variables. Meanwhile, SYS-GMM can also verify the validity of instrumental variables through an exogeneity test and over-identification test to ensure the credibility of the results. Therefore, to further assess the exogeneity of instrumental variables and address endogeneity issue effectively, we construct a dynamic panel model and employ SYS-GMM for estimation. The model is shown below:

$$Cir_{it} = \alpha_0 + \varphi L.Cir + \beta_1 Pcl_{it} + \eta_n Controls_{it} + \lambda_i + \mu_t + \varepsilon_{it} \tag{2}$$

where $L.Cir$ is the lag 1 period of the explanatory variable Cir , the rest of the alphabet and signs have the same meaning as in model (1). $L.Cir$ was treated as an endogenous variable in the dynamic panel model, with $Tops_y$ and $L_2.Cir$ serve as instrumental variables while others are considered exogenous. The estimation results, presented in column (2) of Table 5, indicate a p-value of 1.000 for Hansen’s test, suggesting that the hypothesis of over-identification of instrumental variables cannot be rejected, affirming the validity of instrumental variable selection. Through a residual serial correlation test, the p-value for AR (1) is 0.000, while for AR (2) is 0.298. The results reveal first-order serial correlation in the residuals but not second-order serial correlation, indicating the absence of serial correlation in the error term of the original model. The estimated coefficients of $L.Cir$ and Pcl are both significantly positive, indicating a long-term cumulative impact of circulation industry development and supporting the role of land prices in fostering the development of the circulation industry.

4.2.3. Control variables lagged one period

To address the possible endogeneity of the control variables, we lagged all control variables by one period. By lagging the control variables by one period, reverse causality will be weakened, and the control variables’ long-run effects will be captured. Lagging the control variables will improve the fit and explanatory power of the model and further enhance the model’s ability to infer causality. Column (3) of Table 5 shows the regression results after lagging the control variables by one period. The analysis demonstrates that the regression coefficient associated with land price remains notably positive. The outcome reinforces the finding that elevated land prices play a crucial role in stimulating the advancement of the circulation sector.

In this part, we use the two-stage least squares method and SYS-GMM to effectively address the endogeneity between land prices and circulation industry development by introducing the average slope of terrain as an instrumental variable for land prices. Meanwhile, the control variables are lagged by one period to further weaken the reverse causality. The methods enhance the accuracy and reliability of model estimation and enrich the theoretical understanding of land and circulation economics. In practice, the conclusions provide a scientific basis for local governments to formulate land policies and circulation industry development plans, which help to promote the urban economy’s prosperity.

Table 6
Robustness test results.

Variables	(1)	(2)	(3)
	Replacement of measurement method	Elimination of outlier effects	Exclusion of the impact of administrative factors
	<i>Cir</i>	<i>Cir</i>	<i>Cir</i>
<i>Pcl</i>	0.511*** (14.515)	0.037*** (12.564)	0.046*** (20.111)
<i>Pgdp</i>	0.000 (0.586)	0.003*** (9.010)	0.000 (0.408)
<i>Pop</i>	1.630*** (10.273)	0.023** (2.389)	0.034*** (4.302)
<i>Tec</i>	0.312*** (4.303)	0.019*** (5.573)	0.021*** (6.046)
<i>Innov</i>	0.028 (1.234)	0.006*** (6.027)	0.004*** (4.049)
<i>Gov</i>	−0.070* (−1.751)	0.004** (2.107)	−0.002 (−1.006)
<i>Open</i>	−0.035** (−2.511)	−0.004*** (−5.251)	−0.003*** (−4.118)
Constant	1.556*** (5.601)	0.018 (1.412)	0.036*** (2.807)
City fixed	YES	YES	YES
Year fixed	YES	YES	YES
Observation	1976	1976	1900
R ²	0.559	0.685	0.698

4.3. Robustness tests

The result of the benchmark regression shows that the increase in land price helps improve the circulation industry's development level. To test the reliability of the results, we conduct a series of robustness tests. Table 6 reports the results of the specific robustness tests.

4.3.1. Replacement of measurement method

In the previous section, the circulation industry's development level was measured using the Entropy method. Principal Component Analysis (PCA) is a widely used multivariate statistical analysis method that can effectively extract a few uncorrelated principal components from multiple original variables. PCA can retain most of the information of the original data, and it can also fully reflect the development of the circulation industry. Therefore, to eliminate the model estimation error caused by the measurement method, we changed the measurement method of the circulation industry development level. PCA was employed to assess the development level of the circulation industry, and the resulting measurements were substituted into the model for regression analysis to evaluate the robustness of the benchmark regression results. Column (1) of Table 6 outlines the regression results after altering the explanatory variables' measurement method. Notably, the estimated coefficient of the core explanatory variables is 0.511, which is significant at the 1 % significance level. The results show that even if the variable measurement method is replaced, the estimated coefficient is still significantly positive, and the model's conclusions are still robust. The reliability of the entropy method is further demonstrated. The results indicate that the model conclusions are not affected by the choice of a particular measure, which enhances the generalizability and applicability of the study's conclusions.

4.3.2. Elimination of outlier effects

The outliers in the data may adversely affect the statistical results and lead to biased estimation. The effect of outliers on the regression results can be effectively reduced by shrinking the tail treatment, improving the accuracy and reliability of data analysis. Therefore, to address the influence of potential outliers, a 5 % reduction in data across all variables was undertaken while considering the data characteristics. The regression outcome in column (2) of Table 6 demonstrates that the estimated coefficient of land price remains significantly positive at the 1 % significance level with a coefficient value of 0.037, indicating that the increase in land price still significantly contributes to the development of the circulation industry. The outcome indicates that the direction and significance of the coefficients remain consistent with the benchmark regression results after considering the effect of possible outliers in the variable data. This result further proves that the benchmark regression results are robust.

4.3.3. Exclusion of the impact of administrative factors

Differences in administrative levels are often accompanied in policy preferences and resource allocation differences, which may significantly impact the circulation industry's development. Therefore, excluding the sample of municipalities from the study helps to exclude the interference caused by the differences in administrative levels so that the estimation results more purely reflect the impact of land prices on the circulation industry development. The 104 cities included in this study do not fall within the same administrative echelon. The four municipalities of Beijing, Tianjin, Shanghai, and Chongqing possess political privileges akin to provinces, distinguishing them from other prefecture-level cities [84]. Given the potential bias in estimation results due to the inclusion of municipalities, an analysis excluding these municipalities was conducted for robustness testing. The regression result in column (3) of Table 6 reveals that the coefficient of the explanatory variable is 0.046, which is still significantly positive, further supporting the baseline regression result that higher land prices will promote the development of the circulation industry. The results indicate that the promotion effect is independent of administrative factors, and also indicate that the estimation results of this paper have good robustness.

The robustness test of this paper verifies the robustness of the promotion effect of land price increase on circulation industry development by replacing the variable measurement method, eliminating the effect of outliers and removing the effect of administrative factors. The robustness test enhances the reliability and generalizability of the study's conclusions and provides policymakers with more solid empirical support. The methodology used for the robustness test in this paper also provides a valuable reference for similar economic analyses.

4.4. Mechanism tests

The analysis above indicates that higher land prices play a crucial role in fostering the advancement of the circulation industry. Therefore, we further analyze the influence mechanism that how land price affects the development of the circulation industry. In mediated effects analysis, the two-step method has significant advantages over the traditional three-step method. By directly estimating the indirect effects, the two-step method can effectively avoid the endogeneity problem, improve statistical efficiency, and have a wider scope of application. This paper uses the two-step method to directly test the mediation effect, avoiding the complexity of multiple steps and hypothesis testing in the three-step method. According to the specification for the empirical examination of the two-step method, we construct a regression model incorporating mechanism variables and explanatory variables to probe into the internal mechanism through which land prices influence the development of the circulation industry [85]. The specific model is as follows:

$$Med_{it} = \alpha_0 + \gamma_1 Pcl_{it} + \eta_n Controls + \lambda_i + \mu_t + \varepsilon_{it} \quad (3)$$

Among them, *Med* is the mechanism variable, which represents the two mechanism variables of real estate investment (*Invest*) and industrial structure upgrading (*Ind*), respectively. γ_1 is the parameter of the bias effect of land price on the mechanism variables, and the rest of the parameters are the same as the regression model (1).

The results of the mechanism test are presented in Table 7. Column (1) displays the results of the benchmark regression, while Columns (2) and (3) present the regression outcomes for the explanatory variables and the two mechanism variables, respectively. As observed from the results, the estimated coefficients of the mechanism variables consistently exhibit positive significance at the stringent 1 % level, with distinct magnitudes observed for the effects of land price on the ratio of secondary to tertiary industry output. Specifically, our analysis predicts that for every 10000 yuan/square meter increase in land prices, the ratio of secondary industry output to tertiary industry output will increase by 0.007 percentage points. While this increment may be insignificant in numerical terms, the coefficient highlights the positive role of land prices in facilitating the economy’s structural transformation to a service-oriented tertiary sector. The upgrading of the industrial structure has facilitated optimized resource allocation and a spillover effect of technology, enabling a seamless flow of diverse production factors and resources into the circulation industry. The results match those observed in earlier studies [88]. The circulation industry chain has been reorganized, further fueling the continuous development of the sector.

Furthermore, the analysis reveals that for every 10000 yuan/square meter augmentation in land prices, a commensurate increase of 274.2 billion yuan in real estate development investment is expected. The pronounced positive correlation underscores the criticality of land price appreciation as a fundamental driver of real estate investment growth. The results suggest that higher land prices can invigorate real estate investment and facilitate the upgrading of industrial structures, aligning with the conclusions drawn by some scholars [86,87]. The mechanism test enriches the interdisciplinary research between land economics and circulation economics, emphasizing the micro-mechanism through which land prices, as market signals, impact the development of the circulation industry via real estate investment and industrial structural upgrading. According to the previous theoretical analysis, real estate is closely intertwined with several industries, particularly the circulation industry, demonstrating a robust capacity to propel the industry forward, supporting evidence from previous observations [35]. Real estate investment has attracted substantial capital, injecting vibrancy into the market and generating a notable circular correlation effect on the circulation industry from both supply and demand perspectives.

Thus, real estate investment and industrial structure upgrading proved to be the key role channels for higher land prices to promote the development of the circulation industry. Hypothesis 2 and Hypothesis 3 are proved. The mechanism test offers concrete and actionable recommendations for policymakers. By reasonably regulating land prices, the government can foster healthy growth in real estate investment and promote the optimization and upgrading of industrial structures, thereby effectively driving the prosperity of the circulation industry and high-quality economic development.

4.5. Moderating effects tests

4.5.1. Moderating effect

Moderating effects refer to changes in the extent to which the cause affects the outcome by other factors, such as individual characteristics or environmental conditions. In statistical and empirical research, the moderating effect usually refers to how the moderating variable affects the direction and intensity of the relationship between the independent and dependent variables. This paper chooses the Internet as a moderating variable because the Internet is profoundly changing the circulation industry’s operation

Table 7
Mechanism test results.

Variables	(1)	(2)	(3)
	<i>Cir</i>	<i>Ind</i>	<i>Invest</i>
<i>Pcl</i>	0.032*** (16.668)	0.007*** (2.600)	2.742*** (9.070)
<i>Pgdp</i>	0.000 (0.528)	0.000 (0.476)	0.001 (0.151)
<i>Pop</i>	0.061*** (7.095)	−0.019 (−1.525)	17.028*** (12.485)
<i>Tec</i>	0.026*** (6.619)	0.038*** (6.645)	2.882*** (4.619)
<i>Innov</i>	0.002* (1.861)	−0.002 (−1.322)	0.033 (0.167)
<i>Gov</i>	−0.003 (−1.584)	−0.017*** (−5.234)	1.033*** (3.013)
<i>Open</i>	−0.002*** (−2.856)	0.002 (1.555)	0.274** (2.274)
Constant	0.023 (1.534)	0.341*** (15.449)	−22.058*** (−9.239)
City fixed	YES	YES	YES
Year fixed	YES	YES	YES
Observation	1976	1976	1976
R ²	0.656	0.712	0.476

mode and market environment. The Internet can improve transaction efficiency and expand market boundaries, thus significantly moderating the relationship between land prices and the development of the circulation industry. In addition, differences in the level of Internet development also affect the sensitivity and response of the circulation industry to changes in land prices, so choosing the Internet as a moderating variable can reveal the complex impact of land prices on circulation industry development more comprehensively. In this paper, the moderating effect profoundly reveals the dynamics and complexity of the impact of land prices on the development of the circulation industry. The findings will help to show how the causal relationship in this paper changes with the Internet's development, further strengthen the conclusions of the previous paper, and provide a reference for the government to formulate relevant policies as well as for enterprises to make strategic decisions to adapt to the Internet era.

Based on the model (1), we construct a model of moderating effect to further test the moderating effect of Internet development. The specific model is as follows:

$$Cir_{it} = \alpha_0 + \beta_1 Pcl_{it} + \beta_2 Inter_{it} + \beta_3 Pcl_{it} * Inter_{it} + \eta_n Controls_{it} + \lambda_i + \mu_t + \varepsilon_{it} \tag{4}$$

where *Inter* denotes Internet development, *Pcl*Inter* denotes the interaction term between Internet development and land price, and other alphabets and signs are the same as in model (1).

We further conduct an empirical analysis of the model (3). Column (1) of Table 8 shows that the coefficient of *Pcl*Inter* is 0.021, which is significant at the 1 per cent level. The result suggests that Internet development has a positive moderating effect on the promotion that high land prices stimulate the development of the circulation industry, similar to previous research [53]. Specifically, a higher level of Internet development leads to a more pronounced promotion between land prices and the circulation industry development. As land prices escalate, circulation enterprises encounter heightened cost pressures. In response, the enterprises continuously innovate in technology and scenarios to drive the sustainable progression of the circulation industry. With the Internet's resource aggregation and innovation effect, circulation enterprises actively expand channels and broaden the sales scene, driving traditional circulation enterprises' digital transformation, thereby enhancing the integration of modern information technology in the circulation industry [57]. Traditional business processes have undergone comprehensive deconstruction and reconstruction, achieving process reengineering and model innovation. As a result, new operational modes are consistently emerging, leading to upgrading the circulation industry and accelerating brand innovation, thereby improving the advancement of the circulation industry. Thus, Hypothesis 4A is proved. Internet development plays a positive moderating role between land price and circulation industry development. The findings enrich the theoretical research on land economics, circulation economy and Internet economy, revealing that the innovation effect of the Internet enhances the positive effect of land price on circulation industry development. The study results provide empirical support for policymakers to optimize the allocation of land resources by using the Internet and for circulation enterprises to realize digital transformation by relying on the Internet.

4.5.2. Threshold effect

The findings from the previous moderating effect suggest that Internet development can effectively regulate the promotion effect of land price on the development of the circulation industry. However, will different levels of Internet development produce large differences in the moderating effect, and then lead to a nonlinear characteristic that the impact of land price on the development of the circulation industry? The threshold model can effectively capture the nonlinear relationship between variables, determine thresholds

Table 8
Moderating effect and threshold effect results.

Variables	(1)	(2)
	<i>Cir</i>	<i>Cir</i>
<i>Pcl</i>	0.032*** (16.77)	
<i>Pcl</i> ₁		0.005* (1.907)
<i>Pcl</i> ₂		0.030*** (16.565)
<i>Pcl</i> ₃		0.065*** (24.715)
<i>Pcl</i> ₄		0.044*** (20.540)
<i>Inter</i>	0.020*** (4.08)	
<i>Inter*Pcl</i>	0.021*** (4.16)	
Constant	0.032** (2.17)	0.012 (0.993)
Controls	YES	YES
City fixed	YES	YES
Year fixed	YES	YES
Observation	1976	1976
R ²	0.668	0.709

through automated data identification, and classify variables into different intervals to analyze the influence mechanism within each interval in detail. The model can reduce the subjectivity of artificially set thresholds and enhance the scientificity and accuracy of the study. Therefore, we apply the panel threshold model proposed by Hansen (1999) to identify the threshold value using automated data identification, categorizing the Internet development level into distinct intervals. Subsequently, we conduct a detailed analysis of the nonlinear relationship between land prices and the level of circulation industry development. The threshold effect model is as follows:

$$Cir_{it} = \rho_0 + \rho_1 Pcl_{it} * I(Inter_{it} \leq \tau) + \rho_2 Pcl_{it} * I(Inter_{it} > \tau) + \eta_n Controls_{it} + \lambda_i + \mu_t + \epsilon_{it} \tag{5}$$

where *Inter* is the threshold variable, τ is the threshold value to be estimated, and $I(-)$ is the indicator function, which takes the value of 1 when the condition is satisfied, otherwise takes the value of 0. Other alphabets and signs are the same as model (1).

Analyzing the panel threshold regression method, we delve deeper into the relationship between land prices and the circulation industry’s development across varying Internet development levels. Initially, we conducted the panel threshold effect test with a 95 % confidence interval and repeated the overlapping simulation likelihood ratio test statistic 300 times. The results in Table 9 reveal that in the single-threshold, double-threshold, and triple-threshold models, the F-statistics are all statistically significant at the 1 % level. The level of Internet development successfully withstands the single-threshold, double-threshold, and triple-threshold tests. Consequently, this study identifies three threshold values for Internet development levels, namely 0.3410, 0.5851, and 0.6432.

We extend the analysis of the panel threshold effect, presenting the results in column (2) of Table 8 above. The findings indicate that when the level of Internet development is below 0.3410, the coefficient is 0.005. Within the range of 0.3410–0.5851, the coefficient increases to 0.030. In the interval of 0.5851–0.6432, the coefficient further rises to 0.065. Once the level of Internet development surpasses 0.6432, the coefficient decreases to 0.044. The results show that the regression coefficients are consistently positive but with an “inverted u-shaped” trend. The trend suggests that excessively high or low levels of Internet development hinder the full realization of land prices’ role in promoting circulation industry development, emphasizing an optimal range. Only beyond a specific threshold in Internet development can the promotion effect of higher land prices on circulation industry development be fully maximized. Thus, Hypothesis 4B is proved.

This study further investigates the reasons for a triple threshold in the level of Internet development. When the level of Internet development is low, the weak infrastructure and immature technology limit circulation enterprises, and it is not easy to effectively use the Internet to promote the optimization and innovation of business processes. With the progression of Internet development, circulation enterprises gain deeper access to online resources, facilitating model innovation, scene expansion, and the integration of online and offline resources. Enterprises continue to drive digital transformation, foster innovation, and propel the rapid advancement of the circulation industry. However, further challenges have arisen as Internet development attains a certain level. The rapid growth of the Internet has led to many investors investing in digital economy assets, bringing about a technology bubble [88]. The tech bubble hurt the financial and general industries, limiting circulation growth [89]. Consequently, the efficacy of increasing land prices in stimulating circulation industry development needs to improve.

The Internet significantly and positively moderates the promotional effect of land prices on the circulation industry’s growth, thereby enriching theoretical research in land economics, circulation economics, and Internet economics. Our findings demonstrate how the Internet enhances the positive impact of land prices on the circulation industry. Importantly, we identify a threshold effect in this promotion, contingent upon the level of Internet development, suggesting that land prices can maximize their promotional effects only when Internet development is within a reasonable range. The discovery offers crucial insights for policymakers to formulate targeted land and development policies and for enterprises to optimize resource allocation by leveraging the Internet.

4.6. Heterogeneity analysis

Heterogeneity analysis is a pivotal methodology to delve into the nuanced and differentiated impacts of land price fluctuations on the circulation industry across diverse contextual settings. This analytical approach provides a robust scientific foundation for formulating targeted policies and regulating markets. Accordingly, this paper examines heterogeneity from two distinct dimensions: city size and city region. The analysis enables a more comprehensive assessment of how land prices interact with and influence the circulation industry within varying urban contexts, informing more effective policy interventions.

4.6.1. City scale heterogeneity

Both land prices and the development of the circulation sector are affected by the size of the city. Different city scales are associated with different levels of development and population size, resulting in significant disparities in land prices across cities. Moreover, city scale impacts the circulation industry, leading to heterogeneous effects of land prices on industry development. Therefore, we further explore the impact of land prices on circulation industry development across different city sizes based on the State Council’s Circular

Table 9
Panel threshold effect test results.

Number of thresholds	F-value	P-value	Threshold value	95 % Confidence interval
Single-threshold	322.60	0.0000	0.3410	[0.3333,0.3486]
Double-threshold	161.77	0.0000	0.5851	[0.5552,0.6059]
Triple-threshold	67.71	0.0400	0.6432	[0.6059,0.6796]

on Adjusting the Standard for City Scale and the city categorization [90]. Specifically, we classify first- and second-tier cities as part of the large-scale cities group, while others fall under the small and medium-sized cities group. Our analysis focuses on exploring the heterogeneity of city sizes, with detailed results presented in columns (1)–(2) of Table 10.

The results indicate significant city-size heterogeneity in how land prices impact the development of the circulation industry. The estimated coefficients on land prices at the 1 % significance level for both large-scale and small cities suggest that higher land prices foster circulation industry growth across cities of varying sizes. The finding aligns with the core conclusion of our study and reinforces the robustness of our previous regression findings. Specifically, the regression coefficient is 0.021 for the large-scale cities group and 0.057 for the small and medium-sized cities group, highlighting a more pronounced effect of increasing land prices on circulation industry development in the latter. Small and medium-sized cities typically possess abundant land resources during economic development, easing the pressure on circulation enterprises despite rising land prices. Enterprises in small and medium-sized cities can readily adjust business strategies and optimize resource allocation to adapt to market shifts, facilitating rapid industry growth [91]. In contrast, large cities face constraints due to limited land resources, with industries often gravitating towards high-value-added sectors like finance and high-tech [92]. Consequently, large cities’ circulation industry encounters greater innovation and development challenges.

4.6.2. City region heterogeneity

The geographical location of a city region plays a significant role in influencing land prices and the development of the circulation industry. Disparities in cities’ geography lead to varying policy preferences and resource allocation levels, consequently impacting land prices and circulation industry growth. Variances arise in the industries prioritized by cities across different regions, and in governmental policies and financial support directed toward circulation industry development. Hence, regional heterogeneity in the effect of land prices on circulation industry development is likely. We segmented cities into eastern, central, and western regions to capture the regional disparities based on their geographic placement within provincial administrative regions. The results are shown in columns (3)–(5) of Table 10.

As can be seen from the results, the regression coefficients of land price on the development of the circulation industry in the eastern, central, and western regions are all significantly positive at the 1 % significance level, but the size of the coefficients varies. The estimated coefficient for the central region is 0.050, and the estimated coefficients for both the eastern and western regions are 0.025, which suggests that the promotion of land prices for circulation industry development is significant in all three regions. However, the effect is greatest in the central region. The discrepancy may stem from proactive guidance and support from local governments in the central region to promote regional innovation efficiency and foster circulation industry development [93]. For example, Hunan Province spearheaded innovative initiatives in circulation industry development, aiming to establish a leading New Consumption development highland. In pursuit of the goal, the province, cities, and districts have introduced tailored policies to drive New Consumption development, such as the “Hunan Province Modern Circulation System Construction Program (2022–2025)” and the “Changsha City 14th Five-Year Plan for the Development of Commerce and Trade Circulation” issued in 2023 by Changsha City, as well as the “Three-Year Action Plan for the High-Quality Development of New Consumption in Tianxin District” released in 2023 by Tianxin District.

Table 10
Heterogeneity test results.

Variables	(1)	(2)	(3)	(4)	(5)
	City scale heterogeneity		City region heterogeneity		
	Large-scale cities	Small and medium-sized cities	Eastern Region	Central Region	Western Region
	<i>Cir</i>	<i>Cir</i>	<i>Cir</i>	<i>Cir</i>	<i>Cir</i>
<i>Pcl</i>	0.021*** (9.431)	0.057*** (16.897)	0.025*** (10.440)	0.050*** (8.079)	0.025*** (3.417)
<i>Pgdp</i>	0.001** (2.310)	0.000 (0.038)	0.002*** (5.024)	0.002*** (6.111)	−0.000 (−0.339)
<i>Pop</i>	0.054*** (4.648)	0.047*** (3.978)	0.052*** (4.124)	0.012 (0.899)	0.141*** (7.058)
<i>Tec</i>	0.034*** (5.985)	0.004 (0.663)	0.043*** (6.607)	0.001 (0.230)	−0.008 (−0.564)
<i>Innov</i>	0.002 (1.338)	0.004** (2.268)	0.007*** (3.297)	0.001 (0.485)	−0.009*** (−2.694)
<i>Gov</i>	−0.006* (−1.963)	−0.005 (−1.528)	−0.006 (−1.516)	−0.003 (−1.212)	0.006 (1.146)
<i>Open</i>	−0.001 (−0.977)	−0.003*** (−2.772)	−0.001 (−0.929)	0.002 (0.706)	0.002 (0.937)
Constant	0.016 (0.804)	0.093*** (4.337)	−0.046* (−1.797)	0.122*** (8.820)	0.110** (2.290)
City fixed	YES	YES	YES	YES	YES
Year fixed	YES	YES	YES	YES	YES
Observation	874	1102	988	684	304
R ²	0.610	0.725	0.708	0.663	0.723

The study discovered that land prices have varying degrees of impact on the circulation industry, depending on city size and region. Notably, the promotion effect is more significant in small and medium-sized cities and the central regions. This finding enriches our understanding of land and circulation economics by highlighting the crucial role of city size and regional differences in influencing industry development. Moreover, the results provide practical guidance for policymakers to promote the balanced and efficient growth of the circulation industry.

5. Conclusions and policy implications

5.1. Conclusions

Utilizing city-level panel data spanning from 2003 to 2021, this study examines the impact effects and mechanisms between land price and the development of the circulation industry while investigating the moderating role of Internet development in the dynamic mechanism. The main conclusions of this study are as follows:

First, the study examines the impact of land prices on the development of the circulation industry. The findings find that elevated land prices significantly stimulate the growth of the circulation industry, leading to an expansion in industry scale, optimization of industry structure, and enhancement of industry facilities. The findings remain robust even after addressing endogeneity concerns and conducting various robustness tests. The impact of high land prices on the development of circulation is more pronounced in small and medium-sized cities group as well as central region cities group.

Second, the paper explores the path of land prices on the circulation industry development. The results reveal that real estate investment plays an industry-driven effect, while industrial structure upgrading contributes to resource allocation and technology spillover effects. The two channels are the key mechanisms through which high land prices promote the development of the circulation industry.

Finally, we examine the moderating and threshold effects of Internet development. Internet development has a positive moderating effect on the promotion that high land prices stimulate the development of the circulation industry. Notably, only when Internet development surpasses a certain threshold that the promotional effect of land prices on the circulation industry's development be fully realized.

5.2. Policy implications

Based on the above conclusions, the following recommendations are put forward:

First and foremost, it is necessary to deepen the reform of the marketization of land elements, which can optimize the space for the development of the circulation industry. The government should accelerate the market-oriented reform of land elements and strengthen the management of land use efficiency. It is necessary to establish a sound land market information disclosure system. By leveraging advanced technologies such as big data and cloud computing, real-time updates and sharing of land transaction information can significantly improve market transparency. Adopting various land supply models, including flexible term grants and lease-grant combinations, is crucial to address the evolving needs of the circulation industry throughout different development stages. In conjunction with urban development planning and the layout of the circulation industry, the authorities should scientifically prepare land-use planning to clarify the scale and spatial layout of land for the circulation industry. On the premise of guaranteeing food security and ecological security, the proportion of land used for the circulation industry should be increased appropriately to reserve space for the development of the circulation industry. A comprehensive land use performance evaluation system should be established to regularly assess and enhance land use efficiency for the circulation industry. Additionally, setting appropriate benchmark land and transfer prices will guide the industry towards higher efficiency through pricing strategies. Furthermore, fostering integration between the circulation industry and other sectors can create synergistic effects, promoting overall industrial advancement.

Secondly, policymakers must conduct precise industrial policy support to stimulate the circulation industry's innovative vitality. Government departments should comprehensively evaluate the existing real estate resources to identify properties suitable for developing the circulation industry. By renovating or re-planning the properties, some can be transformed into exhibition and trading centers required by the industry. Encouraging real estate and circulation enterprises to establish long-term cooperation mechanisms for resource sharing and complementary advantages is essential. Utilizing existing real estate resources, the government should plan multifunctional circulation industry parks to attract upstream and downstream enterprises, fostering industrial agglomeration effects. Differentiated fiscal and tax incentives should be formulated to address the varying stages and needs of the circulation industry. Active guidance and support are necessary for traditional industries to achieve transformation and upgrading through technological advancements and model innovation. Additionally, increased support for emerging industries, particularly e-commerce, intelligent logistics, and big data services, is crucial as they are closely related to the circulation sector. Combining policy guidance with market development will facilitate the rapid growth of these emerging industries. The circulation industry must integrate with the real economy, such as the manufacturing sector, to enhance competitiveness and added value by providing specialized and personalized service support.

Lastly, this study recommends accelerating the digital transformation and upgrading the modernization level of the circulation industry. The government shall strengthen the construction of digital infrastructure for the circulation industry, including cloud computing centers and big data platforms. Advanced technologies like blockchain should be encouraged to ensure full traceability of commodities from production to consumption, thereby improving informationization within the industry. Furthermore, the widespread adoption of Internet of Things (IoT) technology can enhance intelligence in warehousing and logistics. It is imperative to

actively explore new business models such as new retail, instant retail and social e-commerce. By integrating online and offline channels, circulation enterprises can create an omnichannel retail system that meets diverse consumer needs. Strong government support for developing digital circulation platforms, including e-commerce and instant retail, will improve circulation efficiency. Utilizing social media platforms for e-commerce allows circulation enterprises to leverage private domain traffic and social networks for precise marketing and effective word-of-mouth communication. Continuous optimization of supply chain management practices and a robust data governance system are necessary to facilitate the seamless sharing of data resources. Circulation enterprises should actively engage in data cooperation and exchange, enabling more accurate and intelligent market analysis and trend predictions through in-depth data value exploration.

This study still has some limitations, which can be solved in future research. Firstly, while the study has examined how land prices impact Internet development, we have yet to explore the spatial correlation and spillover effect of land prices on the circulation industry. It would be beneficial to investigate how changes in land prices in one area affect the development of the circulation industry in neighbouring areas, which could provide insights into the inter-regional transmission mechanism of land price changes in the circulation industry and inform the development of cross-regional cooperation policies. Secondly, we will adopt a multidimensional approach to explore various facets shaping the relationship between land prices and the circulation industry. Additionally, the impact of land prices on the circulation industry is influenced by various factors, including the policy environment, economic cycles, and demographic structures. This study primarily focuses on the role of Internet development in the mechanism. Future research should consider and analyze other factors comprehensively to reveal a more nuanced understanding of the relationship between land prices and the development of the circulation industry.

CRediT authorship contribution statement

Yuanyuan Yin: Writing – original draft, Methodology, Conceptualization. **Zhang Liu:** Writing – original draft, Software, Methodology, Data curation. **Chen Gao:** Writing – review & editing, Validation, Methodology.

6. Note

Sorted by alphabetical order, the 104 cities include Anyang, Anshan, Bengbu, Baotou, Baoding, Beihai, Beijing, Benxi, Changzhou, Chengdu, Dalian, Daqing, Datong, Dandong, Dongguan, Foshan, Fuzhou, Fushun, Fuxin, Guangzhou, Guiyang, Harbin, Haikou, Handan, Hangzhou, Hefei, Hegang, Hengyang, Hohhot, Huzhou, HuaiBei, Huainan, Huangshi, Jixi, Jilin, Jinan, Jining, Jiamusi, Jiaying, Jiaozuo, Jinzhou, Jingzhou, Jiujiang, Kaifeng, Kunming, Lanzhou, Langfang, Liaoyang, Linyi, Liuzhou, Luoyang, Mudanjiang, Nanchang, Jiamusi, Jiaying, Jiaozuo, Jinzhou, Jingzhou, Jiujiang, Kaifeng, Kunming, Lanzhou, Langfang, Liaoyang, Linyi, Liuzhou, Luoyang, Mudanjiang, Nanchang, Nanchong, Nanjing, Nanning, Nantong, Ningbo, Pingdingshan, Qiqihar, Qinhuangdao, Qingdao, Quanzhou, Xiamen, Shantou, Shanghai, Shenzhen, Shenyang, Shijiazhuang, Suzhou, Taiyuan, Tai'an, Tangshan, Tianjin, Weifang, Wenzhou, Urumqi, Wuxi, Wuhu, Wuhan, Xi'an, Xining, Xiangtan, Xiangyang, Xinxiang, Xuzhou, Yantai, Yangzhou, Yichun, Yibin, Yichang, Yinchuan, Yueyang, Zaozhuang, Zhanjiang, Zhangjiakou, Changchun, Changsha, Zhengzhou, Zhongshan, Chongqing, Zhuhai, Zhuzhou, Zibo.

Data availability statement

Data will be made available on request.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

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