Journal of Combinatorial Mathematics
and Combinatorial Computing
www.combinatorialpress.com/jcmcc

A Study of Regional Real Estate Market Differences and Convergence under Panel Data Modeling

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ABSTRACT

This paper examines the differences and convergence of regional real estate markets based on panel statistics of 28 provinces, autonomous regions and municipalities directly under the central government in China from 2010 to 2023. Relevant variables such as urban construction land area, population and economic growth are set and the data are processed. The data show that the degree of industrial convergence and circulation costs have a positive spatial correlation and an upward trend from 2015 to 2021. From the viewpoint of regional real estate market divergence, the proportion of the real estate industry in GDP has remained above 5% since 2015, and this proportion is larger in the eastern region, for example, it was 8.74% in Beijing in 2015, but it has slightly decreased in some provinces and cities. The proportion in central and western provinces and cities has been rising faster year by year. The extreme deviation and standard deviation coefficient of the eastern region are relatively large, with the extreme deviation of the eastern region being 4.35% and the standard deviation coefficient being 1.45529 in 2021, indicating that the internal development is not balanced. From the analysis of convergence, the rate of convergence in the absolute convergence test is 3.66%, and the rate of convergence in the conditional convergence test is 2.89%, with a half-life of about 23.8 years. It indicates that the regional real estate market differences are shrinking, showing a trend of convergence, but the convergence process is relatively slow, which provides an important basis for an in-depth understanding of the characteristics of the regional real estate market.

Keywords: panel statistics, real estate market, differentiation, convergence, standard deviation coefficient

1. Introduction

China's regional real estate market has seen a complex situation, with differences and convergence between regions becoming increasingly prominent [1]. In the process of economic development and

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Received 03 March 2024; Revised 20 April 2024; Accepted 10 November 2024; Published Online 15 April 2025.
DOI: 10.61091/jcmcc127a-470

urbanization, the real estate markets of different regions are affected by particularly many factors, such as the level of economic growth, policy regulation, population movement and so on, which leads to the differences in regional real estate markets. Moreover, with the advancement of economic integration and policy guidance, the real estate market also shows a certain trend of convergence [2-3]. Such differences and convergence have a far-reaching impact on the coordinated development of regional economy, social stability and resource allocation. An in-depth study of the differences and convergence of regional real estate markets is of great significance for understanding the operation law of real estate markets and formulating reasonable policies [4].

With the rapid development of the regional economy, the regional real estate market is also rising rapidly, and many scholars have gathered their attention on the differences and convergence of the regional real estate market. In terms of differences, literature [5] in its study shows that the regional economy has uniqueness, that is, the economic characteristics of all regions are not consistent, in the regional economic development of the ideal region, because of its residents have a high income and reasonable industrial structure. Therefore, the local purchasing power of real estate is very strong, when the local demand for real estate supply exceeds demand, resulting in an increase in housing prices. On the contrary, in the region with unsatisfactory economic development, there is no demand for real estate because of the low income of the residents, and the local housing prices are low. Literature [6] that the scale of real estate development and the quality of development can reflect the state of the region's economic development, economic development of the region, the corresponding real estate development scale is large, comprehensive facilities, and construction quality is ideal. And economically underdeveloped areas, there will be a small scale of real estate development, infrastructure is not comprehensive problem. Literature [7] points out that geographic location is also one of the important reasons for the variability of the real estate market, for example, the coastal areas due to its convenient transportation, rich resources, a high degree of openness, resulting in the price of its property than the inland areas of the property price is higher. Inland areas are not close to the sea, less open and relatively fewer resources, thus leading to a less active real estate market. Literature [8] in its study that different locations in the same city also affect the price of real estate, close to the center of the city. Properties near the city center have higher prices because of convenient transportation and good facilities. On the other hand, properties near the suburbs have lower prices due to their remote location, inconvenient transportation, and incomplete infrastructure. Literature [9] discusses the impact of regional policies on the real estate market, the inconsistency of economic control policies in each region leads to differences in real estate prices, many regions in order to reasonably control the price of property, will be introduced to limit the purchase of some of the policies, such as raising the property tax, and there are many regions in order to improve the economy, stimulate the property market will be introduced to reduce the property tax and other policies. Literature [10] points out that the area of land available for regional construction determines the development of the real estate market, when a region itself is used for construction of less land, it will lead to higher local property prices. On the contrary, when a region's building land is more adequate, its real estate prices will not be affected too much, but if there is too much building land, supply exceeds demand, then property prices will be reduced accordingly.

In terms of convergence, the literature [11] believes that although the real estate market in different regions is not the same, but through certain macroeconomic means can regulate the real estate market in different regions, promote the price of housing prices rose too fast in the region to slow down the rate of increase. Literature [12] that the process of urbanization has an important impact on the development of the real estate market, in the environment of urban development, many rural residents began to concentrate in the city, at this time, whether it is economically developed cities or cities with less than optimal economic development, have increased its housing demand, urban housing prices will rise. Literature [13] in its study will focus on the role of market mechanisms, that the real estate market demand and supply and price adjustment price will promote

the same development trend in different regions.

This paper adopts a panel data model to analyze the real estate market data of 28 provinces, autonomous regions and municipalities directly under the central government in China from 2010 to 2023. The differences and convergence of real estate markets are studied by setting relevant variables, such as urban construction land area, population, and economic growth. Meanwhile, spatial econometric model and convergence analysis model are applied to dig deeper and analyze the data in order to reveal the inner law and development trend of the real estate market.

2. Data sources and research methodology

2.1. Variable Setting, Data Sources and Processing

Using China's inter-provincial panel statistics from 2010-2023, the regional real estate market variables and their main meanings are shown in Table 1, taking into account the availability, completeness and quality of the data. The study area excludes China's Hong Kong, Macao and Taiwan, as well as Hainan Province and Shanghai Municipality, totaling 28 provinces, autonomous regions and municipalities directly under the central government. As the effect of natural geography on the expansion of construction land is not obvious in the short term, it is not considered in this study.

Table 1. Regional real estate market variables and key implications

Variable Settings	Main Meaning
Urban built-up land area (Land)	Including settlements and industrial and mining land, transportation land and water facilities land
Population (POP)	Total population at the end of the year, population growth is the direct driving force for the expansion of land for construction.
Economic Growth(GDP)	Gross regional product, the expansion of construction land is a visualization of economic growth.
Industrial restructuring(STRU)	The proportion of value added of secondary and tertiary industries to that of primary industry, reflecting the quality of economic growth and promoting the formation of three, two and one industrial circles, which in turn drives urban construction
Fixed Asset Investment(INV)	Fixed asset investment is mainly reflected in infrastructure construction and real estate development, and its growth is the demand for incremental land induced in the city
Dummy variable (regional differences P1)	P1=0 in the eastern region, where construction land indexes are scarce and land acquisition costs are high, and the road of economical and intensive development should be taken P1=1 in the central and western regions; a large amount of arable land in the central and western regions has yet to be sorted out and developed, and emphasis should be placed on moderate-scale operation and priority should be given to arranging land for industrial parks
Dummy variable (policy change P2)	P2=0 in 2005-2013 and P2=1 in 2013-2021 in the central region; the State proposed the “Rise of the Central Region” strategy in 2004 to promote the economic development of the central region, which has a positive impact on the expansion of construction land.

2.2. Data sources and processing

Panel data model, regional real estate market, difference and convergence, urban construction land area, population, economic growth, industrial structure adjustment, fixed asset investment, "China Urban Construction Statistical Yearbook", "China Urban Statistical Yearbook", "China Statistical Yearbook", "Statistical Yearbook of all provinces, municipalities and autonomous regions", Beijing construction land area data in 2005 and 2010 are missing, data of one year before and after the observation of missing years, mean value instead of missing value, linear interpolation estimate, Due to official statistical reasons, the data of construction land area in Shanghai are often missing,

eliminated, the GDP data adjust the current year to the actual value with 2010 as the base period, eliminate the impact of price fluctuations, the investment price index for fixed asset investment is revised to the current value with 2010 as the base period, a small number of missing investment price indexes, calculate the investment implied deflator according to the method of estimating the inter-provincial physical capital stock instead, eliminate the influence of heteroskedasticity, and logize the above variables except for the dummy variables [14-15].

2.3. Research methodology

2.3.1. Panel data modeling. Panel Data Model, Regional Real Estate Markets, Difference and Convergence, Realistic Consistency of Observations with Geographic Location, also known as Spatial Dependence, Traditional Regression Methods Assume Spatial Observations to be Uncorrelated or Homogeneous, Ordinary Least Squares Methods Neglecting Spatial Effects are Biased, Spatial Measurement Models, Spatial Lag Models, Spatial Error Models, SEMs, SLMs Reflect the Spillover Effects of Observed Variables in One Region on Neighboring Regions. The SLM reflects the spillover effect of an observed variable in one region on neighboring regions, the spatial dependence of SEM exists in the perturbation error term and focuses on the extent to which error shocks in neighboring regions with respect to the observed variable affect the observed values in the region, and the generalized expression is:

$$\begin{aligned} Y_{it} &= \rho W_1 Y_{it} + \sum_1^J \beta_j X_{it} + \alpha_i + \nu_t + \varepsilon_{it} \\ \varepsilon_{it} &= \lambda W_2 \varepsilon_{it} + \mu_{it}, \mu_{it} \sim N\left(0, \sigma^2 In\right) \end{aligned} \tag{1}$$

where i denotes province and t denotes year. Y represents the real estate explanatory variables, X_i represents the spatially correlated real estate explanatory variables, and β_j represents the parameter vector. W_1, W_2 represents the real estate spatial weights matrix, ρ, λ, respectively, for the spatial lag term $W_1 Y$ and spatial error term $W_2 \varepsilon$ coefficients. ε, μ for the disturbance error term, are subject to normal distribution, α, ν, respectively, real estate individual effects and time effects. If $\rho \neq 0$ and $\lambda = 0$, the model is a spatial lag model, if $\rho = 0$ and $\lambda \neq 0$, the model is a real estate spatial error model [16].

The Lagrange multiplier LM form of LM-Lag, LM-Err and RobustLM-Lag, RobustLM-Err are used to test which model can more reasonably fit the characteristics of the real estate sample datal [17].

2.3.2. Regional Real Estate Market Convergence Analysis Model. The concept of convergence comes from convergence in mathematics. If the level of economic development is taken as a variable, the regional economy is considered to be convergent if, over time, the economic gap between the regions continues to narrow and the economic level of the region can converge to a steady state. There are more models to test the convergence of regional economic development, including α-convergence model, β-convergence model, club-convergence model and coefficient of variation method [18-19]. This paper draws on the classic β convergence model to construct the convergence model of regional real estate market development as follows:

$$\frac{1}{T} \cdot \ln\left(\frac{Y_{i+l}T}{Y_x}\right) = \alpha - \left(\frac{1 - e^{-\beta T}}{T}\right) \cdot \ln Y_x + \varepsilon_{i,t+T+T} \tag{2}$$

where, Y is the level of economic development of sample i in the t period, $\frac{1}{T} \cdot \ln\left(\frac{Y_{i,t+T}}{Y_{it}}\right)$ can indicate the average growth rate of the level of economic development in the T period, α, β are the parameters of the model, and ε is the random error term. β is the rate of convergence of the economic development of the regional real estate market in the period, if $B > 0$, it indicates that the

economic development of the regional real estate market is converging, and vice versa, it shows non-convergence [20].

The above model is suitable for testing the absolute convergence of regional real estate market economic development [21]. Considering the influence of many factors on the economic growth of regional real estate market, based on the above model, the relevant control variables affecting the economic growth of the real estate market are introduced to get the extended model of convergence of the economic development of regional real estate market:

$$\frac{1}{T}\cdot\ln\left(\frac{Y_{i,t+T}}{Y_{it}}\right)=\alpha-\left(\frac{1-e^{-\beta T}}{T}\right)\cdot\ln Y_{it}+X_{i,t+T}\Gamma+\varepsilon_{i,t,t\,T} \tag{3}$$

The model is suitable for testing conditional convergence in the economic development of regional real estate markets, where $X_{i,t+T}$ denotes the set of control variables and Γ is a vector consisting of the corresponding coefficients. In order to reduce endogeneity, this paper sets the interval between each period to 2 years, i.e. $\Gamma=2$.

2.3.3. Smoothness test for panel data. Unit root tests were performed on the variables in the panel data using the LLC test and Fisher-ADF test. The results of the tests showed that all variables rejected the original hypothesis at least at 5% significance level, indicating that none of the panel data contains unit root i.e. there is no spurious regression and the data can be analyzed by direct regression [22].

2.3.4. Spatial correlation test. In order to verify the spatial dependence situation between regional industrial convergence and distribution costs, Moran's I index was used to test the spatial correlation. The calculation of this index is shown in equation (4):

$$\frac{1}{T}\cdot\ln\left(\frac{Y_{i,t+T}}{Y_{it}}\right)=\alpha-\left(\frac{1-e^{-\beta T}}{T}\right)\cdot\ln Y_{it}+X_{i,t+T}\Gamma+\varepsilon_{i,t,t\,T} \tag{4}$$

where Z_i and Z_j denote the observed values of industry convergence and distribution costs, respectively, n is the sample size, S_0 is the scaling constant, and $S_0=\sum_i^n\sum_j^n W_{ij}$ and W_{ij} are the normalized spatial weight matrices [23].

3. Analysis of results under the panel data model

3.1. Spatial correlation test analysis

The Moran's I index of industrial convergence and circulation cost is shown in Fig. 1. Judging from the trend of Moran's I statistic, it is found that the degree of industrial convergence and the cost of circulation have a positive spatial correlation and the spatial correlation is showing an upward trend in the study period. It gradually rises from 0.15 in 2005 to 0.5 in 2021, which also reflects the objective fact that the interaction between regional industrial convergence and circulation cost is strongly dependent.

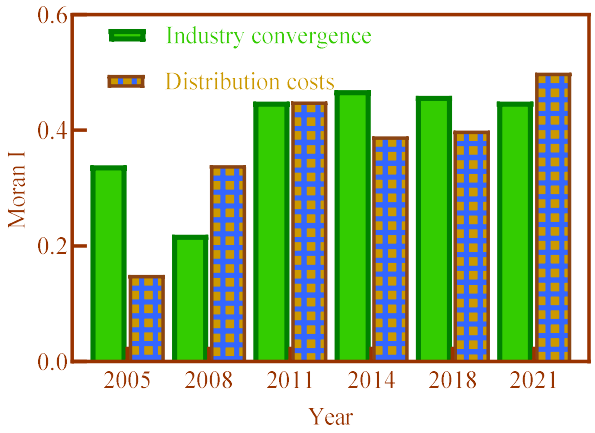

Fig. 1. Moran's I Index of Industry Convergence and Distribution Costs

3.2. Model estimation results

For the ordinary panel data model and the panel spatial data model, the Hasman test and the Lagrange multiplier test revealed that the panel spatial data model focuses more on the nonlinear relationship of the variables, and thus regression analysis is performed separately. Table 2 shows the comparison of the two model fitting effects, the panel spatial data model passes the test at 10%, 5%, and 1% significance levels, and the Adj R^2 is 0.9938, which exceeds the ordinary panel model by 0.6777.

Table 2. Comparison of the fitting effects of the two models

Variant	Ordinary Panel Data Model	Panel Spatial Data Model
Zone	0.0939**(1.9390)	0.0483***(2.3900)
$Zone^2$	-0.0511***(1.2929)	-0.0629***(2.0087)
Cost	0.0045**(2.3993)	0.0745**(2.7500)
W.Zone	0.0016(2.3330)	0.0030**(2.0029)
W.Cost	0.2989***(2.3929)	0.0384***(1.3822)
Adj R^2	0.6777	0.9938
Log-likelihood	456.490	630.248

Note: *, **, and *** represent that the data passes the test at 10%, 5%, and 1% significance levels, respectively.

3.3. Robustness Tests

The results of the robustness test are shown in Table 3. Accordingly, after regression analysis using different spatial weight matrices, the estimated coefficients of the core variables have the same sign, significant degree and general consistency except for the change in the degree of significance, for example, the final validation results of the economic distance matrix are 666.709 and 534.986, respectively, which indicate that the regression results under different spatial weight matrices have robustness.

Table 3. Robustness test results

Variant	Geographic distance matrix		Economic distance matrix	
	Cost	Zone	Cost	Zone
Zone	0.0263***	(0.0036)	0.0209**	(0.0981)
$Zone^2$	-0.0443*** (2.6992)	-	-0.0637** (1.2209)	-
Cost	-	-0.0559*** (2.4467)	-	-12.4930***

				(4.1098)
W.Zone	0.0745**(2.5433)	0.0028** (2.1144)	0.0335** (2.4560)	0.0028** (2.1345)
W.Cost	-0.0539**(9.4332)	-0.0654** (2.1166)	-0.0226** (9.4310)	-0.0521** (2.1456)
Adj R^2	0.0112*** (1.3822)	0.2699*** (0.7939)	0.0442*** (1.212)	0.2449*** (0.7450)
Log-likelihood	1099.873	970.898	666.709	534.986

3.4. Regional Real Estate Market Differentiation Analysis

3.4.1. GDP share. Since 2014, real estate policies have continued to change, greatly improving the ability of real estate developers to finance, but also side to strengthen the supply of the real estate industry, which in turn affects all aspects of the real estate industry. At the same time, a series of preferential policies for home purchases, such as vigorously reducing the sales tax and the mortgage interest rate for the first suite, have compressed the cost of home purchases for home buyers and stimulated consumer investment demand. Since 2009, China's real estate industry has seen a substantial increase in sales area, an increase in the scale of commercial housing sales, real estate prices, real estate inventory and other issues have gradually come to the fore. Thus, this paper focuses on analyzing the changes in China's real estate industry since 2015.

The proportion of value added of the real estate industry to GDP is shown in Table 4, since 2015, the proportion of the real estate industry to GDP has had some ups and downs, but the overall level of 5%, and according to the current statistical caliber, the construction industry related to the real estate industry is calculated into the scope of the secondary industry. This level may be an underestimation of the role of the real estate industry in driving the economy, further indicating that the real estate industry is not only the main vehicle to meet the housing needs of the general public, but also an important pillar industry in China.

Table 4. Value added of real estate sector as a share of GDP (in %)

Year	2015	2016	2017	2018	2019	2020	2021
Proportion	6.70	5.78	5.84	5.80	6.06	5.92	6.07

Note: Data from China Real Estate Statistical Yearbook 2015-2021, China Statistical Yearbook 2015-2021, and Zhongjing.com; due to the relatively serious data missing for individual indicators in Tibet, Tibet is excluded from this section and subsequent modeling.

3.4.2. Performance Analysis of Regional Real Estate Market Development Differences. Table 5 shows the added value of real estate industry in the east from 2015 to 2021. In 2021, for example, Guangdong Province and Beijing City have the highest, 7.03% and 6.25%, respectively, and Tianjin has the lowest, 3.74%, in addition, Beijing was 8.74% in 2015, indicating that due to the different economic development of each region, the value added of the real estate industry as a proportion of GDP is both high and low.

Table 5. Eastern 2015-2021 Real Estate Sector Value Added (%)

Province	2015	2016	2017	2018	2019	2020	2021
Beijing	8.74	7.13	6.61	6.96	6.76	6.23	6.25
Tianjin	4.10	4.09	3.64	3.49	3.60	3.50	3.74
Hebei	3.55	3.42	3.74	3.70	3.66	3.81	4.41
Liaoning	3.98	3.97	3.94	4.23	4.17	4.00	4.08
Jiangsu	5.88	6.28	5.60	5.54	5.75	5.48	5.36
Zhejiang	5.73	5.84	5.19	5.56	5.80	5.39	5.48
Fujian	5.37	4.61	5.19	5.28	5.56	4.53	4.15

Shandong	3.92	4.14	4.05	3.97	4.05	4.25	4.12
Guangdong	6.26	6.12	6.24	6.39	6.73	6.62	7.03

Table 6 shows the value added of the real estate industry in central China from 2015 to 2021, with Shanxi Province gradually increasing from 2.36% in 2015 to 5.01% in 2021. It shows that the value added of the real estate industry directly affects the proportion of GDP due to regional policy and other differences.

Table 6. Middle Value Added of Real Estate Sector (%), 2015-2021

Province	2015	2016	2017	2018	2019	2020	2021
Shanxi	2.36	2.09	2.00	2.49	2.60	4.69	5.01
Jilin	2.75	2.45	2.26	2.02	2.04	3.14	3.10
Heilongjiang	3.51	3.58	3.70	3.81	3.83	3.87	3.96
Anhui	4.95	4.31	4.15	3.87	3. 97	3.87	3.95
Jiangxi	4.00	3.60	3.44	3.26	3.47	3.33	3.28
Henan	3.20	3.35	3.66	3.52	3.62	4.41	4.48
Hubei	4.21	3.53	3.23	3. 11	3.22	3.88	3.85
Hunan	3.06	2.89	2.63	2.57	2.68	2.49	2.60

Table 7 shows the value added of the real estate industry in the west from 2015 to 2021, the western region, compared with the central and eastern regions, accounted for a relatively low percentage, In 2021 the highest district is Chongqing, 5.39%. It shows that due to geographic factors location and other differences, resulting in significant differences in real estate in various regions.

Table 7. Western 2015-2021 Real Estate Sector Value Added (%)

Province	2015	2016	2017	2018	2019	2020	2021
Inner Mongolia	2.94	2.65	2.68	2.43	2.45	2.49	2.48
Chongqing	3.51	3.36	3.96	5.44	5.70	5.73	5.39
Sichuan	3.87	3.25	2.95	2.95	2.89	3.73	4.17
Guizhou	3.48	3.03	2.81	2.58	2.51	2.38	2.21
Yunnan	3.32	3.09	2.50	2.36	2.22	2.15	2.07
Shanxi	2.94	3.12	3.18	3.11	3.13	3.28	3.86
Gansu	2.99	2.67	2.67	2.59	2.50	3.42	3.61
Guangxi	4.50	4.24	3.97	3.75	3.60	3.78	3.91
Qinghai	2.13	1.88	1.74	1.66	1.61	2.13	2.22
Ningxia	3.51	3.58	3.76	3.74	3.95	4.15	3.33
Xinjiang	2.69	2.64	2.67	2.59	2.75	3.04	3.06

The extreme difference of the proportion of value added of the real estate industry to GDP is shown in Table 8, and the extreme difference in the eastern region is the largest, between 4.35% and 5.19%. The central region is the lowest, between 1.85%-2.59%.

Table 8. Extreme difference in value added of real estate sector as a share of GDP (%)

Area	2015	2016	2017	2018	2019	2020	2021
East	5.19	5.7	4.63	4.85	5.48	4.94	4.35
Central	2.59	2.22	2.15	1.85	1.93	2.2	2.41
West	2.37	2.36	2.23	3.78	4.09	3.6	3.32

The standard deviation coefficient of the value added share of the real estate industry is shown in Table 9, and the standard deviation coefficient of the eastern region in 2021 is 1.45529, indicating uneven internal development.

Table 9. Standard deviation coefficients of value added share of real estate sector

Area	2015	2016	2017	2018	2019	2020	2021
East	1.79158	1.68173	1.41815	1.48799	1.65271	1.50912	1.45529
Central	0.84534	0.7125	0.75932	0.66716	0.68872	0.70591	0.77218
West	0.62977	0.60673	0.68321	1.00585	1.094	1.06391	1.02494

In summary, relative to the eastern region, the central and western regions of the real estate industry added value accounted for a relatively small proportion of GDP, indicating that the real estate industry for the eastern region of the economy to play a larger role, but from the development trend point of view, the eastern region of the traditional economically developed areas, such as Beijing, Shanghai, Tianjin, Jiangsu and other provinces and municipalities, the proportion of this proportion except for the rise in some years, in the whole time interval slightly decreased, while in Shanxi, Chongqing and other central and western provinces and municipalities, this proportion of the year-on-year increase in the faster rate. In the central and western provinces and municipalities such as Shanxi, Chongqing, etc., the proportion has been rising faster year by year. At the same time from the perspective of intra-regional differences, the eastern provinces and municipalities of the real estate industry added value accounted for the proportion of GDP of the extreme and standard deviation coefficients are relatively large, indicating that although the overall level of economic development in the eastern region, but due to the population, the industry focuses on the degree of factors such as the level of real

estate and economic development of the provinces and municipalities within the region is large, resulting in the status quo of the region's development is not balanced.

3.5. Regional Real Estate Market Convergence Analysis

3.5.1. Absolute convergence test. Using equation (1) as a blueprint, the panel data of 28 provinces, municipalities and autonomous regions were substituted and regressed using Eviews software, and the regression results of the absolute convergence test are shown in Table 10. By judging the regression method of the panel data, the unit root test was performed on the variables in the panel data using the LLC test and the Fisher-ADF test. A p-statistic of 0.005 was obtained, which means that the random effects method was rejected, so the fixed effects method was finally chosen for the regression. In terms of the accuracy of the fixed effects model, the adjusted coefficient of fit is 0.8729 and the F value is 142.0048.This shows that the model fit is more accurate.

The regression coefficient of the explanatory variable In Y is -0.0353 and is significant at the 1% level This indicates that the level of regional real estate market development at the beginning of the period has a significant impact on the rate of development of the regional real estate market in the observation period, and the growth of the regional real estate market economy can inhibit the expansion of the disparity in the level of economic development between the regional real estate markets to a certain extent. Answer from the perspective of convergence, that is, the overall economic development of the regional real estate market is in line with the trend of absolute convergence. According to the regression coefficient, the rate of convergence of regional real estate market economic development is 3.66%.

Table 10. Regression results of absolute convergence test

Variant	Coefficient value	p-statistic
In Y	-0.0353***	(0.000)
Convergence rate β	3.66%	/
Adj-R^2	0.8729	/
F-value	142.0048	/
DW value	2.1827	/
Type of regression effect	FE	/

Note: ***, **, * indicate 1%, 5% and 10% significance levels, respectively.

3.5.2. Conditional convergence test. The panel data of 28 provinces, municipalities and autonomous regions are still used for regression through Eviews software, and the regression results of conditional convergence test are shown in Table 11. After the introduction of control variables, the regression coefficient of the explanatory variable In Yit becomes -0.0281 and is significant at the 1% level, passing the 5% significance test. It also shows that the level of economic development of the regional real estate market at the beginning of the period has a significant impact on the rate of economic development of the regional real estate market in the observation period, but the negative inhibitory effect is relatively reduced. From the perspective of convergence, the conditional convergence test yields a convergence rate of 2.89%, which is 0.77% lower than that of the absolute convergence test. Considering the intervention of multiple factors such as consumption, investment, foreign trade, urbanization and government regulation, the differences in China's regional real estate markets are gradually narrowing, showing a trend of convergence. According to existing research, the half-life of this convergence is about 23.8 years. Compared with the results of the overall regional economic convergence test, the real estate market convergence process seems to be slower, with an additional time span of 5 years, highlighting the uniqueness and complexity of the real estate market in regional development.

Table 11. Regression results of conditional convergence test

Variant	Coefficient value	p-statistic
In Y	-0.0281***	(0.000)
X1,.+T	0.2707*	(0.000)
X2,t+T	0.4596**	(0.000)
X3,T	0.0083	(0.164)
X4,+T	-0.0743**	(0.024)
Xs,T	0.0335**	(0.038)
Convergence rate β	2.89%	/
Adj-R^2	0.9246	/
F value	270.1482	/
DW value	2.3412	/
Type of regression effect	FE	/

Note: ***, **, and * denote 1%, 5%, and 10% significance levels, respectively, and FE and SUR denote fixed and random effects, respectively.

4. Conclusion

This paper investigates the panel statistics of 28 provinces, autonomous regions and municipalities directly under the central government in China from 2010 - 2023, establishes a panel data model, a regional real estate market convergence analysis model, as well as conducts a smoothness test and a spatial correlation test for the panel data. The results show that industry convergence and circulation costs have a positive spatial correlation in 2015-2021 and the correlation is increasing, as shown by Moran's I index. The panel spatial data model fits better, with an Adj R^2 of 0.9938 and a Log - likelihood of 630.248. In terms of regional real estate market variability, in 2021, Guangdong Province and Beijing City have the highest proportion of 7.03% and 6.25%, respectively, and Tianjin has the lowest proportion of 3.74%, with a significant difference between provinces. Central and western provinces and cities this proportion is rising faster year by year. The extreme deviation and standard deviation coefficient of the eastern region are relatively large, such as the extreme deviation of the eastern region in 2021 is 4.35%, and the standard deviation coefficient is 1.45529, which indicates that the internal development is not balanced. From the analysis of convergence, the rate of convergence in the absolute convergence test is 3.66%, indicating that the regional real estate market differences are narrowing, showing a trend of convergence, but the convergence process is relatively slow.

Funding

This work was supported by “Three Levels” Talent Construction Project of Zhuhai College of Science and Technology.

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