

The High-Quality Coordination Between Modern Production Capacity And Urbanization Construction: A Case Study of Northeast China

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Abstract. As Chinese traditional industrial base, Northeast Chinese economic growth driver lags behind that of other parts of the country. The secret to revitalization is found in the integrated development of industrialization, informatization, urbanization, and agricultural modernization. This study adopts the improved entropy weight-topsis method and panel Tobit model to analyze the coordination between modern production capacity and urbanization construction in Northeast China from 2013 to 2020. The findings are as follows: (1) Transport facilities, economic growth driver level and technological innovation ability have a significant impact on the coordination of the three northeastern provinces and the overall two systems; (2) Industry composition and government efficiency a notable positive effect on the coordination of the two systems outside Liaoning Province; (3) Labor quality plays a crucial role in the coordination of the two systems outside the overall system. It is suggested to formulate differentiated and contribute to the strategic planning for Northeast China's future regional development strategies, optimize resource allocation, and narrow the development imbalance.

Keywords: Northeast China; Urbanization Construction; Modern Production Capacity; Coupling Coordination Degree; Unbalanced Regional Development.

1. Introduction

Studying the high-quality Coordination between modern production capacity and urbanization construction promotes the progress of the optimization and upgrading of economic structure in Northeast China, realizing the sustainable development of the regional economy. It is crucial for rejuvenating the historical industrial heartland of Northeast China, elevating the well-being of its inhabitants, and bridging the gap in regional development. At present, in academia, Ma Wanli et al. (2024) found that the urbanization construction is positively correlated with the digital economy, and suggested promoting urbanization and regional balanced development through innovative factor allocation and differentiated measures. Wang Xu et al. (2022) pointed out that the degree of coordinated development in Northeast China was low and declining, with spatial agglomeration but weakened autocorrelation. The above literature provides a good research basis for this paper, but there are still some gaps in the research of Northeast China in this field. Therefore, The research is devoted to the development patterns in Northeast China, constructs the evaluation index system of coupling coordination degree from the two dimensions of productivity development and urbanization construction, and uses the improved entropy weight-topsis method and panel Tobit model to explore the influence path of productivity development and urbanization construction on coupling coordination degree [1]. It presents useful perspectives for enhancing the regional economy's quality development.

2. Research design and index data construction

2.1. Construction of a scoring index framework and data source

The evaluation and measurement of productivity development and urbanization construction need to rely on a multi-attribute comprehensive evaluation method. In Table. 1, combining several research directions of literature [2-3], this paper selects 6 second-level indicators and 15 third-level indicators

to analyze the development level of modern production capacity. Simultaneously, according to Chen Jingshuai et al. (2022), it can be used as the index of the urbanization construction index evaluation system from multiple perspectives such as industrial development and environmental governance[4].

The study draws on panel data from Northeast China from 2013 to 2020 as the research samples, with the majority of data coming from the *China Statistical Yearbook* and *China Energy Statistical Yearbook*.

Table 1. Coupling coordination optimization evaluation system of the two systems.

Level 1	Level 2	Level 3	Attributes
Urbanization construction	Macroeconomic level	Proportion of secondary industry(%)	+
		Proportion of tertiary industry (%)	+
	Environmental economic level	Forest coverage rate (%)	+
		Gas popularization rate (%)	+
		Per capital urban park green space area (square meters)	+
	Labor economic level	Urban registered unemployment rate at year-end (%)	-
	Regional economic level	Per capital regional gross domestic product (yuan/person)	+
		Urban population proportion (%)	+
		Disposable income (yuan)	+
		Proportion of college students per 100,000 population	+
Bed count in healthcare institutions(sheets)		+	
Modern production capacity	Productivity of innovation	Regional authorized patents(number)	+
		High-tech industry business income (thousand yuan)	+
	Productivity of technology	Industrial enterprise innovation expenditure (ten thousand yuan)	+
		Total equivalent full-time R&D staff in large industrial companies (hours)	+
	Resource-saving productivity	Energy intensity per GDP (%)	-
		Water expenditure per GDP in industry(%)	-
	Environmentally friendly productivity	Industrial solid waste reduction rate(%)	+
		Industrial wastewater emission Progress domestic product (%)	-
		Industrial so ₂ emission per gross domestic product (%)	-
	Industry digital productivity	Number of broadband internet access lines (ten thousand)	+
		Income from software operation. (ten thousand yuan)	+
		Ratio of optical cable. length to regional area	+
		Electronic commerce sales. (ten thousand yuan)	+
	Digital industry productivity	Total telecommunications business volume (billion yuan)	+

2.2. Research Methods

2.2.1. Standardized data processing

In this study, we first use the extreme value processing method to standardize the indicators to meet the requirement of the entropy weight method for positive values of indicators. This step helps to reduce the protective influence between different data and the impact of dimensional differences on the evaluation results. Specifically, we convert all indicator values into an interval of [0,1] by calculating the Difference between each indicator value and subtracting the minimum value from the maximum value of the indicator, then dividing the indicator's minimum value by this difference and ensuring that their relative positions within the range of the dataset are accurately reflected.

Throughout the evaluative and decisive process, the entropy weight method and topsis are two commonly used methods. Using the entropy weight method, weights are determined based on the entropy values of the indices, which helps to lessen the effect of subjectively assigned weights. However, this method may give a large weight to an index due to its large dispersion degree. To solve

this Problem. This study refers to the research methodology of Du Li et al.(2024), which uses the improved entropy weight-topsis method, based on the basic idea of the analytic hierarchy process (AHP). It obtains the judgment matrix by comparing the difference coefficients of indicators. The entropy value is solved to give weight to the Modern production capacity index, and better evaluation results are obtained [5].

2.2.2. Model of coupling coordination degree

The calculation formula of the coupling coordination degree with productivity development and urbanization construction is as follows:

$$\begin{aligned} A &= \left\{ \frac{F_1 \times F_2}{[(F_1 + F_2)]^2} \right\}^{\frac{1}{2}} \\ B &= \alpha_1 F_1 + \alpha_2 F_2 \\ D &= \sqrt{AB} \end{aligned} \tag{1}$$

Among them, the value of coupling degree A reflects the degree of interdependence and restriction between systems. Coordination index B value: represents the coordination index of productivity development and urbanization construction. α_1 and α_2 are the weights to be determined for the two systems. The D value of coupling coordination degree: combining coupling degree and coordination index, it is used to evaluate coupling coordination degree among systems.

The D value is divided into 10 levels, ranged from every 0.1 as a level, which is divided into profound dissonance, acute dissonance, moderate dissonance, slight dissonance, minimal dissonance, reluctant coordination, fundamental coordination, moderate coordination, superior coordination, ideal coordination, and escalating levels of synchronization.

2.2.3. Panel Tobit model

Because coordination between productivity development and urbanization construction is between 0 and 1, it is a Two-sided restricted situation. When the model contains truncated data, It is more justifiable to apply the panel Tobit model. The characteristic of this model is that the equations contain certain constraints and are continuous variables. In this paper, it is changed into a truncated variable by some processing to meet the conditions of the Tobit model, and the maximum likelihood method (MLE) will be used for parameter estimation in this study [6].

$$\begin{cases} y = \alpha + \beta x + \mu + \varepsilon, y > 0 \\ 0, y \leq 0 \end{cases} \tag{2}$$

Among them, y represents the D value, and x represents the index data of economic growth driver level, technological innovation ability, labor quality, industry composition, government efficiency, and transport facilities, which are intercept terms, model parameters, individual effects and random errors.

3. Analysis on the synergistic effect and development level of of modern production capacity and urbanization construction

3.1. Evaluation of the development levels of productivity and urbanization

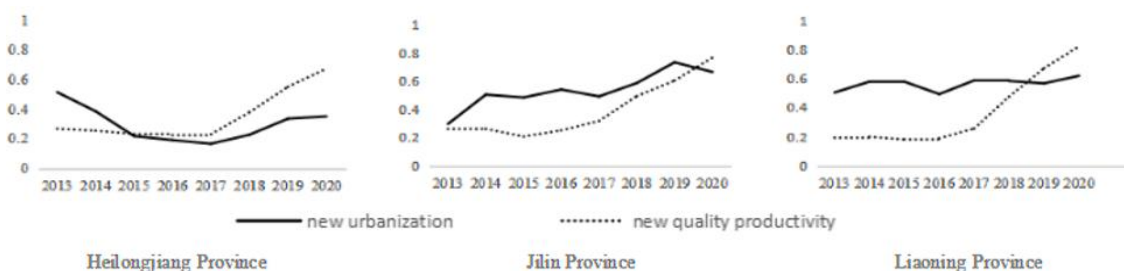


Figure 1. The development levels of productivity and urbanization of three provinces in Northeast China.

In Figure 2, from the perspective of Heilongjiang Province, throughout the duration of the research, it is evident that the urbanization construction first dropped from 0.516 in 2013 to 0.167 in 2017. From the perspective of productivity development, the fluctuation from 2013 to 2017 was small, because it focused on stimulating endogenous power, and the cultivation of new growth areas greatly increased its effect.

From the perspective of Jilin Province, It is indicated that the urbanization construction development index and the modern production capacity development index have small fluctuations but an overall upward trend. The urbanization construction development index ascended from 0.299 in 2013 to 0.668 in 2020. The development index of modern production capacity grew from 0.264 in 2013 to 0.769 in 2020. The development rate of modern production capacity was higher, so we need to pay attention to the development of urbanization construction in the future.

From the perspective of Liaoning Province, it can be seen that during the study period, the urbanization construction development index has a small fluctuation, but the overall trend is a small upward trend, from 0.505 in 2013 to 0.620 in 2020. On the whole, the development rate of the modern production capacity development index after 2017 is much higher than that of the urbanization construction development index, and the change of the urbanization construction development index is relatively gentle.

3.2. Analysis of the coordination between modern production capacity and urbanization construction

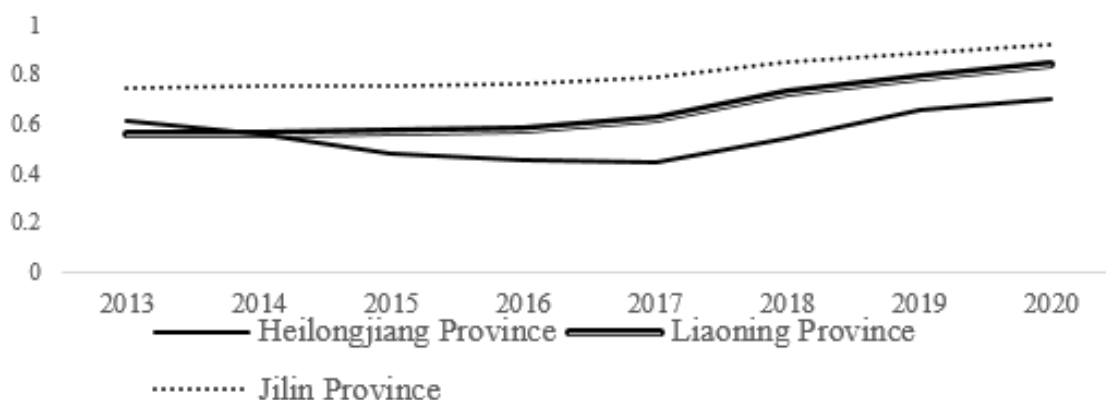


Figure 3. Coordination of modern production capacity.

It is apparent from Figure 2 that the D value of Jilin Province from 2013 to 2020 is the highest, markedly above that of the other two provinces, averaging in the range of moderate coordination to superior coordination, and reaching ideal coordination (0.919) in 2020. Liaoning Province has the fastest growth rate, from 0.556 in 2013 to 0.860 in 2021, with a growth rate of 33.18%. Heilongjiang Province has a promising future. From 2013 to 2017, it experienced three stages of fundamental coordination (0.610), close to minimal dissonance (0.443), and then gradually rising to close to moderate coordination (0.698).

On the whole, the D value of the two systems should pay attention to the influence of the Matthew effect to avoid the amplification of regional development dissonance. At present, Jilin Province's coordination in recent years is much higher than that of the other two provinces and is in a relatively stable rising stage, which embodies the endeavors within the urbanization process, Jilin province also pays attention to rural revitalization, which decreases the urban-rural development gap, fostering a more harmonious growth pattern. Remarkable results have been achieved in the adjustment of industry composition, and the growth of emerging industries and the modernization of traditional ones have reinforced each other's progress, improving the competitiveness of the overall economy. More investment in social undertakings has boosted the life quality of the population and advanced the development of social enterprises coordinated with economic growth drivers. Therefore, the other two provinces should be more effective in implementing the national urbanization construction policy, At the same time, we will determinedly push for the growth of modern service and high-tech

industries in terms of industrial restructuring and optimization and urbanization construction in Northeast China.

4. Analysis of influencing factors

4.1. Setting of influence factors

Aiming to reduce the outcomes of different constraints and propose policy measures for the development of Northeast China, we use the panel Tobit model. After referring to relevant studies and combining them with the actual situation [7-8], We can regard the synergistic effect of modern production capacity and urbanization construction as the dependent variable in the research process, and take economic growth driver level, technological innovation ability, labor quality, industry composition, government efficiency and transport facilities from Table. 2 as independent variables for further analysis.

Table 2. Factors influencing the synergistic effect of modern production capacity and urbanization construction.

Variable name	Variable symbol	Variable description	Unit
Economic growth driver level	Gdp	Gross domestic product/value added(current year price) (100 million yuan)	100 million yuan
Technological innovation ability	Tec	Number of r&d projects in high-tech industries	Item
Labor quality	Lab	Educational fund	Ten thousand yuan
Industry composition	Ind	Gan chun huitel index measures rationalization	%
Government efficiency	Gov	Fiscal expenditure /GDP	%
Transport facilities	Tra	Density of highway	Km/km ²

Since the panel Tobit model with fixed effects cannot be used in the absence of adequate statistics to capture individual heterogeneity, conditional maximum likelihood estimation is utilized, we will adopt the panel Tobit model with random effects and winnow 20% [9], to provide more accurate and unbiased estimation results. We will conduct the panel Tobit model with random effects in Northeast China as a whole and individuals, and the results are shown in Table. 3.

Table 3.Tobit regression results.

Variate	Industry composition	Government efficiency	Transport facilities	Economic growth driver level	Technological innovation ability	Labor quality
The whole	0.6183354 *(1.79)	2.814093 *** (3.35)	0.9539197 *** (3.70)	-0.00003 ** (-2.55)	0.0000286 ** (2.17)	0.0000001 (-0.44)
Heilong-jjiang Province	1.099975 *** (6.31)	5.4906767 ** (-5.15)	10.7306426 *** (34.87)	0.0000397 *** (-24.29)	-0.0000888 ** (17.30)	-0.0000006 *** (3.37)
Liaoning Province	-1.202779 (-1.46)	3.087115 (2.48)	2.203752 ** (7.69)	0.000043 * (4.16)	0.0000257 * (3.72)	0.0000001 ** (5.55)
Jilin Province	4.672461 *** (13.39)	2.378251 *** (7.99)	5.727777 *** (9.93)	-0.0003099 *** (-13.96)	-0.0000004 ** (4.52)	0.0000003 *** (17.92)

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

4.2. Analysis of regression results of influencing factors

On the whole, industry composition, government efficiency, transport facilities, technological innovation level and the D value of the two systems all have a significantly positive correlation, indicating that the coordinated development of municipal economy and basic public services in the

three provinces of Northeast China is realized by the mutual promotion and restriction of intrinsic and extrinsic motivators. Strengthening the government's macro-control, economic pull, social promotion and scientific and technological support can significantly enhance the economic and social development and regional coordination in Northeast China. The level of economic growth driver the synergistic effect and shows a significant negative correlation, indicating that this negative correlation may be that the economic growth driver lever in some cases excessively focuses on GDP growth and ignores the quality and efficiency, and the government may needs to adjust or optimize its development strategy. There exists a markedly positive association between labor quality and the D value of the two systems, which indicates that there may be a situation of low efficiency in the use of education funds in the three eastern provinces.

From the perspective of each province, in terms of technological innovation level, labor quality, transport facilities and economic growth driver level, the impact on the D value of the three northeastern provinces is significant. At the same time, basically, all provinces have a promoting role in the coordination of the two systems. This shows that these factors are important driving forces for the improvement of the D value of the three provinces in Northeast China, and also provides an important reference regarding the establishment and enforcement of area-specific policies. Among them, although Jilin Province has seen improvements in the field of scientific and technological innovation, there is an imbalance between the level of technological innovation and the level of economic growth driver, which may lead to a negative correlation between the two. In terms of industry composition, Liaoning Province shows an insignificant negative correlation with the D value of the two systems, while the other two provinces show a significant positive correlation, which indicates that their regional development strategies are different. Heilongjiang Province and Jilin Province need to adopt a more active industrial restructuring strategy, while Liaoning Province needs to further optimize its regional development strategy. The government efficiency is positively correlated with the D value of the two systems in all regions, but only in Liaoning Province, it is not significant, indicating that this may be related to the unique economic structure of Liaoning Province and the response speed of local governments to policies.

4.3. Robustness test

4.3.1. Substitution variable method

This study employs the technique of alternative variables to test the robustness of the results. Therefore, this paper re-regresses the number of R&D projects in high-tech industries instead of R&D investment [10], with other variables remaining unchanged, and tests the overall regression results of the three eastern provinces. As shown in Table. 4, the direction of the coefficients has not changed, and the size and significance of some regression coefficients have changed slightly.

4.3.2. Endogeneity test

The instrumental variable two-stage least squares (2SLS) method will be used to test the endogeneity in the following. The explanatory variable industry composition lagged one period is selected as the instrumental variable [11]. On the one hand, the level of technological progress in the current period is highly correlated with its lag period and has a strong correlation. On the other hand, the one-period lag of the industry composition is not correlated with the random disturbance term, which satisfies the homogeneity condition. At the same time, the F-statistic test is used to find that in the first-stage regression of 2SLS from Table. 4, the F-statistic is greater than 10, which means that this instrumental variable is strong enough and there is no problem of a weak instrumental variable. The magnitude and significance of partial regression coefficients in the second stage change slightly, but the overall conclusion is consistent with the previous one. So, there is no endogeneity in the model

Table 4. Results of substitution variable method and endogeneity.

Variate	Substitution variable method	Instrumental variable method			
	The whole	The first stage		The second stage	
Industry composition	0.714932** (2.10)			0.9447432*** (3.89)	
Iv		0.8723969 (5.16)			
Government efficiency	2.0574726*** (3.59)	-0.3517214 (-1.07)		2.323897*** (4.49)	
Transport facilities	0.7317739** (2.75)	0.0112777 (0.08)		0.5841037*** (3.17)	
Economic growth driver level	-0.0000515*** (-3.36)	-0.00000196 (-0.38)		-0.00000293 (-0.37)	
Technological innovation ability	0.0000007* (2.56)	0.000000148 (0.02)		0.0000206** (2.08)	
Labor quality	0.00000002 (-0.62)	-0.00000000149 (-0.07)		-0.0000000316 (-0.97)	
Fixed effect		Yes	Yes	Yes	Yes
R ²		0.9444	0.9444	0.8741	0.8741
Sample size		21	21	21	21
F		26.6023	26.6023		

5. Conclusions and decision-making suggestions

From the perspective of development index, the urbanization construction index and modern production capacity index of the three provinces in Northeast China showed a trend of first decreasing and then increasing, and the modern production capacity index gradually exceeded the urbanization construction index. After 2017, both indexes have improved significantly, and the development mode has shifted from urbanization to modern production capacity. Jilin Province's economic expansion outpaces that of the other two provinces, resulting in unbalanced regional development. It is suggested that all provinces should establish an effective monitoring and evaluation mechanism, regularly evaluate the development effects of urbanization construction and modern production capacity, and timely adjust development strategies to advance even development in the entire Northeast region. Especially in Liaoning Province, it is urgent to promote the upgrading of industry composition and find an industrial path suitable for its development to promote economic growth.

From the perspective of coupling coordination degree, by 2020, the three provinces are in a coordinated state, and Liaoning Province has the highest growth rate, transforming from barely coordinated to well-coordinated. The coordination of Jilin Province ascended to the peak of high quality. Heilongjiang Province maintains primary coordination. It is suggested that Liaoning Province should continue to strengthen infrastructure construction, especially digital infrastructure, to support the overall upgrading of the economy. Jilin Province should play its exemplary role and lead the other two provinces to enhance the synergy between the development of urbanization construction and Modern production capacity and narrow the regional development gap. At the same time, relevant policies should be formulated according to the resource endowment and economic foundation of each province, so as to improve the complementarity between the modern production capacity and the urbanization construction in the development and enhance overall effectiveness.

From the perspective of influencing factors, industry composition, government efficiency, transport facilities, economic growth driver level, technological innovation ability, and labor quality have a significant impact on the coordination of the two systems. The industry composition and Government efficiency contribute to enterprise innovation in all except Liaoning Province. The quality of the labor force has a significant influence on each province, but not on the whole. It is suggested that for Liaoning Province, it is necessary to find a suitable industrial path in time and

improve the efficiency of government services and policy implementation, and the other two provinces also need to continue their efforts. Provinces in the Northeast region need to continue to promote technological innovation and personnel training to enhance their overall competitiveness and enhance the quality of the labor force.

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